11.0 Noise and Vibration

11.1 Introduction

This Chapter assesses the likely noise and vibration impact of the proposed redevelopment of The National Maternity Hospital at the St. Vincent's University Hospital Campus, Dublin 4. The assessment has been conducted in the context of current relevant standards and guidance, and identifies any requirements or possibilities for mitigation.

The proposed development comprises the redevelopment of The National Maternity Hospital at St. Vincent's University Hospital campus, Elm Park, Dublin 4. The proposed new National Maternity Hospital building will be located at the eastern side of the hospital campus and comprises the construction of a building that rises to 5 and 6 storeys above ground level, with one partial basement level, plus additional ancillary plant areas at the roof level. The proposed development also includes an extension to the existing multi-storey car park at the north of the campus. The proposed development will be constructed in a sequential manner that allows for the continual operation of the hospital campus and, as such, includes the phased demolition of existing buildings at St. Vincent's University Hospital campus to facilitate clearing the site for the proposed development and the construction of temporary accommodation to facilitate construction sequencing (including a single storey temporary canteen, catering staff changing facilities, household services store and carpenters workshop). The full detail of the nature and extent of the proposed development is set out in Chapter 2 of this EIS and the Draft Construction Management Plan is appended to same.

11.1.1 Fundamentals of Acoustics

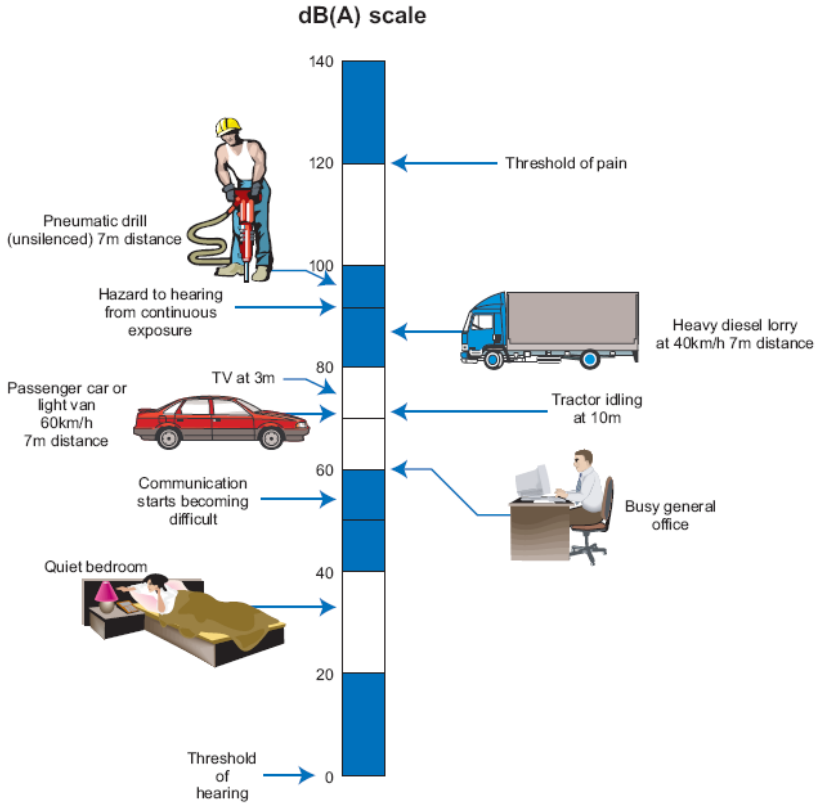
A sound wave travelling through the air is a regular disturbance of the atmospheric pressure. These pressure fluctuations are detected by the human ear, producing the sensation of hearing. In order to take account of the vast range of pressure levels that can be detected by the ear, it is convenient to measure sound in terms of a logarithmic ratio of sound pressures. These values are expressed as Sound Pressure Levels in decibels (dB).

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

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

An indication of the level of some common sounds on the dB(A) scale is presented in Figure 11.1, which shows a quiet bedroom at around 35 dB(A), a nearby noisy Heavy Goods Vehicle at 7m at 90 dB(A) and a pneumatic drill at 7m at about 100 dB(A).

Figure 11.1: The Level of Typical Common Sounds on the Db(A) Scale (NRA)



11.1.2 Fundamentals of Vibration

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 Peak Particle Velocity.

Peak Particle Velocity is defined in *BS 5228+A1 (2014): Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration* as the:

> *'Instantaneous maximum velocity reached by a vibrating element as it oscillates about its rest position.'*

The unit of measurement of Peak Particle Velocity is most commonly millimetres per second, mm/s. However, when dealing with human perception to vibration and the tolerances of sensitive equipment the unit of measurement of micrometers per second, µm/s, may be used. It is also important to take account the frequency at which the vibration occurs, which similar to sound is expressed in Hertz (Hz). Buildings are sensitive to vibration at very low frequencies, i.e. less than 10Hz, and are more resistant to vibration at higher frequencies, i.e. above 50Hz.

It is acknowledged, however, that humans are sensitive to vibration stimuli at much lower magnitudes than those likely to cause damage to buildings. Vibration typically becomes perceptible at around 150 to 300µm/s PPV and may become disturbing or annoying at higher magnitudes. However, 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.

11.2 Methodology

In assessing the noise and vibration impacts the following methodology will be adopted:

- Characterise the receiving environment through a series of baseline surveys;
- Determine appropriate criteria for evaluating the significance of noise and vibration impacts through reference to local guidance documents where applicable and international best practice;
- Calculate the potential noise & vibration impacts using industry standardised calculation methods;
- Assess the impact by comparing the calculated levels against the adopted criteria;
- Where necessary specify ameliorative, remedial or reductive measures to control the impacts to be within the adopted criteria, and;
- Present the predicted impact of the proposed development including the ameliorative, remedial or reductive measures.

11.3 Receiving Environment

The following Sections detail the results of the baseline noise and vibration surveys conducted to determine the receiving environment in the vicinity of the St. Vincent's University Hospital Campus. Note that Appendix 11.1 provides details of all measurement parameters used in this Chapter.

11.3.1 External Survey

11.3.1.1 External Survey Locations

Fourteen external measurement locations were selected; each is described in turn below and shown on Figure 11.2.

NM01 is located on the flat roof of the Dermatology Unit, the survey location is deemed to be representative of noise incident to the eastern façade of the Clinical Services Building

NM02 is located in the rear garden of No. 31 Herbert Avenue the survey location is deemed to be representative of noise level incident to the nearest noise sensitive locations at Herbert Avenue

NM03 is located on the flat roof of the underground tunnel emergency access in the Herbert Wing car park, the survey location is deemed to be representative of noise level incident to the eastern façade of the Herbert Link Building

NM04 is located on the flat roof of the porta-cabin building adjacent the Herbert Link Building, the survey location is deemed to be representative of noise level incident to the eastern façade of the Herbert Link Building

NM05 is located a ground level in the Dermatology Unit car park, the survey location is deemed to be representative of noise level incident to the northern façade of the proposed National Maternity Hospital

NM06 is located on Merrion Road, the survey location is deemed to be representative of noise levels at noise sensitive receptors located on Merrion Road

NM07 is located on the internal access road, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction noise

NM08 is located at the entrance to St Vincent's Private Hospital, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction noise

NM09 is located at the adjacent to the façade of the Hebert Wing, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction traffic

NM10 is located on the site access road adjacent to the south-eastern façade of the Herbert Wing, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction traffic

NM11 is located on the site access road adjacent to the southwestern façade of the Herbert Wing, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction traffic

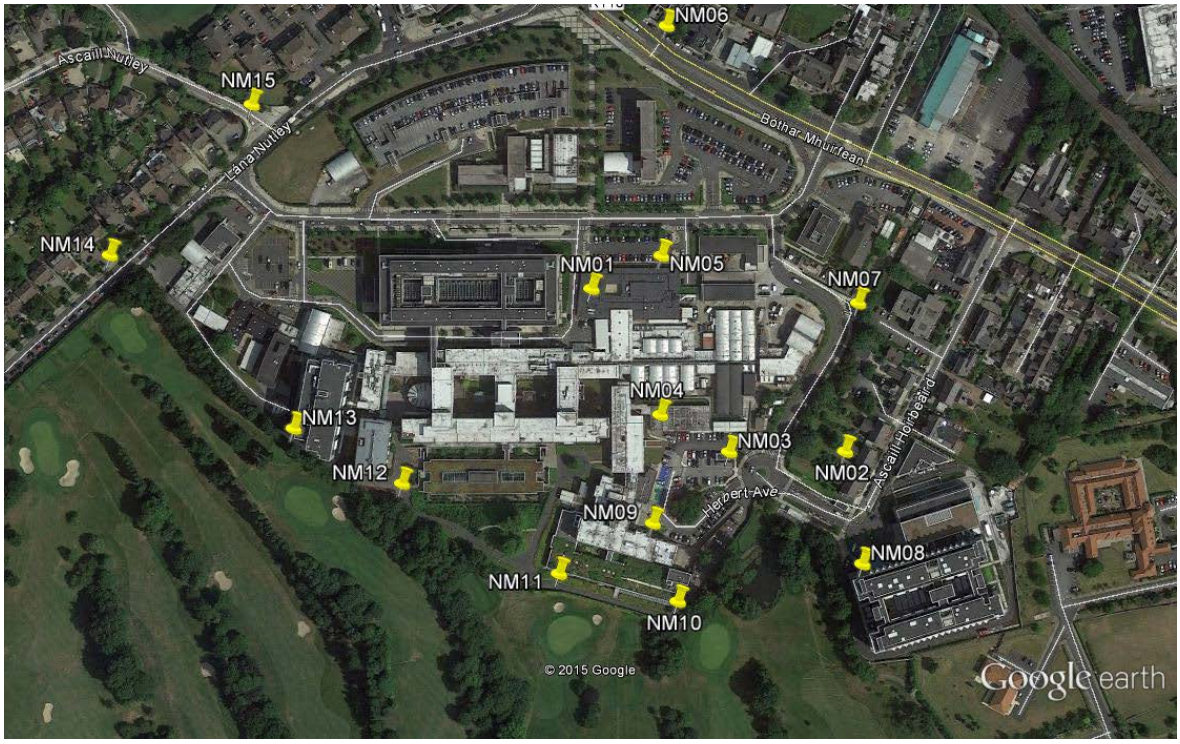
NM12 is located on the site access road adjacent to the Elm Mount Unit, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction traffic

NM13 is located on the site access road adjacent to the Nutley Wing, the survey location is deemed to be representative of noise levels at noise sensitive receptors that may be effected by construction traffic

NM14 is located on Nutley Lane, the survey location is deemed to be representative of noise levels at noise sensitive receptors located on Nutley Lane that may be effected by construction traffic noise

NM15 is located on Nutley Lane, the survey location is deemed to be representative of noise levels at noise sensitive receptors located on Nutley Lane and Nutley Avenue that may be effected by noise from the enabling works

Figure 11.2: External Noise Survey Locations



11.3.1.2 Survey Periods

Attended daytime noise measurements were conducted at Locations NM05 to NM15 between 09:30 and 16:30 on 26th November 2015[1]. Unattended noise measurements were conducted at Locations NM01 to NM04 over the dates indicated in Table 11.1.

[1] *It AWN understanding that no significant changes to onsite activities or operations have occurred since the baseline survey was completed. Similarly, it is noted that an updated traffic survey has demonstrated that baseline traffic volumes on the surrounding road network have decreased marginally since the period when the original baseline noise survey. As such the use of the data compiled as part of this baseline survey is deemed to be relevant for the deriving appropriate noise limits and assessing the potential noise impact of the proposed development.*

Table 11.1: Summary of Unattended Noise Monitoring Periods

Location	Start Date	Finish Date
NM01	12:03 on 25 November 2015	09:00 on 27 November 2015
NM02	13:05 on 4 November 2015	08:55 on 10 November 2015
NM03	11:41 on 25 November 2015	09:30 on 27 November 2015
NM04	09:30 on 23 October 2015	09:15 on 29 October 2015

The daytime measurements represent a typical period that was selected in order to provide a snapshot of the existing noise climate, with the primary purpose being to ensure that the proposed noise criteria associated with the development are commensurate with the prevailing environment. The night-time period provides a measure of the lowest existing background noise levels.

The weather during the attended survey periods was dry and bright with a breeze with winds between 2 and 3m/s.

The weather during the unattended survey periods was mixed with some periods of rain and heavy wind, the majority of survey periods were dry with wind speeds less than 5m/s.

11.3.1.3 Personnel & Instrumentation

Ronan Murphy (AWN) conducted the measurements and installed the unattended noise meters.

Noise measurements were conducted using Brüel & Kjær Type 2250 Precision Sound Level Analysers. The measurement apparatus was check calibrated both before and after each survey using a Brüel & Kjær Type 4231 Sound Level Meter Calibrator.

11.3.1.4 Results & Discussion

The survey results are summarised in Table 11.2.

Table 11.2: Summary of Noise Measurements

Location	Time	Measured Noise Levels (dB re. 2x10-5 Pa)					Comments
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}	
NM01	Average Day	56	85	47	56	51	Onsite road traffic dominant intermittent noise source, road traffic noise from Merrion Road also influencing noise levels. Background influenced by rooftop plant and distant road traffic. Wind borne noise also present intermittently.
	Average Evening	53	75	45	54	49	
	Average Night	50	81	43	51	45	
NM02	Average Day	54	82	41	54	49	Onsite road traffic dominant intermittent noise source. Background influenced by wind borne noise and distant traffic.
	Average Evening	50	78	41	50	46	
	Average Night	50	79	39	48	44	
NM03	Average Day	56	97	47	57	52	Onsite road traffic dominant intermittent noise source. Wind borne noise also present intermittently.
	Average Evening	53	77	46	54	50	
	Average Night	49	71	45	49	47	
NM04	Average Day	52	81	46	53	50	Onsite road traffic dominant intermittent noise source. Wind borne noise also present intermittently.
	Average Evening	51	73	46	51	49	
	Average Night	49	73	45	50	48	
NM05	11:57 - 12:07	54	65	49	56	50	Onsite road traffic dominant intermittent noise source. Car park noise and idling taxis also influencing levels. Background noise levels influenced by distant road traffic.
	15:34 - 15:44	55	75	48	58	52	
NM06	11:43 - 11:53	69	79	53	73	57	Road traffic dominant intermittent noise source. Background noise levels influenced by music from nearby pub and distant road traffic.
	15:21 - 15:31	70	88	52	73	57	
NM07	12:09 - 12:19	58	81	50	60	52	Onsite road traffic dominant intermittent noise source. Background noise levels influenced by distant road traffic and wind borne noise. Angle grinder nearby raising L_{AFMax}.
	15:47 - 15:57	58	68	49	61	53	
NM08	12:22 - 12:32	55	69	50	57	52	Noise climate dominated by vehicular movement in the setdown area, some intermittent noise from SVUH service yard.
	16:14 - 16:24	55	69	49	58	50	
NM09	09:42 - 09:52	56	76	47	58	49	Noise climate dominated by vehicular movement in the set down area. Road traffic noise dominant background noise source.
	13:50 - 14:00	56	78	48	57	49	
NM10	09:59 - 10:09	52	67	48	53	49	Noise dominated by noise from the golf course (lawnmowers and leafblowers) operating. Some intermittent site traffic. Background noise dominated by distant road traffic.
	14:10 - 14:20	51	57	49	52	50	
NM11	10:29 - 10:39	53	63	49	54	51	Noise dominated by noise from the golf course (lawnmowers and leafblowers) operating. Some intermittent site traffic. Background noise dominated by distant road traffic.
	14:12 - 14:22	53	64	48	53	51	
NM12	10:52 - 11:02	56	71	48	57	50	Noise dominated by a street sweeper operating on the site road. Some intermittent site traffic. Background noise dominated by distant road
	14:19 - 14:29	50	62	48	51	49	

Location	Time	Measured Noise Levels (dB re. 2x10-5 Pa)					Comments
		L_{Aeq}	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}	
							traffic.
NM13	11:04 - 11:14	54	65	50	55	52	Road traffic from Nutley Lane dominant intermittent noise source. Some intermittent site traffic.
	14:42 - 14:52	53	58	49	54	51	
NM14	11:18 - 11:28	67	78	51	71	58	Road traffic from Nutley Lane dominant intermittent noise source. People talking nearby also influencing measurements.
	14:56 - 15:06	68	79	55	72	59	
NM15	11:30 - 11:40	64	74	51	68	55	Road traffic from Nutley Lane dominant intermittent noise source. People talking nearby also influencing measurements.
	15:07 - 15:17	64	85	52	66	56	

11.3.2 Internal Survey

A series of internal noise and vibration surveys were conducted in order to quantify the existing baseline environment within Clinical areas of St Vincent's University Hospital that are close to the proposed new National Maternity Hospital development site. In addition, baseline measurements were also undertaken in St Vincent's Private Hospital.

Vibration surveys were conducted, in general accordance with BS ISO 4866: 2010: Mechanical vibration and shock – Vibration of fixed structures – Guidelines for the measurement of vibrations and evaluation of their effects on structures. Specific details are set out below.

11.3.2.1 Internal Survey Locations

A total of twenty seven measurement locations were selected; each is described in turn below and shown on Figure 11.3.

St Vincent's University Hospital

INM01 is located in the Clinical Services Block on Lvl 04 - Conference Room
INM02 is located in the Clinical Services Block on Lvl 04 - Operating Theatre
INM03 is located in the Clinical Services Block on Lvl 04 - Operating Theatre
INM04 is located in the Clinical Services Block on Lvl 03 - Office
INM05 is located in the Clinical Services Block on Lvl 03 - Stem Cell Labs
INM06 is located in the Clinical Services Block on Lvl 03 - Consultants Suites
INM07 is located in the Clinical Services Block on Lvl 03 - Office
INM08 is located in the Clinical Services Block on Lvl 02 - X Ray
INM09 is located in the Clinical Services Block on Lvl 02 - US room
INM10 is located in the Clinical Services Block on Lvl 01 - Mammography Room

INM11 is located in the Clinical Services Block on Lvl 01 - Endoscopy Recovery Room

INM12 is located in the Clinical Services Block on Lvl 00 - Admissions

INM13 is located in the Herbert Link Block on Lvl 00 - Nurses Room

INM14 is located in the Herbert Link Block on Lvl 00 - Meeting Room

INM15 is located in the Herbert Wing Block on Lvl 00 - Staff Room

INM16 is located in the Herbert Wing Block on Lvl 03 - Day Room

INM17 is located in the Herbert Wing Block on Lvl 04 - 4 Bed Ward

INM18 is located in the Herbert Wing Block on Lvl 00 - Consultants Suite

INM19 is located in the Herbert Wing Block on Lvl 00 - IV Therapy

St Vincent's Private Hospital

INM20 is located in the main Hospital block on Lvl 01 - Radiology Sub Waiting Area

INM21 is located in the main Hospital block on Lvl 01 - Maples Centre US1

INM22 is located in the main Hospital block on Lvl 01 - Admin level

INM23 is located in the main Hospital block on Lvl 02 - Storage rear of cat theatre

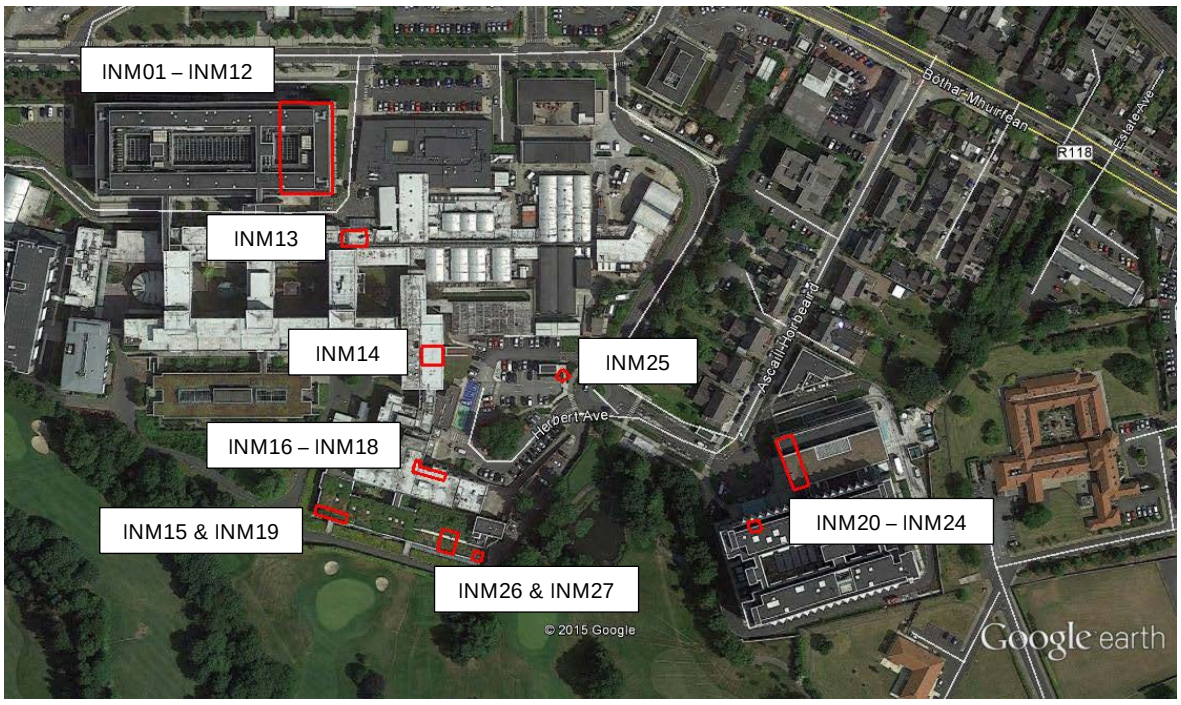
INM24 is located in the main Hospital block on Lvl 04 - Ward Bedroom 440

INM25 is located in access tunnel - Adjacent emergency stairwell

INM26 is located in the Herbert Wing on Lvl -01 - Radiotherapy Bay 01

INM27 is located in the Herbert Wing on Lvl 00 - Radiotherapy Exam Room 1

Figure 11.3: Internal Noise & Vibration Survey Locations



11.3.2.2 Survey Periods

Measurements were conducted at Locations INM01 to INM27 over the course of the following survey period:

- 07:20hrs to 10:05hrs 4 November 2015;
- 08:01hrs to 08:17hrs 10 November 2015, and;
- 09:15hrs to 11:15hrs 11 November 2015.

The measurements represent a typical period that was selected in order to provide a snapshot of the existing internal noise and vibration climate, with the primary purpose being to ensure that the proposed criteria associated with the development are commensurate with the prevailing environment.

11.3.2.3 Personnel and Instrumentation

Ronan Murphy (AWN) conducted the measurements.

Vibration measurements were conducted using a Rion VM54 vibration monitor and accelerometer at all locations.

Noise measurements were conducted using a Brüel & Kjær Type 2250 Precision Sound Level Analyser. The measurement apparatus was check calibrated both before and after each survey using a Brüel & Kjær Type 4231 Sound Level Meter Calibrator.

11.3.3 Results and Discussion

The internal survey results are summarised in Table 11.3 below.

Table 11.3: Summary of Internal Noise & Vibration Monitoring Results

Survey No.	Building	Location	Measured Noise Levels (dB re. 2x10-5 Pa)					RMS Acceleration (m/s²)
			$L_{Aeq,5min}$	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}	
INM01	Clinical Services	Lvl 4 - Conference Room	40	53	38	41	39	0.0006
INM02	Clinical Services	Lvl 4 - Operating Theatre	52	54	51	52	51	0.0006
INM03	Clinical Services	Lvl 4 - Operating Theatre	53	61	52	54	53	0.0006
INM04	Clinical Services	Lvl 3 - Office	46	55	44	47	45	0.0006
INM05	Clinical Services	Lvl 3 - Stem Cell Labs	50	52	48	50	49	0.0006
INM06	Clinical Services	Lvl 3 - Consultants Suites	40	53	39	41	40	0.0006
INM07	Clinical Services	Lvl 3 - Office	35	54	32	36	33	0.0006
INM08	Clinical Services	Lvl 2 - X Ray	49	61	47	49	48	0.0006
INM09	Clinical Services	Lvl 2 - US room	52	60	51	53	52	0.0006
INM10	Clinical Services	Lvl 1 - Mammography Room	52	58	51	53	52	0.0006
INM11	Clinical Services	Lvl 1 - Endoscopy Recovery Room	41	63	37	41	38	0.0006
INM12	Clinical Services	Lvl 0 - Admissions	41	55	38	42	39	0.0006
INM13	Herbert Link	Lvl 0 - Nurses Room	51	83	34	42	36	0.0006
INM14	Herbert Link	Lvl 0 - Meeting Room	39	61	25	38	28	0.0003
INM15	Herbert Wing	Lvl 0 - Staff Room	42	68	35	40	36	0.0002
INM16	Herbert Wing	Lvl 3 - Day Room	39	59	29	41	32	0.0011
INM17	Herbert Wing	Lvl 4 - 4 Bed Ward	35	56	31	35	32	0.0010
INM18	Herbert Wing	Lvl 0 - Consultants Suite	36	63	23	35	26	0.0003
INM19	Herbert Wing	Lvl 0 - IV Therapy	40	48	34	45	36	0.0001

Survey No.	Building	Location	Measured Noise Levels (dB re. 2x10-5 Pa)					RMS Acceleration (m/s²)
			$L_{Aeq,5min}$	L_{Amax}	L_{Amin}	L_{A10}	L_{A90}	
INM20	St Vincent's Private - Main Building	Lvl01 -Radiology subwait	ND[2]					0.0010
INM21	St Vincent's Private - Main Building	Lvl01 - Maples Centre US1	41	54	39	41	40	0.0012
INM22	St Vincent's Private - Main Building	Lvl01 - Admin level	47	57	45	47	46	0.0006
INM23	St Vincent's Private - Main Building	Lvl02 - Storage rear of cat theatre	ND[3]					0.0005
INM24	St Vincent's Private - Main Building	Lvl04 - Ward Bedroom 440	41	52	36	43	38	0.0015
INM25	St Vincent's Private - Main Building	Tunnel - Emergency stairwell	28	36	24	29	26	0.0032
INM26	St Vincent's Private - Herbert Wing	Lvl-01 - Radiotherapy Bay 01	56	66	53	58	54	0.0024
INM27	St Vincent's Private - Herbert Wing	Lvl00 - Radiotherapy Exam Room 1	35	55	32	35	33	0.0016

2 Noise measurement not undertaken due to elevated ambient noise levels
[3] Proxy survey position for vibration in adjacent operating theatre so no noise survey undertaken

In all locations services noise was noted as the dominant background noise source. Conversation and footfall in adjacent corridors and rooms was noted to be the dominant intermittent noise source.

In all locations footfall was noted to be the dominant vibration source. The average level of vibration in all areas is below the level that would typically be subjectively noticeable and well below the level where an adverse effect would be expected.

11.4 Characteristics of the Proposed Development

The potential noise and vibration impact of the proposed development on the surroundings must be considered for two distinct stages:

- Construction phase, and;
- Operational phase.

The construction phase will involve the demolition of a number of existing buildings, excavation over the development site, and construction of a secant piled wall around the perimeter of the site, the formation of the basement levels and the construction of the new buildings and car park.

During the operational phase of the developments following describes the primary sources of outward noise that are deemed long term and which will be assessed in detail for each development as part of this EIS:

- Building services noise;
- Additional vehicular traffic on public roads;
- Car parking on site, and;
- Waste and service yard areas.

11.5 Potential Impact of the Proposed Development

11.5.1 Construction Phase

This section summarises the likely noise and vibration impact associated with the proposed developments on the St Vincent's University Hospital Campus.

There is no published statutory Irish guidance relating to the maximum permissible noise and vibration 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 and vibration limits at their discretion. However, there are several publications commonly used in Ireland to set appropriate construction criteria.

Appendix 11.2 discusses in detail the derivation of appropriate criteria for this Project. The adopted criteria for construction noise and vibration are presented below.

11.5.1.1 Noise Criteria

Table 11.4 presents the adopted construction noise criteria at residential dwellings in the vicinity of the development site. The limits outlined in table 11.4 have been derived in consideration of best practice guidance as well as the prevailing noise climate, further details on this process can be found in Appendix 11.2. Please note that the majority of the construction activity in relation to the proposed development is expected to occur during normal site working hours, i.e. full days on Mondays to Fridays and half days on Saturdays.

Table 11.4: Summary of Construction Noise Limits at Residential Dwellings[4]

Period over which criterion applies		Noise Impact Criterion ($L_{Aeq,1hr}$)
Monday to Friday	Day: 07:00 to 19:00	65 dB
	Evening: 19:00 to 22:00	55 dB*
	Night: 22:00 to 07:00	The higher of 45 dB or the ambient level*
Saturday: Day: 08:00 to 14:00 (work outside these hours will not be permitted)		65 dB
Sundays and Bank Holidays*: Day: 08:00 to 14:00 (work outside these hours will not be permitted)		55 dB*

In addition, an internal noise limit of 45dB $L_{Aeq,1hr}$ will be adopted for construction noise intrusion in all Hospital and Clinical Buildings.

11.5.1.2 Vibration Criteria

Typically vibration standards come in two varieties: those dealing with human exposure and those dealing with cosmetic or structural damage to buildings. In addition to these impacts it is also considered appropriate in this instance to assess the impact of vibration on the operations of the existing Hospital and Clinical Buildings neighbouring the site. Appendix 11.2 presents a detailed discussion of the derivation of the adopted vibration limit values presented below.

[4] Derived in accordance with best practice procedures as outlined in BS 5228-1: 2009+A1(2014)

Table 11.5 presents the vibration criteria to be adopted during construction at nearby soundly constructed residential properties and similar structures that are generally in good repair. These limit values have been selected to avoid cosmetic (i.e. non-structural) damage. Please note that the potential for vibration induced damage is greater at lower frequencies of vibration. Therefore, the limit values proposed are related to the frequency range of the vibration. To put this into context most building damage from man-made sources (construction, traffic etc.) occurs in the frequency range of 1Hz to 150Hz.

Table 11.5: Allowable Vibration during Construction Phase for Soundly Constructed Buildings[5]

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

Consideration should also be given to the potential for vibration induced damage to underground services nearby. Generally underground structures are less susceptible to damage due to vibration. Notwithstanding this, *BS 5228-2: 2009+A1(2014): Code of practice for noise control on construction and open sites – Part 2: Vibration* recommends that in the absence of specific criteria from the statutory undertakers the following criteria should be applied to underground services:

- Maximum Peak Particle Velocity for intermittent or transient vibrations – 30mm/s, and;
- Maximum Peak Particle Velocity for continuous vibrations – 15mm/s.

These criteria should be reduced by 30% in the case where elderly or dilapidated brick sewers are encountered.

Finally, due to the proximity of the development to existing Hospital and Clinical services it is also considered appropriate to specify vibration criteria within these buildings during construction. Table 11.6 presents the maximum frequency weighted accelerations for both continuous and intermittent sources that should not be exceeded in order to avoid adverse comment.

[5] Derived in accordance with best practice as outlined in BS5228-2: 2009+A1(2014)

Table 11.6: Allowable Vibration during Construction Phase for Clinical Buildings[6]

Location	Frequency weighted acceleration
Operating theatres, precision laboratories, audiometric testing booths	0.005 m/s^2
Wards	0.01 m/s^2
General Laboratories, treatment areas	0.02 m/s^2
Offices, Consulting Rooms	0.04 m/s^2

11.5.1.3 Forecasting Methods

Noise calculations for construction activity have been conducted in accordance with ISO 9613 (1996): Acoustics – Attenuation of sound outdoors – Part 2: General method of calculation using noise source data from BS 5228-1: 2009+A1(2014): Code of practice for noise control on construction and open sites – Part 1: Noise.

The vibration impact due to the construction works will be assessed by making reference to published empirical data rather than detailed predictions. This assessment will comment on the expected vibration levels from various construction activities at a range of distances from the source.

11.5.1.4 Noise

At this stage, although a draft construction management plan has been drawn up, specific and detailed information on the construction programme is not yet available. In order to provide an indication of the magnitude of construction noise impacts, reference has been made to typical construction activity levels associated with Hospital construction. This information has been obtained from *BS 5228-1: 2009+A1(2014): Code of Practice for Noise Control on Construction and Open Sites – Part 1: Noise*.

The plant items likely to be required during the construction phase have been presented in Table 11.7 with typical sound power levels and operational on-time values.

[6] Derived in accordance with best practice as outlined in UK Department of Health document *Health Technical Memorandum 08-01: Acoustics*

Table 11.7: Plant Noise Levels at Various Phases of the Construction Programme

Construction Programme Phase	Plant Item	On time	Sound Power, L_w dB(A)
Demolition & Site Preparation	Pulveriser Mounted on Excavator	66%	104
	Tracked Excavator	90%	104
	Shovel Loading Dump Truck	20%	108
	Wheeled Backhoe	90%	96
Secant Pile Wall Construction	Augured Piling Rig	95%	114
	Tracked Excavator	10%	104
	Tracked Mobile Crane	20%	104
	Hand Held Welder x 2	5%	101
	Welder Generator	10%	101
	Concrete Mixer Truck	10%	108
	Concrete Pump	10%	106
Excavation	Tracked Excavator x 2	90%	104
	Shovel Loading Dump Truck	20%	108
	Wheeled Backhoe x 2	90%	96
Pre-stressing	Hydraulic Drill	70%	114
	Hydraulic Mud Mixer	70%	90
	Angle Grinder x 2	15%	89
	Hand Held Welder x 2	5%	101
	Welder Generator x 3	10%	101
	Bit Sharpening Tool	20%	110
	Generator for Angle Grinder	20%	103
Pouring concrete slabs	Water Pump (Diesel)	66%	97
	Crawler Mounted Hydraulic Drill	66%	107
	Power Floating	66%	100
	Poker Vibrator	66%	106
	Concrete Pump	66%	103

Noise levels predicted for each of the most disruptive construction phases are presented in Table 11.8. Please note that the sources listed in Table 11.7 for each phase of construction have been calculated on the basis that all plant is operating simultaneously on the boundary of the construction site in close proximity to the nearest receiver locations. It must be noted, that for the majority of the time, plant and equipment will be a greater distance from the nearest noise sensitive locations than that used for the calculations and consequently will have lesser impact. The assessment is therefore representative of a "worst-case" scenario.

Table 11.8: Plant Noise Levels at Various Phases of the Construction Programme

Phase	Receptor Type	Nearest Receptor	Distance	Construction Phase				
				Demolition & Site Preparation	Secant Pile Wall Construction	Excavation	Pre-Stress Level 1	Pouring Concrete Slabs
Enabling Works	Residential	No. 85 Nutley Lane	50	55	62	61	61	57
		Brooklands Apartments	40	57	64	63	63	59
	Hospital	Clinical Services	45	56	63	62	62	58
		Nutley Wing	100	49	56	55	55	51
Phase 1	Residential	Rear of Herbert Place	45	56	63	62	62	58
		Fortlands Apartments	70	53	59	58	58	54
	Hospital	Herbert Wing	45	56	63	62	62	58
		Herbert Link	5	**70**	**77**	**76**	**76**	**72**
		Main Ward Block	35	59	65	64	64	60
Phase 2	Residential	Fortlands Apartments	40	57	64	63	63	59
		St Johns Nursing Home	90	50	57	56	56	52
	Hospital	Clinical Services	15	**66**	**73**	**72**	**72**	**68**
		Main Ward Block	20	63	**70**	**69**	**69**	65
		Herbert Link	20	63	**70**	**69**	**69**	65

The results in Table 11.8 also include the mitigation offered by the solid site hoarding/barrier which is proposed to be erected around the site boundaries closest to residential and existing Hospital Buildings. As a base scenario, a standard 2.4m high solid site hoarding has been assumed to be in place throughout. Figure 11.4 indicates the location of this hoarding in schematic form whilst Figure 11.5 presents an image of such temporary screening systems.

Figure 11.4: Proposed Extent of Site Hoarding

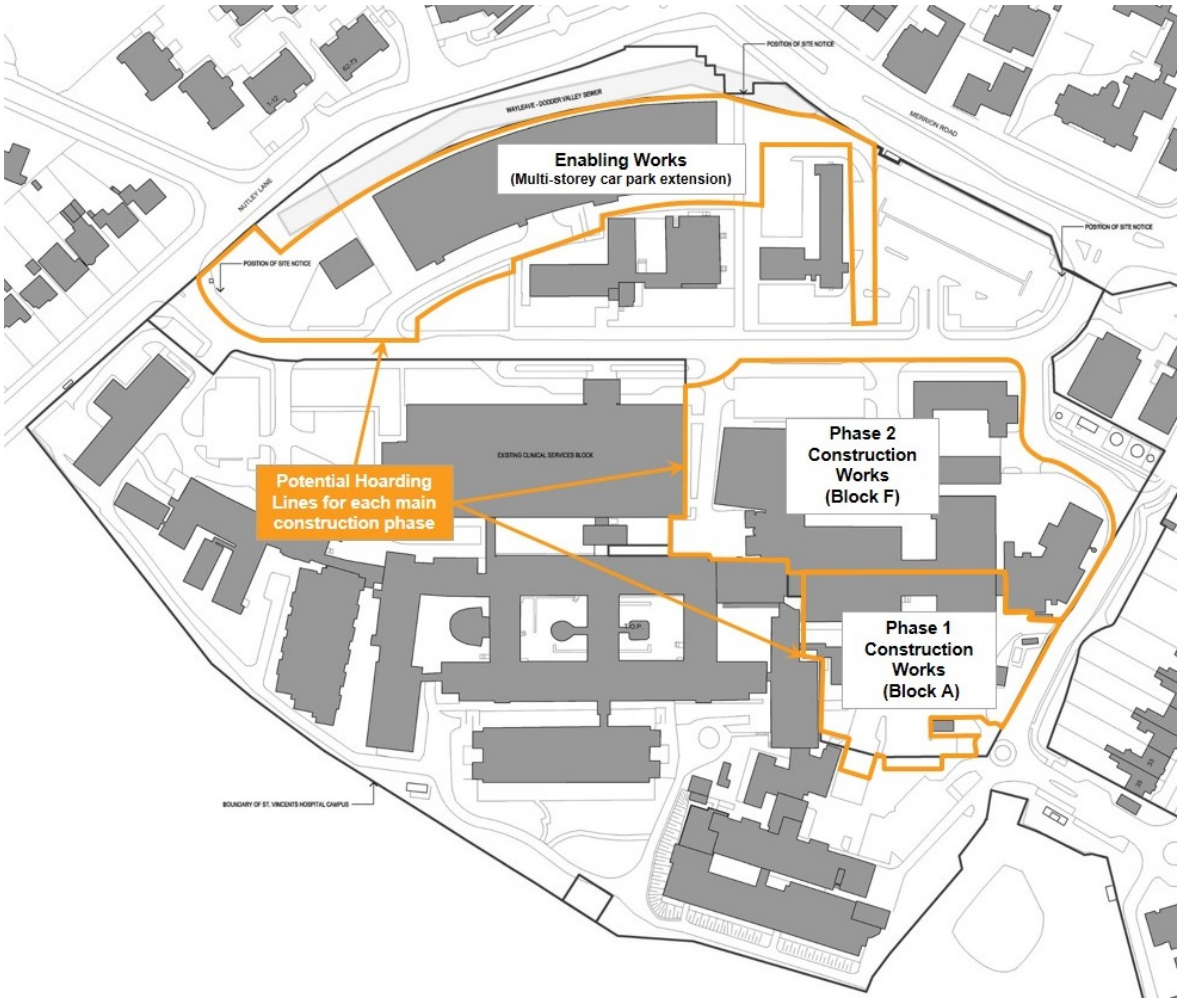


Figure 11.5: Temporary Screens for Use during Construction

The predicted external construction noise levels are below 65dB $L_{Aeq,1hr}$ for all residential locations. During certain activities, the noise levels in the vicinity of the Clinical Services Building, the Herbert Link and the Main Ward Block are in excess of 65dB $L_{Aeq,1hr}$. It should be noted that further reductions in the noise level can be achieved by considering additional mitigation measures such as localised screens around noisy activities and selection of low noise plant. This mitigation measure and others are discussed in detail in Section 11.7.1.

It is also possible to estimate the internal construction noise levels within Clinical areas using the predicted external noise levels from Table 11.8. This is done by factoring in the degree of noise reduction afforded by a closed thermally insulated window. It is assumed that Hospital windows will be closed during construction works in order to control dust and noise intrusion. Table 11.9 below presents the estimated internal construction noise levels within the nearest noise sensitive locations to the proposed development assuming a conservative noise reduction of 25dB for the closed windows on nearby Clinical Buildings.

Table 11.9: Estimated Internal Construction Noise Levels in Clinical Areas

Phase	Nearest Receptor	Distance	Construction Phase				
			Demolition & Site Preparation	Secant Pile Wall Construction	Excavation	Pre-Stress Level 1	Pouring Concrete Slabs
Enabling Works	Clinical Services	45	31	38	37	37	33
	Nutley Wing	100	24	31	30	30	26
Phase 1	Herbert Wing	45	31	38	37	37	33
	Herbert Link	5	45	**52**	**51**	**51**	**47**
	Main Ward Block	35	33	40	39	39	35
Phase 2	Clinical Services	15	40	**47**	**46**	**46**	42
	Main Ward Block	20	38	45	44	44	40
	Herbert Link	20	38	45	44	44	40

For the majority of the time the predicted internal noise levels are within the typical internal noise criterion of 45dB $L_{Aeq,1hr}$. At certain locations, for some construction activities, the internal noise level is predicted to be up to 52dB $L_{Aeq,1hr}$. This level will be audible, however, the levels are not considered to be intrusive. It should also be noted that the mitigation measures discussed in detail in Section 11.7.1 will help to further reduce the noise impact in these areas.

It is important to note that the calculations assume that the construction plant has been located at those points within the site nearest to the noise-sensitive properties. This is in order to provide a 'worst-case' scenario in relation to the proposed National Maternity Hospital site. Therefore, these levels would not be sustained for the entire length of this phase of the construction programme.

11.5.1.5 Traffic

In addition to construction activity on the development site the noise impact of additional traffic on the local road network due to the construction activity should also be addressed. Access to the new National Maternity Hospital development site for construction traffic will be by Nutley Lane with construction traffic exiting at Merrion Road and returning back up Nutley Lane. The nearest noise sensitive locations to the proposed haul routes are the existing onsite buildings particularly the Herbert Wing. The nearest residential receptors are located on Nutley Lane and Herbert Avenue. The noise impact on these locations associated with construction traffic is assessed in the following paragraphs.

The noise level associated with an event of short duration, such as a passing vehicle movement, 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.

The appropriate formula is given below.

$$L_{Aeq,T} = L_{AX} + 10\log10(N) - 10\log10(T) + 20\log10(r1/r2)dB$$

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);

N is the number of events over the course of time period T;

r1 is the distance at which LAX is expressed;

r2 is the distance to the assessment location.

The mean value of Sound Exposure Level for truck moving at low to moderate speeds (i.e. 15 to 45km/hr) is in the order of 82dB L_{AX} at a distance of 5 metres from the vehicle. This figure is based on a series of measurements conducted under controlled conditions.

The construction traffic volumes during various phases of the construction works have been estimated by the Design Team. Table 11.10 below details the expected number of two-way peak hour truck movements from each location discussed above. Note that the construction traffic volume presented here are the peak hour volumes in order that a worst-case assessment is presented. The construction volumes are presented for the following general construction phases:

- Phase 1 – Enabling Works;
- Phase 2 – Main Phase 1, and;
- Phase 3 – Main Phase 2

Table 11.10: Estimated Construction Traffic Noise Levels

Location	Distance (m)	Enabling Works		Phase 1		Phase 2	
		Peak Hour Heavy Goods Vehicles	Noise Level, dB $L_{Aeq,1hr}$	Peak Hour Heavy Goods Vehicles	Noise Level, dB $L_{Aeq,1hr}$	Peak Hour Heavy Goods Vehicles	Noise Level, dB $L_{Aeq,1hr}$
Nutley Lane	20	12	45	12	45	12	45
Herbert Avenue	40	12	39	12	39	12	39
Herbert Wing	4	12	**57**	12	**57**	12	**57**

In relation to offsite residential noise sensitive locations, the predicted levels are noted to be within the levels outlined previously and the likely noise impact on the local environment due to construction traffic during the daytime period is within the construction noise criterion adopted. In addition, the predicted noise levels due to construction traffic are of a similar magnitude to the existing noise levels measured in the vicinity of the nearest noise sensitive locations to the assessment locations. In all instances the existing daytime noise environment is dominated by road traffic and, therefore, the noise generated by construction traffic is not expected to change the character of the existing noise environment significantly.

In relation to the onsite Hospital receptors, due to the potential proximity of the Hospital Buildings to the proposed haul route, the predicted levels are deemed to be in excess of the adopted design goal. As such mitigation will be required here.

11.5.1.6 Vibration

The main source of vibration during the construction programme is likely to be as a result of piling. The proposed secant walls can be constructed using either bored cast in place or continuous flight auger piling methods. Both piling types typically generate a low level of vibration relative to typical driven or vibratory piling methods although bored cast in place can generate some impact noise if the auger strikes the base of the borehole.

At this stage, the exact piling method has not been confirmed. Notwithstanding this, an assessment of the expected vibration levels has been carried out. For the purposes of this assessment the expected vibration levels during piling have been determined through reference to published empirical data and bored cast in-situ has been assumed as the proposed piling method.

The British Standard *BS 5228-2+A1 (2014): Code of practice for noise and vibration control on construction and open sites – Part 2: Vibration*, publishes the measured magnitude of vibration from rotary bored piling using a 600mm pile diameter during two aspects of the operation, (BS5228-2 Table D.6, Ref. No. 105):

- 230µm/s at a distance of 3.5m, for augering;
- 2,400µm/s at a distance of 3.5m, for auger hitting base of hole;
- 40 µm/s at a distance of 8m, for augering, and;
- 1,700µm/s at a distance of 8m, for auger hitting base of hole.

Additional information on the vibration levels when boring with a rock auger is also presented for a 600mm pile diameter in BS5228-2 (BS5228-2 Table D.6, Ref. No. 106):

- 430µm/s at a distance of 5m, for boring with a rock auger.

The pile diameter proposed for the new National Maternity Hospital Building ranges from 900mm to 1200mm. For bored piling such as that proposed here, the vibration amplitude is broadly proportional to pile diameter. Therefore, the vibration magnitude arising from the redevelopment of The National Maternity Hospital would be expected to be approximately one and a half to double the levels presented above.

The closest residential buildings to the piling areas in each phase are outlined in Table 11.11.

Table 11.11: Nearest Residential Receptor to Piling during Each Construction Phase

Phase	Nearest Receptor	Distance (m)
Enabling Works	No. 85 Nutley Lane	50
Phase 1	Houses at Herbert Place	45
Phase 2	Fortlands Apartments	80

The closest Clinical Buildings to the piling line in each phase in outlined in Table 11.12.

Table 11.12: Nearest Clinical Receptor to Piling during Each Construction Phase

Phase	Nearest Receptor	Distance (m)
Enabling Works	Clinical Services Building	45
Phase 1	Herbert Link	4
Phase 2	Main Ward Block	11

Considering the distance of the piling works from the nearby residential buildings the expected vibration levels are expected to be imperceptible.

It is expected that for standard boring the vibration levels within the majority of Clinical areas of St Vincent's University Hospital are expected to be below approximately 80µm/s and such would be imperceptible. In the event of the auger hitting the base of the borehole, vibration levels may be just perceptible within the closest Clinical areas.

In the case of the Herbert Link Building, the proximity of the proposed works is such that vibration levels during piling could be of the order of 460µm/s which would be perceptible. In the event of the auger hitting the base of the borehole, vibration levels could be sufficient to give rise to adverse comment and disruption to vibration sensitive equipment.

It is important to note that the impacts on Clinical areas will only occur when works are on-going in close proximity to the existing Hospital Buildings. For the vast majority of the piling works there will be no perceptible impact on Clinical areas.

It is recommended that the mitigation measures discussed in Section 11.7.1 are implemented in order to minimise the impacts that may occur.

11.5.2 Operational Phase

There are five primary sources of noise associated with the new National Maternity Hospital once operational. These are:

- Building services noise;
- Additional vehicular traffic on public roads;
- Car parking on site, and;
- Waste and service yard area.

Each of these primary noise sources is addressed in turn in the following Sections. Note that there is no significant source of vibration associated with the operational phase of the proposed developments.

11.5.2.1 Building Services Noise

Once a development of this nature becomes fully operational, a variety of electrical and mechanical plant will be required to service the development. The plant items proposed for the redevelopment of The National Maternity Hospital include:

- Air Handling Units (including extract and supply duct terminations);
- Chillers, and;
- Boilers.

It is envisaged that all of this plant may be required to operate 24 hours a day, and hence would be most noticeable during quiet periods (i.e. overnight).

In the first instance, it is important to note that the majority of plant will be located internally. Although some roof mounted plant are proposed, these plant items will be partially enclosed by full height louvred screens. The majority of the air handling units will housed be within a dedicated plant space below the roof level of Block A. The proposed boilers and other plant items will be located in the basement level whilst the chillers will be located at roof level in a screened plant area.

At the outset, all plant will be designed and installed with the following mitigation measures as standard:

- All AHU's will be provided with intake and exhaust attenuation;
- Roof top chillers will be installed with anti-vibration mounts, operate low speed fans and include additional attenuation at compressors;
- Burners to boiler plant in the basement will be provided with acoustic shrouds;
- Suitable attenuation will be provided to the generator air intake and exhaust locations;

- Suitable attenuation measures will be provided to local exhaust systems such as toilet areas, and;
- Suitable attenuation will be provided to air intake to basement medical and surgical air plant rooms and medical vacuum plant rooms.

The criterion for assessing building service noise depends on the type of noise sensitive location. For medical buildings in the vicinity, it is considered appropriate to make reference to the guidance contained within HTM 08-01 for controlling noise intrusion from external noise sources. As discussed previously this document sets design goals for internal levels of noise that are acceptable. Table A11.2 in Appendix 11.2 list the appropriate noise criteria for a range of different Clinical areas. Making reference to this table it can be determined that during the most sensitive night-time period an internal noise criterion of 35dB L_{Aeq} applies to noise intrusion from external noise sources including mechanical plant.

For the purposes of this study it is assumed that once construction is completed Hospital windows will be opened regularly to allow for natural ventilation. Therefore, it is appropriate to derive an external limit based on this internal criterion. This is done by factoring in the degree of noise reduction afforded by a partially open window using the guidance contained within the World Health Organisation's document *Guidelines for Community Noise (Berglund et al 1999)* which describes this reduction as being up to 15dB. As a worst case, 10dB will be assumed in this instance.

Therefore, in order to achieve the recommended internal noise criterion of 35dB $L_{Aeq,1hr}$ an external noise level of less than 45dB $L_{Aeq,1hr}$ should be achieved at the facades of the nearest Clinical Buildings where windows are openable for ventilation. The external noise level can be greater on sealed facades where the noise reduction across the façade will be greater or on facades where the internal rooms are less sensitive to noise. Regardless of the façade type the internal noise criterion should be achieved.

In relation to plant noise levels at non-Clinical sensitive locations Dublin City Council would typically apply the following condition to a development of this nature:

> *"Noise levels from the proposed development should not be so loud, so continuous, so repeated, of such duration or pitch or occurring at such times as to give reasonable cause for annoyance to a person in any premises in the neighbourhood or to a person lawfully using any public space. In particular the rated noise levels from the proposed development shall not constitute reasonable grounds for complaint as provided for in B.S. 4142. Method for rating industrial noise*

affecting mixed residential and industrial area.
Reason: In order to ensure a satisfactory standard of development, in the interests of residential amenity."

Guidance from Dublin City Council on noise emissions from mechanical plant items typically makes reference to the British Standard *BS 4142: 2014: Methods for Rating and Assessing Industrial and Commercial Sound*. This document is the industry standard method for analysing building services plant noise emissions to residential receptors and is the document typically used by Dublin City Council in their standard planning conditions and also in complaint investigations.

BS 4142 describes methods for rating and assessing sound of an industrial and/or commercial nature. The methods described in this British Standard use outdoor sound levels to assess the likely effects of sound on people who might be inside or outside a dwelling or premises used for residential purposes upon which sound is incident.

For an appropriate BS 4142 assessment it is necessary to compare the measured external background noise level (i.e. the $L_{A90,T}$ level measured in the absence of plant items) to the rating level ($L_{Ar,T}$) of the various plant items, when operational. Where noise emissions are found to be tonal, impulsive in nature or irregular enough to attract attention, BS 4142 also advises that a penalty be applied to the specific level to arrive at the rating level.

The subjective method for applying a penalty for tonal noise characteristics outlined in BS 4142 recommends the application of a 2dB penalty for a tone which is just perceptible at the noise receptor, 4dB where it is clearly perceptible, and 6dB where it is highly perceptible.

The following definitions as discussed in BS 4142 as summarised below:

"ambient noise level, $L_{Aeq,T}$" is the noise level produced by all sources including the sources of concern, i.e. the residual noise level plus the specific noise of mechanical plant, in terms of the equivalent continuous A-weighted sound pressure level over the reference time interval [T].

"residual noise level, $L_{Aeq,T}$"	is the noise level produced by all sources excluding the sources of concern, i.e. the ambient sound remaining at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound, in terms of the equivalent continuous A-weighted sound pressure level over the reference time interval [T].
"specific noise level, $L_{Aeq,T}$"	is the sound level associated with the sources of concern, i.e. noise emissions solely from the mechanical plant, in terms of the equivalent continuous A-weighted sound pressure level over the reference time interval [T].
"rating level, $L_{Ar,T}$"	is the specific sound level plus any adjustments for the characteristic features of the sound (e.g. tonal, impulsive or irregular components);
"background noise level, $L_{A90,T}$"	is the sound pressure level of the residual noise that is exceeded for 90% of the time period T.

If the rated plant noise level is +10dB or more above the pre-existing background noise level then this indicates that complaints are likely to occur and that there will be a significant adverse impact. A difference of around +5dB is likely to be an indication of an adverse impact, depending on the context.

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

In this instance the existing prevailing background noise in the vicinity of the nearest sensitive receptors fell in the range of 43 to 44 dB L_{A90} during the most sensitive night-time period. Making the assumption that the majority of mechanical plant serving the development will operate 24/7 the mechanical plant noise emissions must be designed to achieve the BS4142 requirements during the night-time period.

Therefore, in order to limit the noise impact of mechanical plant serving the redeveloped National Maternity Hospital during the detailed design of the development the specific plant noise levels will be designed to be equal or lower to the following levels:

- 40dB $L_{Aeq,T}$ at the façade of the nearest residential noise sensitive locations, and;
- 45dB $L_{Aeq,T}$ at the façade of the nearest Clinical noise sensitive locations.

11.5.2.2 Additional Traffic on Public Roads

A detailed report on roads and traffic has been prepared by Arup Consulting Engineers, further details of which can be found in Chapter 6. Information from this report has been used to determine the predicted change in noise levels in the vicinity of a number of roads and junctions in the area surrounding the proposed development for the Opening Year of 2019. At the request of Dublin City Council, the do nothing traffic has been based on the 2014 base year flows.

For the purposes of assessing potential noise impact, it is appropriate to consider the relative increase in noise level associated with traffic movements on existing roads and junctions with and without the development using the provided Annual Average Daily Traffic figures. Table 11.13 presents the Do Nothing, i.e. without the proposed development, and the Do Something, i.e. with the proposed development, traffic figures and associated change in noise level for the surrounding road network.

Table 11.13: Summary of Change in Noise Level Due To Traffic in the Opening Year

Route	Opening Year Traffic Volume, AADT		Change in Noise Level, dB(A)
	Do Nothing	Do Something	
Merrion Road (north of Merrion Road/ Ailsebury Rd junction)	22,756	23,303	0.1
Merrion Road (south of Merrion Road/ Ailsebury Rd junction)	25,556	26,219	0.1
Merrion Road (north of Merrion Road/ Nutley Lane junction)	25,238	25,901	0.1
Merrion Road (south of Merrion Road/ Nutley Lane junction)	20,365	20,800	0.1
Merrion Road (south of Merrion Road/ SVUH Access junction)	20,358	20,918	0.1
Merrion Road (north of Merrion Road/ Strand Rd junction)	19,841	20,401	0.1
Merrion Road (south of Merrion Road/ Strand Rd junction)	32,454	32,992	0.1
Nutley Lane (east of Nutley Lane/Tesco Access Junction)	12,015	12,335	0.1
Nutley Lane (east of Nutley Lane/Nutley Avenue Junction)	11,495	11,815	0.1
Nutley Lane (east of Nutley Lane/SVUH Access Junction)	12,164	12,485	0.1
Nutley Lane (east of Nutley Lane/Nutley Rd Junction)	16,400	17,583	0.3
Nutley Lane (east of N11/Nutley Lane Junction)	18,889	20,012	0.3
N11 (north of N11/Nutley Lane Junction)	39,708	39,953	0.0
N11 (south of N11/Nutley Lane Junction)	50,370	51,226	0.1

In summary, the predicted increase in noise levels along all of the junctions assessed due to additional vehicular traffic associated with the proposed development is less than 1dB. In order to assist with the interpretation of the noise associated with vehicular traffic on public roads, Table 11.14 offers guidance as to the likely impact associated with any particular change in traffic noise level. The information in Table 11.14 is taken from the draft *Guidelines for Noise Impact Assessment* (2002) produced by the Institute of Acoustics/Institute of Environmental Management and Assessment Working Party.

The findings of the Working Party are draft at present although they are of some assistance in this assessment. The draft guidelines state that for any assessment, the noise level threshold and significance should be determined by the assessor, based upon the specific evidence and likely subjective response to noise.

The corresponding significance of impact presented in the *Guidelines on Information to be contained in Environmental Impact Statements* (2002) is also presented.

Table 11.14: Likely Impact Associated with a Change in Traffic Noise Level

Change in Sound Level (dB L_{A10})	Subjective Reaction	Impact Guidelines for Noise Impact Assessment Significance (Institute of Acoustics)	Impact Guidelines on the Information to be contained in EIS's (EPA)
0	No change	None	Imperceptible
0.1 – 2.9	Barely perceptible	Minor	Slight
3.0 – 4.9	Noticeable	Moderate	Moderate
5.0 – 9.9	Up to a doubling or halving of loudness	Substantial	Significant
10.0 or more	More than a doubling or halving of loudness	Major	Profound

The predicted increase in traffic noise is less than 1dB, such an increase is slight and the associated noise impact is not significant.

11.5.2.3 Car Parking On Site

The proposed development includes for the extension of the existing multi-storey car park to include an additional 413 spaces.

It is considered appropriate to assess the noise impact of vehicular traffic accessing the car park using the same relative increase methodology used to assess additional vehicular traffic on the public road network.

Traffic will enter the Hospital via Nutley Lane and Merrion Road. The peak times for Hospital traffic are expected during the following periods:

- AM Peak: 0700hrs to 0800hrs
- PM Peak: 1600hrs to 1700hrs

These time periods represent the highest amount of development traffic and is therefore the largest difference between 'baseline' and 'do something' scenarios. Table 11.15 presents the two-way traffic flows at both entrances in the PM peak period and the associated change in noise level.

Table 11.15: Summary of Traffic Volumes at Hospital Entrances

Route	Period	Opening Year Traffic Volume, PM Peak		Change in Noise Level, dB(A)
		Do Nothing	Do Something	
Merrion Road	07:00 to 08:00	1516	1567	0.1
	16:00 to 17:00	1411	1445	0.1
Nutley Lane	07:00 to 08:00	1475	1576	0.3
	16:00 to 17:00	987	1049	0.3

In summary, the maximum predicted increase in noise levels in the vicinity of the Hospital entrances due to additional vehicular traffic associated with the proposed development is of the order of 0.1 To 0.3dB. Reference to Table 11.14 confirms that such an increase is slight and the associated noise impact is not significant.

In addition to additional traffic on the site roads, it is appropriate to examine potential additional noise generated from activity within the car park which include car doors closing and revving engines amongst others.

Typical noise levels 10m beyond the boundary of a busy car park during peak periods are of the order of 48dB $L_{Aeq,1hr}$. This figure is based on a series of measurements conducted under controlled conditions.

The nearest residential noise sensitive receptor to the proposed car park extension is No. 85 Nutley Lane which is located at a distance of 45m approximately. Taking account of attenuation due to distance only, the expected noise level at the nearest noise sensitive location is of the order of 35dB $L_{Aeq,1hr}$ which is significantly below the measured ambient and background noise levels at this location. The impact of car parking noise on residential receptors is therefore deemed to be insignificant.

The nearest clinical noise sensitive receptor to the proposed car park extension is the Clinical Services Building which is also located at a distance of 45m approximately. Taking account of attenuation due to distance only, the expected noise level at this location would be of the order of 35dB $L_{Aeq,1hr}$ which is significantly below the measured ambient and background noise levels at a similar location onsite (Survey Location NM05). The impact of car parking noise on Clinical receptors is therefore deemed to be insignificant.

11.5.2.4 Waste and Service Yard Area

The waste and service yard area serving the new National Maternity Hospital shall be located at ground level to the east of the building adjacent the existing access road. The closest sensitive locations to the service yards are located to the east at Herbert Avenue at a distance of approximately 50 meters.

For the noise impact assessment of this area it is appropriate to consider yard activity and Heavy Goods Vehicle movements entering and exiting this area. Similar to the assessment of construction traffic the noise level associated with delivery and waste collection events will be assessed using the Sound Exposure Level associated with the event to calculate the contribution of an event or series of events to the overall noise level in a given period.

The mean value of Sound Exposure Level for a delivery/waste collection truck at low to moderate speeds (i.e. 15 to 45km/hr) is of the order of 82dB L_{AX} at a distance of 5 metres from the vehicle. This figure is based on a series of measurements conducted under controlled conditions.

In addition, the noise level at a distance of 10m from the vehicle dock of a typical service yard is of the order of 64dB $L_{Aeq,1hr}$ during daytime periods. This quoted level includes the effects of reflections from façades and service yard boundaries and contributions from all sources of noise, i.e. vehicles manoeuvring, air brakes, and trolleys.

Table 11.16 details the potential noise impact of each element at the nearest noise sensitive location (residential dwellings at Herbert Avenue) to the service yard. Please note that only the daytime noise impact is presented as it is understood that there will be no deliveries or waste collection activity during the night-time period. Also the assessment presents the noise level including the attenuation due to distance and the shielding offered by the 3m boundary wall in this location.

Table 11.16: Calculated Noise Impact at Noise Sensitive Location from Service Area

Source	Calculated Noise Level, dB $L_{Aeq,T}$
Vehicle Movement (assuming 2 per hour)	29
Service Yard Activity	50
Cumulative	50

In relation to the impacts of the waste and delivery activities on the Clinical areas of The National Maternity Hospital, Table 11.17 details the potential noise impact of each element at the nearest façade to the service yard. Please note that only the daytime noise impact is presented as it is understood that there will be no deliveries or waste collection activity during the night-time period. Also the assessment presents the noise level including the attenuation due to distance and the shielding offered by the waste services building.

Table 11.17: Calculated Noise Impact at nearest façade of Clinical Building from Service Area

Source	Calculated Noise Level, dB $L_{Aeq,T}$
Vehicle Movement (assuming 2 per hour)	25
Service Yard Activity	46
Cumulative	47

At the nearest noise sensitive location the predicted noise level during the daytime is 50dB $L_{Aeq,1hr}$. This is in compliance with the following guidance taken from the World Health Organisation's document *Guidelines for Community Noise (Berglund et al 1999):*

> *"To protect the majority of people from being moderately annoyed during the daytime, the sound pressure level should not exceed 50dB L_{Aeq}."*

In summary, the likely noise impact of service yard activity and delivery vehicles along the service yard access road on the local environment is not significant.

11.6 Mitigation Measures

In order to sufficiently ameliorate the likely noise impacts, a schedule of noise and vibration control measures has been formulated for both construction and operational phases.

11.6.1 Construction Phase

The impact assessment conducted for the construction activity during the construction phase has highlighted that the predicted construction noise levels are within the adopted criterion. However, the following mitigation measures may be considered during certain construction activities in order to further reduce the noise and vibration impact to nearby noise sensitive areas.

As part of these mitigation measures it is recommended that the Contractor should compile a Noise and Vibration Management Plan (NVMP) which will deal specifically with management processes and strategic mitigation measures to remove or reduce significant noise and vibration impacts, and cumulative noise and vibration impacts from the construction works. The Plan will also define noise and vibration monitoring and reporting. The NVMP will also include method statements for each phase of the works, the associated specific measures to minimise noise and vibration in so far as is reasonably practicable for the specific works covered by each plan and a detailed appraisal of the resultant construction noise and vibration generated.

The contractor will provide proactive community relations and will notify the public and vibration sensitive premises before the commencement of any works forecast to generate appreciable levels of noise or vibration, explaining the nature and duration of the works.
The contractor will distribute information circulars informing people of the progress of works and any likely periods of significant noise and vibration.
With regard to potential mitigation measures during construction activities, the standard planning condition typically issued by Dublin City Council states:

> "During the construction and demolition phases, the proposal development shall comply with British Standard 5228 "Noise Control on Construction and open sites Part 1. Code of practice for basic information and procedures for noise control."

BS5228 includes guidance on several aspects of construction site mitigation measures, including, but not limited to:

- selection of quiet plant;
- control of noise sources;
- screening;
- hours of work;
- liaison with the public, and;

- monitoring.

Detailed comment is offered on these items in Appendix 11.3. Noise control measures that will be considered include the selection of quiet plant, enclosures and screens around noise sources, limiting the hours of work and noise monitoring.

11.6.2 Operational Phase

11.6.2.1 Building Services

The assessment outlined previously has specified noise limits at the nearest noise sensitive properties that must be achieved in order to ensure the impact is acceptable. To achieve these noise limits consideration will be given, at the detailed design stage, to a variety of mitigation measures and forms of noise control techniques. As such, the following all plant will be designed and installed with the following mitigation measures as standard:

- All AHU's will be provided with intake and exhaust attenuation;
- Roof top chillers will be installed with anti-vibration mounts, operate low speed fans and include additional attenuation at compressors;
- Burners to boiler plant in the basement will be provided with acoustic shrouds;
- Suitable attenuation will be provided to the generator air intake and exhaust locations;
- Suitable attenuation measures will be provided to local exhaust systems such as toilet areas, and;
- Suitable attenuation will be provided to air intake to basement medical and surgical air plant rooms and medical vacuum plant rooms.

In addition to the above, we propose that the following practices are adopted to minimise potential noise disturbance for neighbours:

- All mechanical plant items e.g. motors, pumps etc. shall be regularly maintained to ensure that excessive noise generated any worn or rattling components is minimised;
- Any new or replacement mechanical plant items, including plant located inside new or existing buildings, shall be designed so that all noise emissions from site do not exceed the noise limits outlined in this document.

11.6.2.2 Additional Traffic on Public Roads

The noise impact assessment outlined above has demonstrated that mitigation measures are not required.

11.6.2.3 Car Parking on Site

The noise impact assessment outlined above has demonstrated that mitigation measures are not required.

11.6.2.4 Waste and Service Yard Area

The noise impact assessment outlined above has demonstrated that mitigation measures are not required.

11.7 Predicted Impact of the Proposed Development

11.7.1 Construction Phase

During the construction phase of the proposed development there will be some impact on nearby properties due to noise emissions from activity on-site and truck movements to and from the site. However, given that the construction phase of the development is temporary in nature, it is expected that the various noise sources will not be excessively intrusive. Furthermore, the application of binding noise limits and hours of operation, along with implementation of appropriate noise and vibration control measures, will ensure that noise and vibration impact is kept to a minimum.

11.7.2 Operational Phase

During the operational phase, potential causes of disturbance are considered to be limited to building services plant, additional vehicles on the existing road system, car parking activity and waste/service yard activities. It has been predicted that with appropriate mitigation none of these will increase the existing noise climate sufficiently so as to be likely to cause disturbance.

11.7.3 'Do Nothing' Scenario

For the Do Nothing scenario the existing noise sources contained within the St. Vincent's University Hospital Campus will remain in place. Traffic volumes on the surrounding road network are not likely to increase by any noticeable amount, as per transport planning

policies for Dublin City Centre which envisages that any increased travel demand within the city will be provided for using alternative travel modes, (i.e. walking, cycling and public transport use). Therefore, the existing baseline noise environment is not expected to change in the Do Nothing scenario.

11.7.4 'Worst Case' Scenario

The assessment of noise and vibration from the proposed development has identified that mitigation measures will be required during all stages of the construction phase. In relation to operational noise, mitigation measures are only required in respect of building services noise.

In the event that the mitigation measures as proposed are either not implemented or suffer catastrophic failure, it would be expected that noise and vibration in excess of the appropriate limits would be generated. Such noise could result in a deterioration of the nearby residential and onsite clinical amenity.

It is important to note that failure of the proposed mitigation measures would not result in any profound, irreversible or life threatening consequences in respect of noise and vibration.

11.8 Monitoring

Noise and vibration monitoring will be undertaken during the construction phase as outlined in Appendix 11.3.

On-going noise and vibration monitoring during the operational phase of the development is not required.

11.9 Reinstatement

This is not applicable to the noise and vibration assessment.

11.10 Interactions and Potential Cumulative Impacts

11.10.1 Interactions

The potential interaction between Noise and Vibration and other Chapters in the EIS is primarily limited to Traffic, Construction Management and Human Beings. This Chapter has been prepared in consideration of and in conjunction with the relevant outputs of the Traffic, Construction Management and Human Beings Chapters.

11.10.2 Potential Cumulative Impacts

The potential cumulative impacts where arising have been addressed and incorporated into the assessment of noise and vibration from the proposed National Maternity Hospital. It has been determined that there will be no cumulative impacts arising due to the development proceeding simultaneously to other extant or permitted developments within the catchment.