Appendix 10.A

Appendix 10A Noise Theory and Terminology

Between the quietest audible sound and loudest tolerable sound there is a million to one ratio in sound pressure (measured in pascals, Pa). Because of this wide range a noise levels scale based on logarithms is used in noise measurement call the decibel (dB) scale. Audibility of sound covers a range of approximately 0 to 140 dB.

The human ear system does not respond uniformly to sound across the detectable frequency range and consequently instrumentation used to measure noise is weighted to represent the performance of the ear. This is known as the 'A weighting' and annotated as dB(A) or LpA dB. Table 10A.1 below lists the sound pressure level in dB(A) for common situations.

Table 10A.1: Sound pressure levels for a range of situations

Noise Level dB(A)	Typical Situation
0	Threshold of hearing
30	Rural area at night, still air
40	Public library, refrigerator humming at 2 m
50	Quiet office, no machinery. Boiling kettle at 0.5 m
60	Normal conversation
70	Telephone ringing at 2 m. Vacuum cleaner at 3 m
80	General factory noise levels
100	Pneumatic drill at 5 m
120	Discotheque – 1 m in front of loudspeaker
140	Threshold of pain

The noise level at a measurement point is rarely steady, even in rural areas, and varies over a range dependent upon the effects of local noise sources. Close to a busy road, the noise level may vary over a range of 5 dB(A), whereas in a suburban area this may increase up to 40 dB(A) and more due to the multitude of noise sources in such areas (cars, dogs, aircraft etc.) and their variable operation. Furthermore, the range of night time noise levels will often be smaller and the levels significantly reduced compared to daytime levels.

Background Noise Levels

A parameter that is widely accepted as reflecting human perception of the ambient noise is the background noise level, L90, this is usually A weighted and can be displayed as L90 dB(A) or LA90 (dB). This is the noise level exceeded for 90% of the measurement period and generally reflects the noise level in the lulls between individual noise events. Over a one hour period, the LA90 will be the noise level exceeded for 54 minutes.

Ambient or Activity Noise Levels

The equivalent continuous A-weighted sound pressure level, LAeq (or Leq dB(A)) is the single number that represents the total sound energy measured over that period. LAeq is the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period. It is commonly used to express the energy level from individual sources that vary in level over their operational cycle.

Noise Changes

Human subjects are generally only capable of noticing changes in noise levels of no less than 3 dB(A). It is generally accepted that a change of 10 dB(A) in an overall, steady noise level is perceived to the human ear as a doubling (or halving) of the noise level. (These findings do not necessarily apply to transient or non-steady noise sources such as changes in noise due to changes in road traffic flow, or intermittent noise sources).

Sound Power

Sound power is the rate per unit time at which airborne sound energy is radiated by a source. It is expressed it watts (W). Sound power level or acoustic power level is a logarithmic measure of the sound power in comparison to the reference level of 1 pW (picowatt). The sound power level is given the letter "Lw" or SWL. It is not the same thing as sound pressure (Lp). Any Lp value is dependent of the distance from the noise source and the environment in which it was measured. Lw values are preferred for noise prediction purposed as their value is independent of distance or environment. There are recognised formulas for converting Lw to Lp.

A-weighted sound power levels are usually denoted LwA (dB) or sometimes Lw (dBA) or SWL (dBA).

Sound Reduction Index

The sound insulation properties of a material are described by the term ‘sound reduction index’ (R) i.e. it is a measure of the reduction in the amount of sound transmitted through a material. The higher the sound reduction index the greater the attenuation provided by the material. The value of R depends on a range of factors, in particular the mass of the material, the nature of the material, and the frequency of the sound. The R values for individual octave bands can be combined into an overall single figure, the weighted sound reduction index Rw.

Internal Noise Levels

In an enclosed space such as an individual room, or a building, the noise from a source cannot propagate in the same way as outdoors because the propagation of the sound is obstructed by the boundaries (walls, ceiling and floor) of the building. These surfaces together with the contents of the building reflect a proportion of the sound back inside the building or room, the amount depending on the absorption coefficient of the various surfaces. Therefore the overall noise level at a position within the building is a combination of the sound received directly from the source (the direct sound field) and the sound received from reflections from the internal surfaces (the reverberant sound field). The more absorptive the surfaces in a building the less sound is reflected and the lower the contribution of the reverberant sound field to the overall noise level.

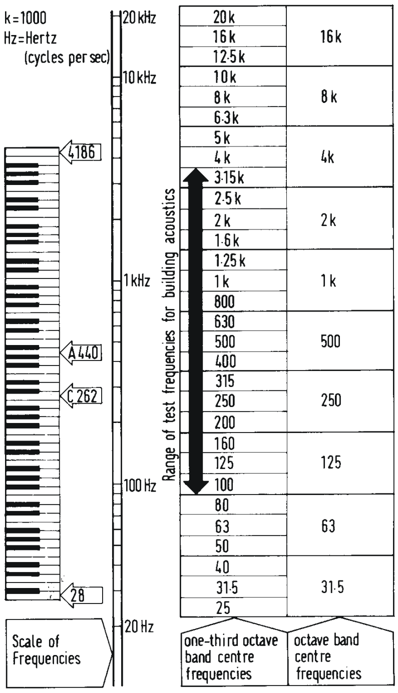
Frequency Spectrum

Frequency is the rate at which the air particles vibrate. The more rapid the vibrations, the higher the frequency and perceived pitch. Frequency is measured in Hertz (Hz).

A young person with average hearing can generally detect sounds in the range 20 Hz to 20,000 Hz (20 kHz). Figure 9A.1 below illustrates the range of frequencies, for example, the lowest note on a full scale piano, ‘A’, has a fundamental at 28 Hz, and the highest, ‘G’, a fundamental at 4186 Hz (there will be higher order harmonics). Human speech is predominantly in the range 250 Hz - 3000 Hz.

The musical term ‘octave’ is the interval between the first and eighth note in a scale and represents a doubling of frequency. A series of octave and one-third octave bands have been derived, as shown on Figure 10A.1 and these are commonly used in noise measurements where it is necessary to describe not only the level of the source noise but also the frequency content. The frequency content of a noise source can be useful for identifying acoustic features such as a whine, hiss or screech.

Figure 10A.1: Octave and 1/3 octave frequency bands



Appendix 10.B

Appendix 10B Construction Noise

The assumed construction activities and plant are given in Table 10B.1, along with corresponding noise data.

Table 10B.1: Construction plant details

Activity	Plant	LWA	Activity On-Time (%)	Reference
Demolition and site clearance	Pulveriser mounted on excavator	105	50	BS 5228 Table C.1 no.s 3-5
	Excavator	105	50	BS 5228 Table C.2 no 2
	Loading lorries	106	20	BS 5228 Table C.2 no.s 26-28
	Tracked crusher	111	10	BS 5228 Table C.1 no.s 14-15
Earthworks	Excavator	105	50	BS 5228 Table C.2 no 2
	Dumper	102	50	BS 5228 Table C.2 no 32
	Loading lorries	106	20	BS 5228 Table C.2 no.s 26-28
Rotary bored piling	Rotary Bored Piing Rig	111	50	BS 5228 Table C.3 no 14
	Service crane	97	50	BS 5228 Table C.3 ave no.s 28-29
	Cement mixer truck	106	50	BS 5228 Table C.4 no 32
Foundations	Excavator	102	75	BS 5228 Table C.2 ave 14-25
	Lorry mounted concrete pump	107	50	BS 5228 Table C.2 ave 26-28
	Lorry mounted concrete pump	105	50	BS 5228 Table D.7 ave 121-122
	Cement mixer truck	106	50	BS 5228 Table C.4 no 32
	Poker vibrator	97	75	BS 5228 Table C.4 no 34
Slab Construction	Lorry mounted concrete pump	107	50	BS 5228 Table C.2 ave 26-28
	Lorry mounted concrete pump	105	50	BS 5228 Table D.7 ave 121-122
	Cement mixer truck	106	50	BS 5228 Table C.4 no 32
	Poker vibrator	97	75	BS 5228 Table C.4 no 34
Building construction	Tower crane	105	50	BS 5228 Table C.4 ave 48-49
	Generator	94	100	BS 5228 Table C.4 ave 76-84
	Electric drills	104	50	BS 5228 Table D.6 no 54
	Welding plant	102	50	BS 5228 Table C.3 no 31
Building Construction	Tower crane	105	50	BS 5228 Table C.4 ave 48-49
	Generator	94	100	BS 5228 Table C.4 ave 76-84

	Electric drills	104	50	BS 5228 Table D.6 no 54
	Metal cutter	107	25	BS 5228 Table C.1 no 18
	Electric bolter	104	25	BS 5228 Table D.6 no 54
	Welding plant	102	50	BS 5228 Table C.3 no 31
Finishing and Fitting	Generator	94	100	BS 5228 Table C.4 ave 76-84
	Electric drills	104	50	BS 5228 Table D.6 no 54
	Welding plant	102	50	BS 5228 Table C.3 no 31
Access Roads and Car Parks	Excavator	102	50	BS 5228 Table C.2 ave 14-25
	Dumper	109	50	BS 5228 Table C.5 no 16
	Asphalt spreader	104	50	BS 5228 Table C.5 ave 30-31
	Road roller	103	50	BS 5228 Table C.5 ave 25-28

Appendix 10.C

Appendix 10C Noise Modelling

The following settings were used during the noise modelling.

Modelling Parameters and Assumptions

Ground Absorption:

- Hard ground (0) for the Site and surrounding area

(Note: Acoustically Soft = 1, Acoustically Hard = 0)

Proposed ground level:

- assumed to be the same as existing ground heights

Receptor heights:

- 1.5 m for ground floor height. For all other floor levels, the height of the receptor varies due to the height of floors being variable between the different existing and proposed buildings.

Order of Reflections = 3

Prediction methodology:

- Calculation of Road Traffic Noise (CRTN), 1988
- TRL (2006) Method for converting the UK road traffic noise index $L_{A10,18h}$ to EU Noise Indices for road noise mapping, TRL Report st/05/91/AGG04442.

Data Sources

The following information was provided by AECOM Dublin:

Site layout: OPRA-ACM-ZZC-ZZ-DR-AR-00501_Proposed Site Layout.dwg
Lidar data: Purchased from Bluesky, received 13.12.2018

Appendix 10.D

Appendix 10D Road Traffic Flows

Road traffic data, including flow, speed and % HGV for both the construction and operational phases were provided from the transport assessment and are given in Table 10D.1.

Table 10D.1: Operational Road Traffic Data

Road Link	2037 Base + Committed Do Minimum		2037 Base + Committed Do Something		Do Minimum and Do Something
	18 Hour AAWT	%HGV	18 Hour AAWT	%HGV	Speed (km/h)
Ellen Street	4512	1.9	5189	1.9	48
Rutland Street	20694	1.5	21695	1.5	48
Patrick Street	13416	1.5	14538	1.5	48
Francis Street	14571	1.2	15363	1.2	48
Bridge Street	11653	1.3	12125	1.3	48
R445 Bank Place	11502	1.6	12044	1.6	48
Michael Street	6214	1.8	7060	1.8	48

* Traffic speed was not available. It has therefore been assumed that traffic on all roads will flow at a speed of 48kph (30mph).