Appendix 9B

Noise Model Details

Noise Model

A 3D computer-based prediction model has been prepared in order to quantify the noise level associated with the proposed development. This section discusses the methodology behind the noise modelling process.

Brüel & Kjær Type 7810 Predictor

Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, Brüel & Kjær Type 7810 Predictor, calculates noise levels in accordance with ISO9613-2:1996 *Acoustics – Attenuation of Sound during Propagation Outdoors - General Method of Calculation*.

Brüel & Kjær Type 7810 Predictor is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. Predictor calculates noise levels in different ways depending on the selected prediction standard. In general, however, the resultant noise level is calculated taking into account a range of factors affecting the propagation of sound, including:

- the magnitude of the noise source in terms of A weighted sound power levels (LWA);
- the distance between the source and receiver;
- the presence of obstacles such as screens or barriers in the propagation path;
- the presence of reflecting surfaces;
- the hardness of the ground between the source and receiver;
- Attenuation due to atmospheric absorption; and,
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have significant impact at distances greater than approximately 400m).

Brief Description of ISO9613-2: 1996

ISO9613-2:1996 calculates the noise level based on each of the factors discussed previously. However, the effect of meteorological conditions is significantly simplified by calculating the average downwind sound pressure level, $L_{AT(DW)}$, for the following conditions:

- wind direction at an angle of ±45° to the direction connecting the centre of the dominant sound source and the centre of the specified receiver region with the wind blowing from source to receiver, and;
- wind speed between approximately 1 m/s and 5 m/s, measured at a height of 3 m to 11 m above the ground.

The equations and calculations also hold for average propagation under a well-developed moderate ground based temperature inversion, such as commonly occurs on clear calm nights.

The basic formula for calculating $L_{AT(DW)}$ from any point source at any receiver location is given by:

$$L_{fT(DW)} = LW + Dc - A \qquad \textbf{Eqn. A}$$

Where:

$L_{fT(DW)}$	is an octave band centre frequency component of $L_{AT(DW)}$ in dB relative to $2x10^{-5}$Pa;
L_W	is the octave band sound power of the point source;
D_c	is the directivity correction for the point source;
A	is the octave band attenuation that occurs during propagation, namely attenuation due to geometric divergence, atmospheric absorption, ground effect, barriers and miscellaneous other effects.

The estimated accuracy associated with this methodology is shown in Table A13 below:

Table A13-1: Estimated Accuracy for Broadband Noise of $L_{AT(DW)}$

Height, h[1]	Distance, d[2]	
	0 < d < 100m	100m < d < 1,000m
0<h<5m	±3 dB	±3 dB
5m<h<30m	±1 dB	±3 dB

Input Data and Assumptions

The noise model has been constructed using data from various source as follows:

- Site Layout — The general site layout has been obtained from the drawings forwarded by JB Barry Partners Ltd.
- Local Area — The location of noise sensitive receptors obtained from Ordinance Survey Ireland (OSI) provided by JB Barry Partners Ltd.
- Heights — Onsite building heights has been obtained from the drawings forwarded by JB Barry Partners Ltd.
- Contours — Site ground contours/heights have been obtained from site drawings forwarded by JB Barry Partners Ltd.

The final critical aspect of the noise model development is the inclusion of the various plant noise sources.

Noise data in relation to existing plant items has been gathered from site surveys. Noise measurements of existing noise sources on site were conducted by Ronan Murphy on 23 June 2016 in accordance with *BS EN ISO 3744:2010 Acoustics - Determination of Sound Power Levels and Sound Energy Levels of Noise Sources using Sound Pressure - Engineering Methods for an Essentially Free Field over a Reflecting Plane*. This standard involves the measurement of sound pressure at a set of points on an enveloping surface around the source, and applying a correction to the measured level to obtain the sound power

[1] *h is the mean height of the source and receiver.*

[2] *d is the mean distance between the source and receiver.*

These estimates have been made from situations where there are no effects due to reflections or attenuation due to screening.

of the source. Where direct noise measurement was not possible, noise data has been input into the model based on plant manufacturers' technical data and/or empirical formulae.

Noise data in relation to proposed new plant items has been based on manufacturers' literature. Where manufacturers' literature was not available for certain plant items, a number of assumptions have been made to estimate noise levels based on empirical data for such units.

Modelling Calculation Parameters

Prediction calculations for noise emissions have been conducted in accordance with ISO 9613-2:1996 *Acoustics – Attenuation of Sound during Propagation Outdoors - General Method of Calculation*. The following are the main aspects that have been considered in terms of the noise predictions presented in this instance.

Directivity Factor: The directivity factor (D) allows for an adjustment to be made where the sound radiated in the direction of interest is higher than that for which the sound power level is specified. In this case the sound power level is measures in a down wind direction, corresponding to the worst-case propagation conditions and needs no further adjustment.

Ground Effect: Ground effect is the result of sound reflected by the ground interfering with the sound propagating directly from source to receiver. The prediction of ground effects are inherently complex and depend on source height receiver height propagation height between the source and receiver and the ground conditions. The ground conditions are described according to a variable defined as G, which varies between 0.0 for hard ground (including paving, ice concrete) and 1.0 for soft ground (includes ground covered by grass trees or other vegetation) Our predictions have been carried out using various source height specific to each plant item, receiver heights of 1.6m for single storey properties and 4m for double. An assumed ground factor of G = 0.5 has been applied off site with the exception of the area covered by water during high tide which has been modelled with an assumed ground factor of G = 0.0.

Geometrical Divergence: This term relates to the spherical spreading in the free-field from a point sound source resulting in attenuation depending on distance according to the following equation:

$$\mathbf{A_{geo} = 20 \times \log(\text{distance from source in meters}) + 11}$$

Atmospheric Absorption: Sound propagation through the atmosphere is attenuated by the conversion of the sound energy into heat. This attenuation is dependent on the temperature and relative humidity of the air through which the sound is travelling and is frequency dependent with increasing attenuation towards higher frequencies.

In these predictions a temperature of 10°C and a relative humidity of 80% have been used, which give relativity low levels of atmosphere attenuation and corresponding worst case noise predictions.

The atmospheric attenuation outlined in Table A has been assumed for all calculations.

Table A13-2: Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Temp (ºC)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	80	0.11	0.38	1.02	1.97	3.57	8.76	28.72	103.21

Barrier Attenuation: The effect of any barrier between the noise source and the receiver position is that noise will be reduced according to the relative heights of the source, receiver and barrier and the frequency spectrum of the noise.

Model Receiver Coordinates

Table A13-3: Noise Model Receiver Coordinates

Receiver	Co-ordinates (ITM)	
	x	y
R01	719,254	732,660
R02	719,164	732,833
R03	719,079	732,966
R04	719,005	733,039
R05	718,904	733,124
R07	718,686	733,534
R08	718,876	733,734
R11	718,913	733,904
R06	718,810	733,189
R09	719,016	733,416
R10	719,133	733,536
R12	718,990	734,312