Tionscadal Soláthair Uisce
Water Supply Project

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(Appendix A6.4) Noise Modelling Details and Assumptions

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Contents

Acronyms and Abbreviations

Acronym	Meaning
A	The octave band attenuation that occurs during propagation, namely attenuation due to geometric divergence, atmospheric absorption, ground effect, barriers and miscellaneous other effects.
BPS	Booster Pumping Station.
BPT	Break Pressure Tank
dB	Decibel - The scale in which sound pressure level is expressed. It is defined as 20 times the logarithm of the ratio between the RMS (Root Mean Square) pressure of the sound field and the reference pressure of 20 micro-pascals (20μPa).
dB(A)	An 'A-weighted decibel' - a measure of the overall noise level of sound across the audible frequency range (20 Hz – 20 kHz) with A-frequency weighting (i.e. 'A'–weighting) to compensate for the varying sensitivity of the human ear to sound at different frequencies.
Dc	Is the directivity correction for the point source.
FCV	Flow Control Valve
Hz	Hertz: The unit of sound frequency in cycles per second.
LpA	Refers to those A-weighted sound pressure noise level.
LAeq	This 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).
Lw	The octave band sound power of the point source.
L_{WA}	Refers to the A weighted measure of sound power.
L_{fT}(DW)	An octave band centre frequency component of L_{AT}(DW) in dB relative to 2x10-5Pa.
R_W	Weighted sound reduction index. It is a laboratory measured value to identify the airborne sound insulation performance of a building element. It is used for internal or external walls, ceilings/floors, windows, doors, or any separating element. The higher the Rw value, the better that element performs in reducing sound transmission.
RWI&PS	Raw Water Intake & Pumping Station.
SPL	Sound Pressure Level typically expressed in Decibels.
TPR	Termination Point Reservoir
WTP	Water Treatment Plant.

1. Noise Modelling Details and Assumptions

1.1 Introduction to the Noise Model

1. 3D computer-based prediction models have been prepared to quantify the noise levels associated with the operation of the proposed infrastructure sites – namely the Raw Water Intake and Pumping Station (RWI&PS), Water Treatment Plant (WTP), Break Pressure Tank (BPT), Booster Pumping Station (BPS), Flow Control Valve (FCV) and Termination Point Reservoir (TPR). This document discusses the methodology behind the noise modelling process.

1.2 Calculation Software

2. Proprietary noise calculation software has been used for the purposes of this modelling exercise. The selected software, iNoise, calculates noise levels in accordance with ISO 9613-1:2024 - Acoustics — Attenuation of sound during propagation outdoors — Part 2: Engineering method for the prediction of sound pressure levels outdoors.

3. iNoise is a proprietary noise calculation package for computing noise levels in the vicinity of noise sources. iNoise 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 (L_{WA})
- 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
- Meteorological effects such as wind gradient, temperature gradient and humidity (these have a significant impact at distances greater than approximately 400m).

1.3 Brief Description of ISO9613-2:2024

4. ISO9613-2:2024 calculates the noise level based on each of the factors discussed in the previous section. 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
- Wind speed between approximately 1ms^{-1} and 5ms^{-1}, measured at a height of 3m to 11m above the ground.

5. 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.

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

$$L_{fT}(DW) = L_W + Dc – A$$

7. The estimated accuracy associated with this methodology is shown in Table A6.4.1:

A.6.4.1: Estimated Accuracy for Broadband Noise of L_{AT}(DW)

Height,h*	Distance, d†	
	0 < d < 100m	100m < d < 1,000m
0<h<5m	±3 dB	±3 dB
5m<h<3 0m	±1 dB	±3 dB

* h is the mean height of the source and receiver. † d is the mean distance between the source and receiver.

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

1.4 Input Data and Assumptions

8. The noise model has been constructed using data from various sources as follows:

Site Layout — The general site layouts have been obtained from the design drawings (see figures that support Chapter 4 (Project Description) in Volume 5 of the Environmental Impact Assessment Report).

Local Area — The location of noise sensitive locations have been obtained from a combination of supplied GeoDirectory data and Google Earth.

Heights — The heights of buildings on site have been obtained from the design drawings. Off-site buildings have been assumed to be 8 m high.

Topography — Flat ground has been assumed in all of the modelling for this study.

1.5 Modelling Calculation Parameters

9. Prediction calculations for noise emissions have been conducted in accordance with ISO 9613-1:2024 - Acoustics — Attenuation of sound during propagation outdoors — Part 2: Engineering method for the prediction of sound pressure levels outdoors. 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 measured 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 is 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). Predictions have been carried out using various source heights specific to each plant item, receiver heights of 1.6m for single storey properties and 4m for double. An assumed ground factor has been applied dependent on the ground conditions on and off-site. Noise contours presented in the assessment have been predicted to a height of 4m in all instances.

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:

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

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 70% have been used (Table A6.4.2), which give relativity low levels of atmosphere attenuation and corresponding worst-case noise predictions.

A.6.4.2: Atmospheric Attenuation Assumed for Noise Calculations (dB per km)

Temp (°C)	% Humidity	Octave Band Centre Frequencies (Hz)							
		63	125	250	500	1k	2k	4k	8k
10	70	0.12	0.41	1.04	1.92	3.66	9.70	33.06	118.4

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.

1.6 Source Sound Power Data and Building Attenuation

10. The following sections outline the noise assumptions made in the preparation of the noise model. Locations of plant that are predicted to be the largest contributors of noise within each of the infrastructure sites were highlighted by the design team. These items of plant are mainly internal with the exception of the substations and some items of plant within the WTP. Other external plant items include solar inverters and the proposed BESS at four of the infrastructure sites. In the absence of provided plant specific sound power levels, a series of assumptions have been made in this assessment in relation to the noise emissions from each of the infrastructure sites.

11. Sound level spectra for plant items have been derived from calculations published in acoustic literature[1] and compared to data available from AWN's database for similar sources. Where sound spectra data is unavailable sound power data has been inputted into the modelling at a frequency of 500 Hz.

12. The noise modelling used the assumed data shown in Table A6.4.3 in relation to the noise breakout from buildings on site as well as external items of plant and noise related to the substations within the infrastructure sites. It is assumed that noise from any plant associated with the development would not have any tonal or impulsive characteristics that would be audible to any noise sensitive location (NSL).

[1] Bies, Hansen and Howard Engineering Noise Control, 5th Ed. 2017.

A.6.4.3: L_{WA} Levels Utilised in Noise Model

Source	Octave Band Centre Frequencies (Hz)								
	63	125	250	500	1k	2k	4k	8k	dB (A)
BESS Units	-	-	-	90	-	-	-	-	90
Plant rooms (internal reverberant levels)	73	74	76	76	79	76	72	66	84
Substations	84	85	85	85	83	81	78	73	92
Sludge feed pumps (WTP)	77	78	80	80	83	80	76	70	89
Sludge transfer pumps (WTP)	73	74	76	76	79	76	72	66	85
Solar Inverter	-	-	-	58	-	-	-	-	58
Lagoon return pumps (WTP)	81	82	84	84	87	84	80	74	93

13. For items of plant housed internally, an assumed sound reduction index has been applied for the walls and roofs of each of the plant buildings within each of the infrastructure sites. For both the walls and roofs, a panel construction with a reduction of 25 R_w has been used. This performance is in line with the sound insulation data for typical unlined insulated cladding system panels. Reference has been made to the document Kingspan – Acoustic Performance Guide – Insulated Roof, Wall and Façade Systems[2]. The frequency dependent sound reduction index for the assumed roof and wall build-ups are presented in Table A6.4.3.

A.6.4.4: Assumed Plant Room Roof and Wall Reductions

Element	Octave Band Sound Reduction Indec R								
	63	125	250	500	1k	2k	4k	8k	R_w
Wall/façade panel construction	15	16	19	23	26	22	39	39	25
Roof panel construction	20	19	21	22	22	32	38	44	25

[2] Available at http://kingspan.wis-studio3.wis.nl/Media/download/10954/Acoustic%20Performance%20Guide%20UK%2006-05.pdf