UNDERWATER AND AIRBORNE NOISE ASSESSMENT

Remediation of the Former Irish Steel Works Factory Site

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1 Underwater Noise Assessment

The site investigation works proposed as part of the Project are potentially noisy activities when occurring in water and can occasionally emit significant noise into the marine environment where they occur on land very near water. This section outlines the typical in-water source levels associated with the proposed SI activities, the maximal likely in-water levels resulting from these and the potential emitted noise levels in the surrounding water.

1.1 SI Works Activities

Three activities have been assessed, as they are the noisiest activities with the greatest potential to leak noise into the marine environment:

1. Rotary coring – Drilling using a rotating corer, non-percussive, non-impulsive* noise. Geobor-S, 15 cm diameter.
2. Sonic drilling – Drilling using vibratory action, main vibration near the drilling head. Fast repeating oscillations, pseudo-percussive, non-impulsive* noise. Diameter 15 cm to accommodate above coring equipment.
3. Standard penetration testing – Repeated impacts on pile in the drilled whole, highly percussive, impulsive* noise.

* Non-impulsive/impulsive noise is used here in line with criteria for underwater noise:

Impulsive sounds:
Sounds which are typically transient, momentary (less than one second), broadband, and consist of high peak sound pressure with rapid rise time and rapid decay (ANSI, 2005; ANSI, 1986; NIOSH, 1998). This category includes sound sources such as seismic surveys, impact piling and underwater explosions. Additionally, sounds under 1 second in duration with a weighted kurtosis over 40 are included here (see note below*).

Non-impulsive (and continuous) sounds:
Sounds which can be broadband, narrowband or tonal, momentary, brief or prolonged, continuous or intermittent and typically do not have a high peak sound pressure with rapid rise/decay time that impulsive sounds do (ANSI, 1995; NIOSH, 1998).This category includes sound sources such as continuous vibro-piling, running machinery, some sonar equipment and vessels. Additionally, sounds over 1 second in duration with a weighted kurtosis under 40 are included here (see note below*).

* Note that the European Guidance: “Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications” (MSFD Technical Subgroup on Underwater Noise, 2014) includes sonar as impulsive sources (see Section 2.2 in the reference). However, the guidance suggests that “all loud sounds of duration less than 10 seconds should be included” as impulsive. This contradicts research on impact from

impulsive sounds suggesting that a limit for “impulsiveness” can be set at a kurtosis[1] of 40 (Martin & Klaus Lucke, 2020). See examples in Appendix A, Impulsiveness.

Therefore, a criterion of kurtosis over 40 is used here to identify impulsive sounds. The justification for departing from the MSFD criterion is that the NMFS 2024 and the Popper et al. 2014 frameworks thresholds are based on the narrower definition of impulsive as given in “Impulsive sounds” above.

1.2 Source levels

Representative source levels for the three noise sources (Sonic drilling, SPT and Rotary coring) are given as if the sources where in-water, as the dB scale conventionally used to specify sound level varies with the acoustic properties of the medium (e.g. air/water/soil) depending on the acoustic impedance[2] of that medium.

Representative band-wise levels are given in **Figure 1-1**, with broadband levels of 189, 175 and dB SPL for Sonic drilling, SPT and Rotary coring respectively.

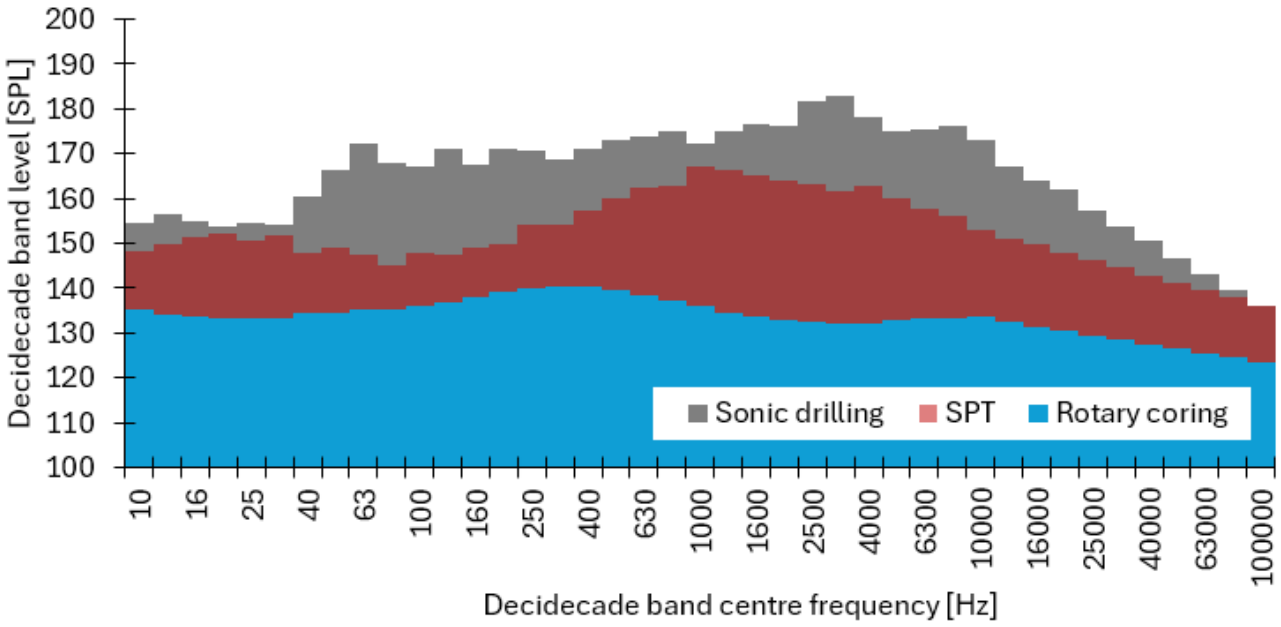


Figure 1-1 Band levels for the activities (represented as if in water).

1.3 Assessment Criteria

The assessment criteria follow the latest international guidance (based on the best available scientific information) to assess the expected worst-case in-water levels.

Thresholds for effects from peak sound pressure level (L_{pk}) and sound exposure level (SEL) are taken from the NOAA Fisheries “2024 Update to: Technical Guidance for Assessing the

[1] Statistical measure of the asymmetry of a probability distribution.

[2] Can be thought of as the acoustical “resistance”, if using a metaphor based on electrical circuits.

Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0)" (NMFS, 2024), the Acoustical Society of America (ASA) Report titled "Sound Exposure Guidelines for Fishes and Sea Turtles" (Popper, et al., 2014), and "National Marine Fisheries Service: Summary of Endangered Species Act Acoustic Thresholds (Marine Mammals, Fishes and Sea Turtles)" (NMFS [ESA], 2024). These three reports reflect the latest robust scientific consensus and recommended assessment criteria for assessing the effect of noise on marine mammals, fishes, and turtles.

The thresholds for marine mammals (and turtles) are compared to the received weighted[3] levels, with all marine mammals falling into one of six groups:

- LF – Low frequency cetaceans: Baleen whales.
- HF – High frequency cetaceans: Most dolphins and large toothed whales such as sperm whales, orcas and beaked whales.
- VHF – Very high frequency cetaceans: Porpoises, river dolphins and a few high-frequency specialised small dolphins.
- PW/PCW – Phocid carnivores in water: True seals.
- OC/OCW – Otarid carnivores in water and other marine mammals: Eared seals, walrus, polar bear, otter.
- SI – Sirenians: Manatees and dugongs, not relevant here.

The weightings associated with the groups are shown in **Figure 1-2**.

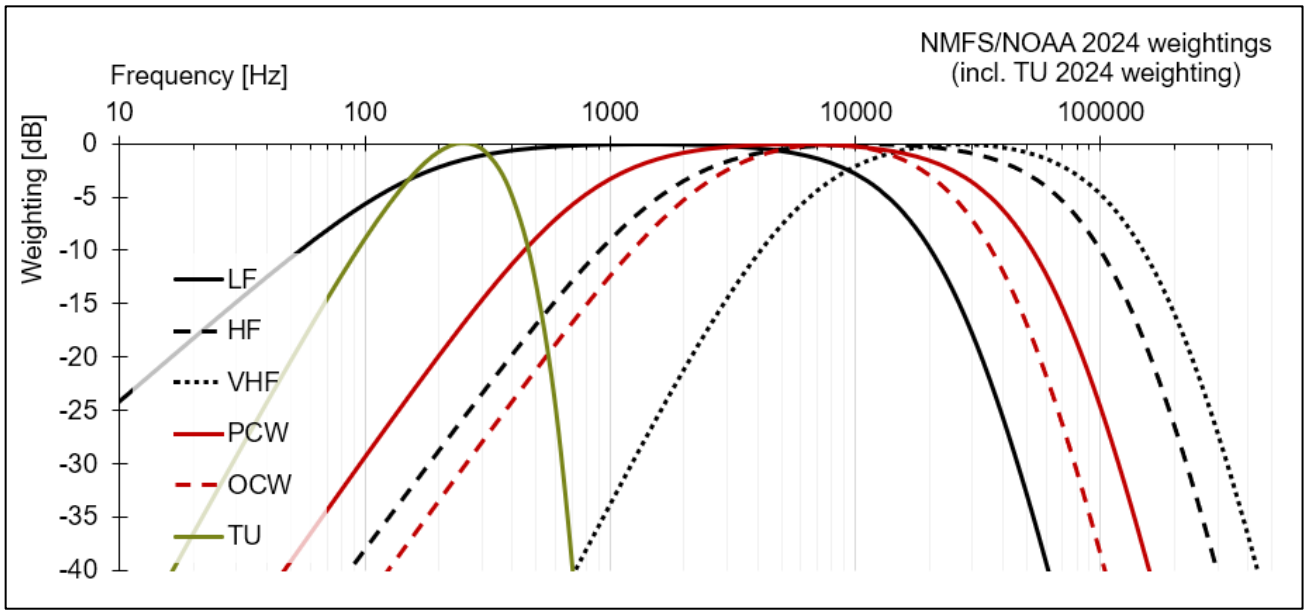


Figure 1-2 Auditory weighting functions for seals, whales, sirenians and turtles.

[3] L_{pk} levels are not weighted, but not relevant here.

The criteria for impulsive and non-impulsive sound are relevant for this report, given the nature of the sound sources used during the Project. The relevant AUD INJ and TTS criteria proposed by NMFS 2024 are summarised in **Table 1-1** and for fish, following Popper et al. 2014 and others, in **Table 1-2**.

Table 1-1 AUD INJ and TTS thresholds for marine mammals

Hearing Group	Parameter	Impulsive [dB]			Non-impulsive [dB]		
		AUD INJ	TTS	Behavioural* [SPL]	AUD INJ	TTS	Behavioural* [SPL]
Low frequency (LF) cetaceans	L_{pk}, (unweighted)	222	216	-	-	-	-
	SEL, (weighted)	183	168	120	197	177	120
High frequency (HF) cetaceans	L_{pk}, (unweighted)	230	224	-	-	-	-
	SEL, (weighted)	193	178	106	201	181	113
Very high frequency (VHF) cetaceans	L_{pk}, (unweighted)	202	196	-	-	-	-
	SEL, (weighted)	159	144	98	181	161	103
Phocid carnivores in water (PCW)	L_{pk}, (unweighted)	223	217	-	-	-	-
	SEL, (weighted)	183	168	120	195	175	120
Other marine carnivores in water (OCW)	L_{pk}, (unweighted)	230	224		-	-	
	SEL, (weighted)	185	170	120	199	179	120

* The behavioural thresholds are all SPL and are based on a conservative but realistic approach derived from a review of Danish and UK guidance documents, as well as scientific reviews, and reflects the approach of the Danish guidance (Danish Centre for Environment and Energy, 2021) and a review submitted to the JNCC (Joint Nature Conservation Committee) of the UK (Nedwell, et al., 2007). A review for Natural Resources Wales (Sinclair, et al., 2023) also acknowledges this approach as suitable.

Table 1-2 Criteria for onset of injury to fishes due to impulsive noise. For this assessment, the lowest threshold for any group is used for all groups

Type of Animal	Unit	Mortality and Potential Mortal Injury [dB]	Recoverable Injury (AUD INJ) [dB]	TTS [dB]	Behavioural [dB]
Fish: no swim bladder (particle motion detection) Example: Sharks.	SEL	219[1]	216[1]	186[1]	150[3]
	L_{pk}	213[1]	213[1]	193[2]	160[2]
Fish: where swim bladder is not involved in hearing (particle motion detection). Example: Salmonoids.	SEL	210[1]	203[1]	186[1]	150[3]
	L_{pk}	207[1]	207[1]	193[2]	160[2]
Fish: where swim bladder is involved in hearing (primarily pressure detection). Example: Gadoids (cod-like).	SEL	207[1]	203[1]	186	148[4] [SPL]
	L_{pk}	207[1]	207[1]	193[2]	160[2]
Sea turtles	SEL	210[1]	(*Near*) High* (*Mid*) Low (*Far*) Low	-	-
	L_{pk}	207[1]		-	-
Eggs and larvae	SEL	210[1]	(*Near*) Moderate (*Mid*) Low (*Far*) Low	-	-
	L_{pk}	207[1]		-	-

[1] (Popper et al. 2014) table 7.4, [2] (Worcester, 2006), [3] (WSDOT, 2020), [4] (Danish Centre for Environment and Energy, 2021; Sinclair, et al., 2023; Nedwell, et al., 2007).

* Indicate (range) and risk of effect, e.g., "(Near) High", meaning high risk of that effect when near the source.

1.4 Estimation of in-soil Transmission Losses

The SI works nearest the water are at a range of c. 20 m to the water (southernmost sampling points). These will be used to estimate the worst-case noise levels.

To estimate the transmission losses through the made ground/soil a numerical model was used (dBSeaPE[4]), assuming saturated soil.

The transmission loss was shown to be well approximated by:

$$TL = 19 \times \log_{10}(r) + (0.00016 \times f) \times r$$

Where "*r*" is the range, given in meters and "*f*" the frequency, given in hertz.

[4] See Benchmark Testing | dBSea Documentation for validation examples.

1.4.1 Additional Losses

Depending on the precise soil conditions present there will be various transitions between the soil, made ground and concrete associated with the coastal defence and road foundations. These additional losses can be approximated using Fresnel's equations governing transmission of sound through interfaces;

$$\frac{P_t}{P_i} = \frac{2 \cdot Z_2 \cdot \cos(\theta_t)}{Z_2 \cdot \cos(\theta_i) + Z_1 \cdot \cos(\theta_t)}$$

With "Z" being the acoustic impedance, "θ" the angle, "1" and "2" referring to first and second material and "i" and "t" referring to incident and transmitted pressure respectively. The energy loss can be found by integrating over all possible transmission angles (180 degrees).

The transmission loss over a concrete-to-water interface is approximately 14 dB.

1.5 Reasonable worst case in-water levels

Applying the above losses to the source levels gives the estimated, reasonable worst-case scenario for the in-water levels, for the three activities (see **Figure 1-3**).

The broadband levels are 145, 132 and 111 dB SPL for Sonic drilling, SPT and Rotary coring respectively.

Note also that the none of the sound reaching the water will be of impulsive character.

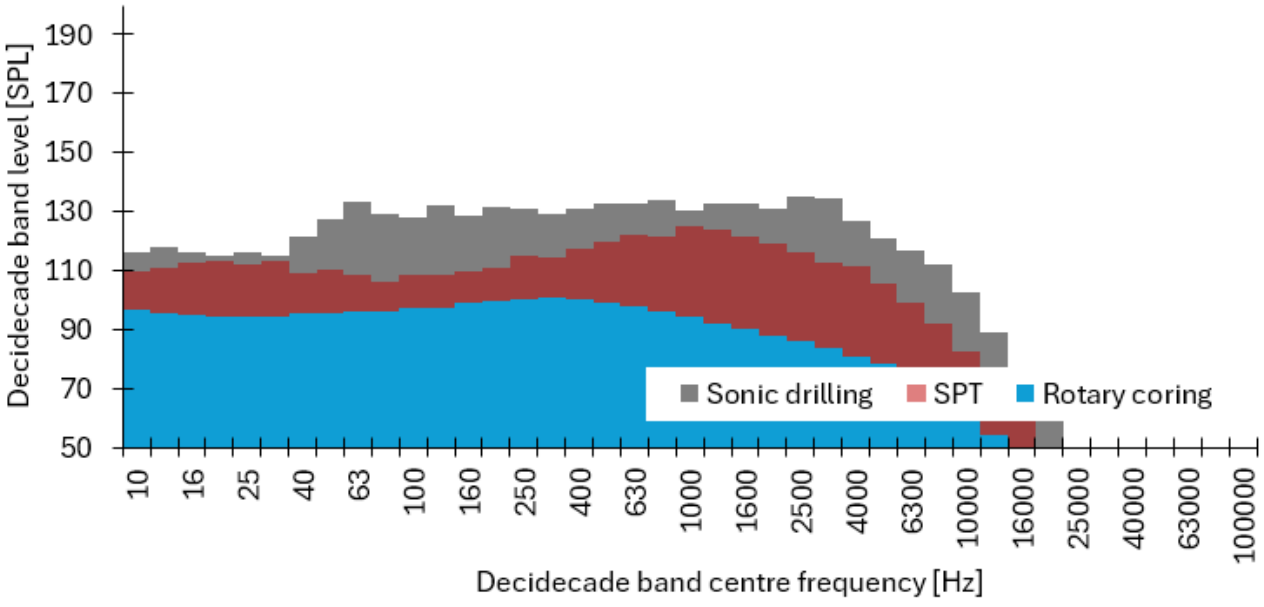


Figure 1-3 Worst-case estimate of in-water levels.

To compare the levels to the assessment thresholds, weightings are applied to give the weighted received level presented in **Table 1-3** (no weightings for fish).

Table 1-3 Weighted received level for marine mammals

Weighted broadband levels [SPL]	LF (baleen whales)	HF (most dolphins)	VHF (porpoises)	PW (true seals)	OW (otters and other marine mammals)
Rotary coring	94	78	100	92	94
Sonic drilling	138	124	141	137	138
SPT	124	107	128	122	124

1.6 Assessment Summary

The in-water noise levels from the SI activities are below TTS thresholds for all species groups (even with cumulative exposure over time), and only marginally above the behavioural noise thresholds. Furthermore, the applicability of the behavioural thresholds for noise transmitted though land is not straightforward and given the effects of in-soil transmission (lengthening and absorption of higher frequencies) the noise will be similar in character to vessel noise (typically 150-180 dB SPL), at or below exiting noise levels in the area, and therefore unlikely to elicit any behavioural responses.

In summary, the noise contribution to the surrounding water will be negligible.

2 Airborne Noise Assessment

2.1 Overview

As part of the pre-application meeting for this MUL, MARA requested an assessment of the noise impact of the proposed SI works. This section details potential noise impacts of the specific ground investigation methods proposed with reference to guidance contained within 'Construction and Waterfowl: Defining Sensitivity, Response, Impacts and Guidance', published by the Institute of Estuarine & Coastal Studies (Cutts et al., 2009).

2.2 Noise Criteria

Impulsive and irregular noise has the potential to cause greater disturbance to waterfowl than continuous noise. Cutts et al. (2009) associate noise levels below 50 dB(A) with a low level of disturbance. The report also differentiates between regular and irregular noise in the 50 to 70 dB(A) range, assigning a lower disturbance category to regular noise and a higher category to irregular noise. For piling-related activity, regular piling noise below 70 dB(A) is classified as moderate, while irregular piling noise above 70 dB(A) is classified as high to moderate.

The indicative response descriptors for different construction noise conditions outlined in the report are:

- Noise below 50 dB: Low
- Regular noise (50-70 dB): Low to moderate
- Irregular noise (50-70 dB): Moderate.
- Regular piling noise (below 70 dB): Moderate.
- Irregular piling noise (above 70 dB): High to moderate.

2.3 Noise Assessment

Table 2-1 presents the plant items required for the SI works. This assessment has assumed that trial pit excavations, borehole drilling and standard penetration testing will be undertaken simultaneously in close proximity to each other. This is a conservative assumption and in reality, not likely to occur.

Predicted noise levels at various distances from the SI works are shown in **Table 2-2**. Noise modelling has been undertaken in accordance with ISO 9613-2:2024 Acoustics – Attenuation of sound during propagation outdoors – Part 2: Engineering method for the prediction of sound pressure levels outdoors. Conservatively, corrections for atmospheric absorption and screening from surrounding structures have been omitted from the predictions. Additionally, 100% hard ground has been assumed.

Table 2-1 Plant for Site Investigation Works

Plant	BS 5228 Ref.	Activity	L_{wA} (dB)
Tracked mechanical excavator (22t) [Caterpillar® 320]	C.4.64	Trial pit excavations	103
Rotary core drilling rig [Comacchio 602]	C.3.14	Drilling boreholes	111
Standard penetration testing [Large hydraulic hammer rig assumed*]	C.3.1	Standard penetration testing	117

* This is a conservative assumption. The actual plant is likely to be smaller with a lower L_{wA}.

Table 2-2 Predicted Noise Levels for Site Investigation Works

Combined Sound Power Level	Predicted Noise Level, L_{Aeq} (dB) at Various Distances				
	100 m	200 m	500 m	1000 m	1500 m
SI Works (118 dB L_{wA})	70	64	56	50	47

2.4 Assessment Summary

Noise levels resulting from the SI works are predicted to be equal to 70 dB at 100 m from the site. At its closest point, the MUL Area is 1.5 km from the boundary of the Cork Harbour SPA. Predicted noise levels at this distance are 47 dB, which is less than the 50 dB disturbance category outlined in Cutts et al. (2009) indicating a low level of disturbance on birds.

3 References

ANSI, 1986. *S12.7-1986 Method for Measurement of Impulsive Noise.* s.l.:American National Standards Institute.

ANSI, 1995. *S3.20-1995 Bioacoustical Terminology.* s.l.:American National Standards Institute.

ANSI, 2005. *S1.13-2005 Measurement of Sound Pressure Levels in Air.* s.l.:American National Standards Institute.

Danish Centre for Environment and Energy, 2021. *Thresholds for behavioural responses to noise in marine mammals,* Aarhus: Aarhus Universitet.

Martin, S. B. & Klaus Lucke, D. R. B., 2020. Techniques for distinguishing between impulsive and non-impulsive sound in the context of regulating sound exposure for marine mammals. 147(4).

MSFD Technical Subgroup on Underwater Noise, 2014. *Monitoring Guidance for Underwater Noise in European Seas, Part II: Monitoring Guidance Specifications,* s.l.: European commision.

Nedwell, .. et al., 2007. *A validation of the dBht as a measure of the behavioural and auditory effects of underwater noise,* s.l.: subacoustech.

NIOSH, 1998. *Criteria for a Recommended Standard: Occupational Noise Exposure.* s.l.:National Institute for Occupational Safety and Health.

NMFS [ESA], 2024. *National Marine Fisheries Service: Summary of Endangered Species Act Acoustic Thresholds (Marine Mammals, Fishes, and Sea Turtles),* s.l.: National Marine Fisheries Service.

NMFS, 2024. *2024 Update to: Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0),* Silver Spring: National Marine Fisheries Service.

Popper, A. N. et al., 2014. *Sound Exposure Guidelines for Fishes and Sea Turtles,* s.l.: Springer.

Sinclair, R. et al., 2023. *Review and recommendations on assessment of noise disturbance for marine mammals,* Bangor: Natural Resources Wales.

Worcester, T., 2006. *Effects of Seismic Energy on Fish; A Literature Review,* Dartmouth, Canada: Department of Fisheries and Oceans, Bedford Institute of Oceanography.