

ARDERSIER PORT ENERGY TRANSITION FACILITY PORT EXTENSION



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Appendix 11.5: Underwater Noise Modelling Assessment



Construction Works – Port of Ardersier: Underwater Noise Modelling Assessment

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Executive Summary

An assessment of the likely effect of underwater noise on marine mammals and fish from planned construction works at the Port of Ardersier, Scotland, has been undertaken by Subacoustech Environmental Ltd. The assessment covers the noise generated from impact piling, vibropiling and cutter suction dredging. Detailed numerical noise propagation modelling of the survey was used to generate noise contours, which were then used to predict the likely impact ranges to the relevant noise exposure criteria for marine mammals and fish.

The results have been interpreted using the guidelines provided in Southall *et al.* (2019), NMFS (2024) and NOAA (2005) for marine mammals, and Popper *et al.* (2014) for fish. These interpretations are based on worst-case parameters with no implemented mitigation measures.

The most sensitive marine mammal species, harbour porpoise, are likely to exceed the permanent auditory injury onset if they are 60 m from impact piling at maximum energy, based on the instantaneous criteria, but in practice marine mammals would be expected to flee from the piling position and would be much further than this distance by the time maximum energy is reached. As a result, when considering the cumulative exposure criteria, any marine mammal species would have to be less than 10 m from the pile at the commencement of piling soft start for the criteria to be exceeded. It is unlikely that vibropiling or dredging will cause permanent auditory injury at any distance from the source for all marine mammal species. Marine mammals are likely to be at risk of disturbance at 2900 m from vibropiling, 2500 m from dredging, and 1000 m from impact piling.

Fish, such as salmon, trout, herring, cod, sprat and shad are predicted to be at risk of mortality if they are at 30 m of impact piling. All fish are at low risk of mortality at any distance from vibropiling or dredging, however, fish such as herring, cod, sprat and shad at risk of recoverable injury if they are within 20 m from the vibropiling, or within < 10 m from dredging.

Note that the modelling calculations and predicted impact ranges will produce results that should be considered indicative of the potential onset of effects on receptors during the works and should not be considered as absolute ranges.

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Terminology

Decibel (dB)	A customary scale commonly used (in various ways) for reporting levels of sound. The dB represents a ratio/comparison of a sound measurement (e.g., sound pressure) over a fixed reference level. The dB symbol is followed by a reference value (e.g., re 1 μ Pa).
Peak pressure	The highest pressure above or below ambient that is associated with a sound wave.
Permanent Threshold Shift (PTS)	Noise threshold that represents the onset level of a permanent impairment hearing caused by acoustic trauma. PTS results in irreversible damage to the sensory hair cells of the ear, and thus a permanent reduction of hearing acuity.
Root Mean Square (RMS)	The square root of the arithmetic average of a set of squared instantaneous values. Used for presentation of an average sound pressure level.
Sound Exposure Level (SEL or $L_{E,p}$)	The constant sound level acting for one second, which has the same amount of acoustic energy, as indicated by the square of the sound pressure, as the original sound. It is the time-integrated, sound-pressure-squared level. SEL is typically used to compare transient sound events having different time durations, pressure levels, and temporal characteristics.
Sound Exposure Level, cumulative (SEL _{cum} or $L_{E,p,t}$)	Single value for the collected, combined total of sound exposure over a specified time or multiple instances of a noise source.
Sound Exposure Level, single strike (SEL _{ss})	Calculation of the sound exposure level representative of a single noise impulse, typically a pile strike.
Sound Pressure Level (SPL or L_p)	The sound pressure level is an expression of sound pressure using the decibel (dB) scale; the standard frequency pressures of which are 1 μ Pa for water and 20 μ Pa for air.
Sound Pressure Level Peak (SPL _{peak} or $L_{p,pk}$)	The highest (zero-peak) positive or negative sound pressure, in decibels.
Temporary Threshold Shift (TTS)	Onset threshold level for a temporary reduction of hearing acuity caused by exposure to sound over time.
Unweighted sound level	Sound levels which are “raw” or have not been adjusted in any way, for example to account for the hearing ability of a species.
Weighted sound level	A sound level which has been adjusted with respect to a “auditory weighting function” or “weighting envelope” in the frequency domain, typically to make an unweighted level relevant to a particular species.

Units

dB	Decibel (sound pressure)
Hz	Hertz (frequency)
kg	Kilogram (mass)
kJ	Kilojoule (energy)
kHz	Kilohertz (frequency)
km	Kilometre (distance)
kW	Kilowatt (power)
m	Metre (distance)
mm	Millimetre (distance)
mms^{-1}	Millimetres per second (particle velocity)
ms^{-1}	Metres per second (speed)
Pa	Pascal (pressure)
Pa^2s	Pascal squared seconds (acoustic energy)
μPa	Micropascal (pressure)

Acronyms

CSD	Cutter Suction Dredging
EMODnet	European Marine Observation and Data Network
HF	High-Frequency Cetaceans
LF	Low-Frequency Cetaceans
MHWS	Mean High Water Springs
PCW	Phocid Carnivores in Water
PW	Phocid Pinnipeds in Water
PPV	Peak Particle Velocity
PTS	Permanent Threshold Shift
RMS	Root Mean Square
SE	Sound Exposure
SEL ($L_{E,p}$)	Sound Exposure Level
SEL _{cum} ($L_{E,p,t}$)	Cumulative Sound Exposure Level
SEL _{ss} ($L_{E,p,s}$)	Single Strike Sound Exposure Level
SPL (L_p)	Sound Pressure Level
SPL _{peak} ($L_{p,pk}$)	Peak Sound Pressure Level
SPL _{RMS} ($L_{p,RMS}$)	Root Mean Square Sound Pressure Level
TSHD	Trailer Suction Hopper Dredging
TTS	Temporary Threshold Shift
VHF	Very High-Frequency Cetaceans

1 Introduction

1.1 Project Overview

Subacoustech Environmental have been requested by SMRU Consulting to undertake an underwater noise modelling assessment for the planned construction works at the Port of Ardersier in the Moray Firth, Scotland, UK.

The construction works are part of plans to expand the port to facilitate the growing demand in port space from the offshore wind industry. The anticipated works plan to install 34 steel tubular piles, which may require the use of impact piling, vibratory (vibro) piling or a combination of both techniques. Deepening of the inner harbour is also planned to use both trailer suction hopper dredging (TSHD) or cutter suction dredging (CSD) in an area near the pile installation site.

An underwater noise assessment is required to consider the potential impact from the noise generated from the works on all marine mammals and fish in the region. This report provides the results of a detailed modelling assessment for piling and dredging activities associated with the works. The modelling has been used to predict the received sound pressure levels and sound exposure levels generated during these noise-generating activities in the region, which are then used to assess the potential impacts for marine mammals and fish.

1.2 Noise Sources

Underwater noise sources that could impact marine fauna, and have therefore been included in the assessment are:

- Impact piling
- Vibropiling
- Dredging

Since CSD is louder than TSHD, only CSD was considered in the assessment, as a worst-case scenario. Details of the input parameters used for the modelling of each of these sources in the assessment are presented in Section 3.1.5.

1.3 Study Area

The area associated with the piling and dredging activities are shown in Figure 1-1. The area is strongly tidal, with tidal levels of a maximum astronomical tidal range of 4.6 m, a mean spring tidal range of 3.3 m and mean neap tidal range of 1.6 m. The area shows bathymetry which gradually gets deeper towards the North Sea, and deep channels running into the Moray Firth and the Cromarty Firth. The maximum depth in the area shown in Figure 1-1 is 57.3 m.

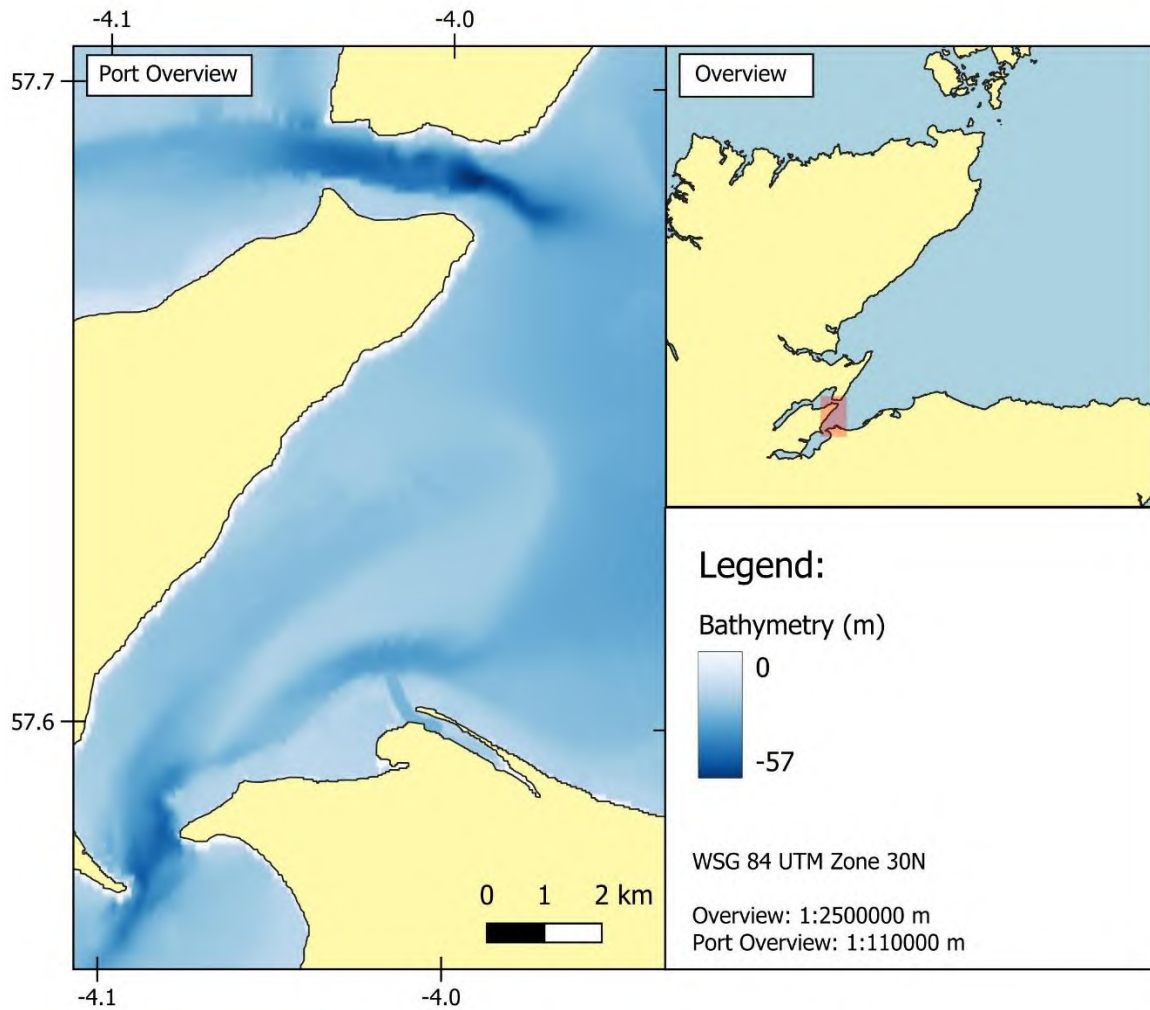


Figure 1-1: An overview of the Port of Ardersier, Moray Firth, Scotland, in the context of the UK, including the bathymetry of the area.

1.4 Document Overview

This report presents a detailed assessment of the potential underwater noise from the construction works at the Port of Ardersier, and covers the following:

- Section 2: Review of background information on the units for measuring and assessing underwater noise.
- Section 3: Discussion of the modelling approach, input parameters and assumptions for the noise modelling undertaken.
- Section 4: Presentation of detailed noise modelling and interpretation of the results using suitable noise metrics and criteria.
- Section 5: Summary and conclusions.

2 Underwater Noise Concepts

Sound travels much faster in water (approximately 1,500 ms⁻¹) than in air (343 ms⁻¹) as water is relatively incompressible and has a higher density than air. This affects the way in which sound measurements are expressed between the two mediums, which means that underwater sound levels are not directly comparable to airborne sound levels. This is noted for context; this report does not contain or include any reference to airborne sound levels.

2.1 Units of Measurement

Sound measurements are usually expressed using the decibel (dB) scale, which is a logarithmic measure of sound. The dB scale represents a ratio, and therefore, it is used with a reference unit, which is the base from which the ratio is expressed. The fundamental definition of the dB scale is given in Equation 1:

(1)

$$\text{Sound pressure level } (L_p) = 20 \log_{10} \left(\frac{P}{P_{ref}} \right)$$

where P is pressure, measured in Pascals (Pa), and P_{ref} is the reference pressure, also measured in Pa. For underwater noise, a reference pressure of 1 μ Pa (1x10⁻⁶ Pa) is used as defined in ISO 18405:2017. Noise can be quantified using various metrics depending on the nature of the sound, as discussed below.

2.1.1 Sound Pressure Level

Sound Pressure Level (SPL or L_p) is a measure of the pressure variation caused by sound waves, expressed in decibels (dB), as seen in Equation 1. Variations of L_p are used depending on the noise source being measured. Unless otherwise defined, all L_p noise levels in this report are referenced to 1 μ Pa.

2.1.1.1 Level of the Mean Squared Sound Pressure

For continuous, non-impulsive noise sources such as drilling or vibropiling, an unweighted sound pressure level, averaged over a measurement period, known as a root mean squared (RMS) sound pressure level (SPL_{RMS} or $L_{p,RMS}$), can be used to represent the noise levels. The RMS period must be specified (e.g. $L_{p,RMS,125ms}$), as the mean level can vary significantly depending on the measurement duration.

2.1.1.2 Level of the Peak Sound Pressure

Transient, impulsive pressure waves, such as generated from impact piling are usually expressed using level of the peak sound pressure (SPL_{peak} or $L_{p,pk}$). This is calculated using the maximum pressure variation from positive to zero, representing the peak change in pressure as the transient wave propagates.

2.1.2 Sound Exposure Level

Sound Exposure Level (SEL or $L_{E,p}$) is a measure of Sound Exposure (SE), which represent the total acoustic energy of a sound event in decibels (dB), accounting for both the sound's intensity and duration. $L_{E,p}$ provides a way to quantify the total energy in a sound, making it useful for assessing the impact of both continuous and transient sounds. Variations of $L_{E,p}$ are used depending on the noise source being measured. For context, $L_{E,p}$ can be compared L_p using Equation 2:

(2)

$$L_{E,p} = L_p + 10 \times \log_{10} T$$

where the L_p is a measure of the average level of broadband noise and the $L_{E,p}$ sums the cumulative broadband noise energy. For continuous sounds shorter than one second, the $L_{E,p}$ is lower than the L_p . For durations longer than one second, the $L_{E,p}$ exceeds the L_p (e.g., a 10-second sound results in a 10 dB higher $L_{E,p}$ and a 100-second sound gives a 20 dB higher $L_{E,p}$). Unless otherwise defined, all $L_{E,p}$ noise levels in this report are referenced to $1 \mu\text{Pa}^2\text{s}$.

2.1.2.1 Single Strike Sound Exposure Level

Single strike Sound Exposure Level (SEL_{ss} or $L_{E,p,ss}$) refers to the total acoustic energy from a single, loud, short duration noise event (such as a blast or impact) measured over a specified duration. This can be expressed using Equation 3:

(3)

$$L_{E,p,ss} = 10 \times \log_{10} \left(\frac{\int_0^T p^2(t) dt}{p_{ref}^2 T_{ref}} \right)$$

where p is the acoustic pressure in Pascals, T is the total duration of sound in seconds, and t is time in seconds.

2.1.2.2 Cumulative Sound Exposure Level

A cumulative Sound Exposure Level (SEL_{cum} or $L_{E,p,t}$) accounts for the exposure from multiple impulses or pile strikes over time, where the number of impulses replaces the T in the Equation 3, leading to Equation 4:

(4)

$$L_{E,cum} = L_{E,p,ss} + 10 \times \log_{10} X$$

Where X is the total number of impulses or strikes.

2.2 Properties of Sound

2.2.1 Impulsive vs Non-impulsive

Sound can be categorised loosely into two types: impulsive and non-impulsive. These can be defined as:

- Non-impulsive: a steady-state sound. It does not necessarily have to have a long duration.
 - Examples: vibropiling, drilling
- Impulsive: a sound with a high peak sound pressure, short duration, fast rise-time and broad frequency content at the source.
 - Examples: seismic airguns, explosives, impact piling

These differences are crucial for assessing auditory injury, as impulsive sound is typically more harmful than non-impulsive sound. Different metrics are needed to describe these distinct sound sources:

- Impulsive: Use SPL_{peak} ($L_{p,pk}$) or SEL_{cum} ($L_{E,p,ss}$ or $L_{E,p,t}$)
- Non-impulsive: Use SPL_{RMS} ($L_{p,RMS}$) or SEL_{cum} ($L_{E,p,t}$).

Categorising sound as impulsive or non-impulsive can be challenging, especially over long distances. As impulsive sounds travel, their energy dissipates, making them less impulsive and therefore potentially less injurious. Ongoing research, such as Martin *et al.* (2020), aims to define these categories. Hastie *et al.* (2019) found that impulsive sound can be considered non-impulsive 3.5 km from the source, while Southall (2021) suggests noise should be non-impulsive if energy above 10 kHz is absent. Research is ongoing to refine pulse characteristics, like kurtosis, for better categorisation.

2.2.2 Particle Motion

Particle motion, a key component of sound, describes the back-and-forth movement of particles in a medium, such as water, caused by sound waves. Unlike sound pressure, particle motion contains directional information (Hawkins and Popper, 2017). It is typically quantified by peak particle velocity (PPV), though acceleration or displacement can also be used. Research shows many fish species and marine invertebrates are sensitive to particle motion (e.g., Popper and Hawkins, 2019; Nedelec *et al.*, 2016, Radford *et al.*, 2012, Sole *et al.*, 2023), but sound pressure metrics are still more commonly used due to limited data (Popper and Hawkins, 2018). Calls for further research on particle motion levels and effects continue.

2.3 Analysis of Environmental Effects: Assessment Criteria

Over the past 20 years, it has become clear that human-generated underwater noise impacts marine species. The severity of these effects depends on factors like sound level, frequency, exposure duration, and repetition rate (Hastings and Popper, 2005). As a result, research on aquatic species' hearing abilities has grown, with studies focused on high-level noise sources such as seismic airguns, impact piling, and blasting, which have the most immediate environmental effects, though interest in chronic noise exposure is rising.

The impacts of underwater sound on marine species can be broadly summarised as follows:

- Physical traumatic injury and fatality.
- Auditory injury (either permanent or temporary).
- Behavioural responses (including disturbance)

The following sections outline the underwater noise criteria used in this study for marine mammals and fish species in the Moray Firth.

2.3.1 Marine Mammals

Three criteria exist. These are:

- Southall et al. (2019): Marine Mammal Noise Exposure Criteria
- NMFS (2024): Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing
- NOAA (2005): National Marine Fisheries Service: Summary of Marine Mammal Protection Act Acoustic Thresholds

It should be noted that notation in these sources referring to peak SPL, root-mean-square SPL and cumulative SEL has since been deprecated (ISO 18405:2017) and will be referred to as $L_{p,pk}$, $L_{p,RMS}$ and $L_{E,p,t}$ in the rest of this report.

These criteria present noise impact thresholds for marine mammal groups based on:

- The sound type (impulsive or non-impulsive)
- The type of auditory injury of concern

Impact ranges based on impulsive criteria are recommended for most sources, except clearly non-impulsive ones. However, if the predicted range exceeds 3.5 km (see Section 1.2.1), the true impact range is likely to lie between the impulsive and non-impulsive ranges. Thus, both criteria are considered unless the sound source is explicitly non-impulsive.

For SEL_{cum} ($L_{E,p,t}$) thresholds in marine mammals, a fleeing animal model is used, assuming the animal swims away from the sound source. These are worst-case assumptions, as marine mammals can swim faster under stress (Kastelein *et al.*, 2018), particularly at the start of a noisy event when they are closest to the source. The following flee speeds are applied for each marine mammal group:

- 2.1 ms⁻¹ for LF cetaceans (Scottish Natural Heritage; SNH, 2016)
- 1.52 ms⁻¹ for HF cetaceans (Bailey and Thompson, 2006)
- 1.4 ms⁻¹ for VHF cetaceans (SNH, 2016)
- 1.8 ms⁻¹ for PCW/PW pinnipeds (SNH, 2016)

2.3.1.1 Southall *et al.* (2019): Auditory Injury (PTS and TTS) criteria

Southall *et al.* (2019), an update of the 2007 version, is the most recognised reference for marine mammal hearing thresholds and aligns with the thresholds provided in the National Marine Fisheries Service (NMFS, 2018) guidance. However, the hearing groups are described differently, so caution is needed when comparing results using these criteria.

The Southall *et al.* (2019) guidance categorises marine mammals into groups based on similar species and applies filters to the unweighted noise levels to approximate their hearing sensitivities. These groups are summarised in Table 2.1, with auditory weighting functions in Figure 2.1. Additional groups for sirenians and other marine carnivores are provided but not included in this study, as these species are not common in the Moray Firth.

Table 2-1: Marine mammal hearing groups (from Southall *et al.*, 2019).

Hearing group	Auditory Weighting Function	Generalised hearing range	Species group	Example species
Low-frequency Cetaceans	LF	7 Hz to 35 kHz	Baleen whales	Fin Whale, Minke Whale, Humpback Whale
High-frequency Cetaceans	HF	150 Hz to 160 kHz	Toothed whales, including dolphins and beaked whales	Bottlenose Dolphin, White-beaked Dolphin, Risso’s Dolphin, Common Dolphin, Orca
Very high-frequency Cetaceans	VHF	275 Hz to 160 kHz	True porpoise	Harbour porpoise
Phocid carnivores in water	PCW	50 Hz to 86 kHz	True seals	Harbour seal, Grey Seal

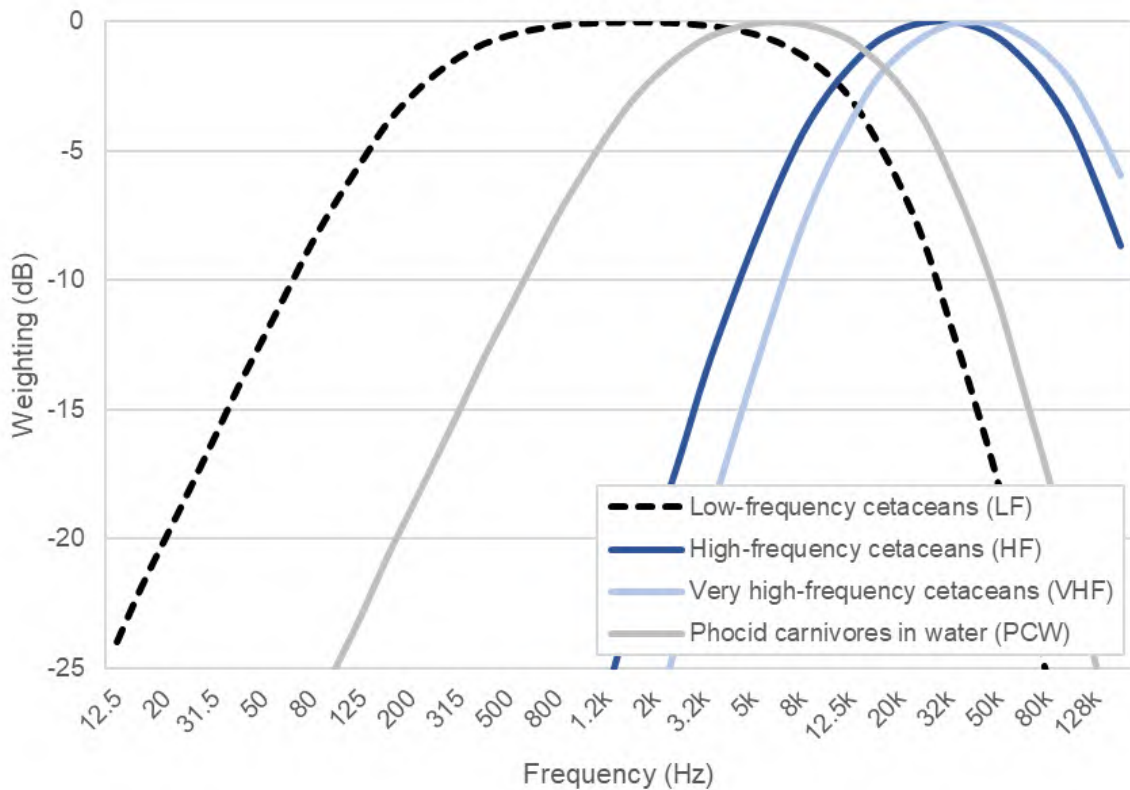


Figure 2-1: Auditory weighting functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PCW) (from Southall *et al.*, 2019)

Southall *et al.* (2019) presents different impact thresholds for impulsive and non-impulsive sound criteria, based on varying levels of auditory injury at different sound levels. Potential auditory impacts are categorised into two types:

- PTS (permanent threshold shift): the greatest severity, which is unrecoverable (but incremental) reduction in hearing sensitivity.
- TTS (temporary threshold shift): the least severity, which is a short-term reduction in hearing sensitivity.

TTS typically results in the largest impact range, but PTS represents the most significant and permanent impairment, making it the key impact threshold.

*Impact piling is an impulsive sound source, and vibropiling and dredging are non-impulsive sound sources. Therefore, this study has considered the both impulsive and non-impulsive sound criteria for marine mammal PTS and TTS thresholds using the $L_{p,pk}$ and $L_{E,p,24h}$ metrics from Southall *et al.* (2019), which is summarised in Table 2-2 and*

Table 2-3.

Table 2-2: Peak SPL ($L_{p,pk}$) criteria for PTS and TTS in marine mammals (Southall *et al.*, 2019)

Southall <i>et al.</i> (2019)	$L_{p,pk}$ (dB re 1 μ Pa)	
	Impulsive	
	PTS	TTS
Low-frequency cetaceans (LF)	219	213
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid carnivores in water (PCW)	218	212

Table 2-3: Cumulative SEL ($L_{E,p,24h,wtd}$) criteria for PTS and TTS in marine mammals (Southall *et al.*, 2019)

Southall <i>et al.</i> (2019)	$L_{E,p,24h,wtd}$ (dB re 1 μ Pa ² s)			
	Impulsive		Non-impulsive	
	PTS	TTS	PTS	TTS
Low-frequency cetaceans (LF)	183	168	199	179
High-frequency cetaceans (HF)	185	170	198	178
Very high-frequency cetaceans (VHF)	155	140	173	153
Phocid carnivores in water (PCW)	185	170	201	181

2.3.1.2 NMFS (2024): Auditory Injury (AUD INJ and TTS) criteria

The NMFS (2024) guidance categorises marine mammals into groups based on similar species and applies filters to the unweighted noise levels to approximate their hearing sensitivities in a similar way to the Southall *et al.* (2019) criteria. These groups are summarised in Table 2-4, with auditory weighting functions in Figure 2-2. Additional groups other marine mammals are provided in NMFS (2024) but are not included in this study, as these species are not common in the Moray Firth.

NMFS is effectively an update to Southall *et al.* (2019) with revisions to the hearing sensitivities of the various marine mammal species groups, and adjustments to the impact criteria. There are only minor adjustments to terminology, with the exception of the use of “auditory injury” instead of PTS (see the following section), and phocid pinnipeds, where the abbreviation is “PW” rather than “PCW” previously.

Table 2-4: Marine mammal hearing groups (from NMFS 2024).

Hearing group	Auditory Weighting Function	Generalised hearing range	Species group	Example species
Low-frequency Cetaceans	LF	7 Hz to 36 kHz	Baleen whales	Fin Whale, minke whale, humpback Whale
High-frequency Cetaceans	HF	150 Hz to 160 kHz	Toothed whales, including dolphins and beaked whales	Bottlenose dolphin, white-beaked dolphin, Risso’s dolphin, common dolphin, orca
Very high-frequency Cetaceans	VHF	200 Hz to 165 kHz	True porpoise	Harbour porpoise
Phocid pinnipeds in water	PW	40 Hz to 90 kHz	True seals	Harbour seal, grey seal

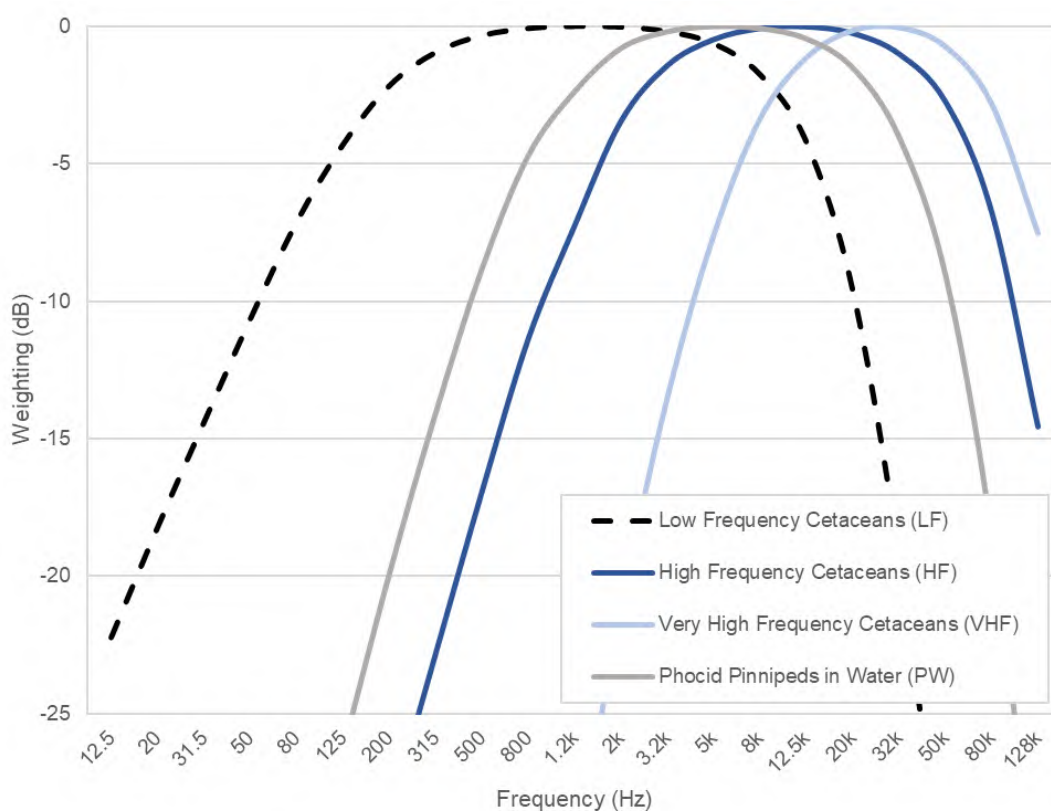


Figure 2-2: Auditory weighting functions for low-frequency cetaceans (LF), high-frequency cetaceans (HF), very high-frequency cetaceans (VHF), and phocid carnivores in water (PW) (from NMFS 2024)

NMFS (2024) defines separate impact thresholds for impulsive and non-impulsive sounds, based on auditory injury risk at different sound levels. Auditory impacts are classified as:

- Auditory injury (AUD INJ): the onset of irreversible inner ear damage, potentially leading to PTS.
- Temporary threshold shift (TTS): a lower severity, onset of a short-term reduction in hearing sensitivity.

TTS typically results in the largest impact range, but AUD INJ represents the onset of the most significant impairment, making it the key impact threshold.

As impact piling is impulsive and vibropiling/dredging are non-impulsive, this study applies both impulsive and non-impulsive criteria for marine mammal AUD INJ and TTS thresholds, using the $L_{p,pk}$ and $L_{E,p,24h}$ metrics from NMFS (2024), which is summarised in Table 2-5 and Table 2-6.

Table 2-5: $L_{p,pk}$ criteria for AUD INJ and TTS in marine mammals (NMFS 2024)

NMFS (2024)	$L_{p,pk}$ (dB re 1 μ Pa)	
	Impulsive	
	AUD INJ	TTS
Low-frequency cetaceans (LF)	222	216
High-frequency cetaceans (HF)	230	224
Very high-frequency cetaceans (VHF)	202	196
Phocid pinnipeds in water (PW)	223	217

Table 2-6: $L_{E,p,24h}$ criteria for AUD INJ and TTS in marine mammals (NMFS 2024)

NMFS (2024)	$L_{E,p,24h,wtd}$ (dB re 1 μ Pa ² s)			
	Impulsive		Non-impulsive	
	AUD INJ	TTS	AUD INJ	TTS
Low-frequency cetaceans (LF)	183	168	197	177
High-frequency cetaceans (HF)	193	178	201	181
Very high-frequency cetaceans (VHF)	159	144	181	161
Phocid pinnipeds in water (PW)	183	168	195	175

2.3.1.3 NOAA (2005): Underwater Level B Harassment Acoustic Thresholds

Data on behavioural effect or disturbance in marine mammals is limited, so the NOAA (2005) Level B harassment criterion is used to account for potential effects, presented in Table 2-8. Impulsive thresholds are used for impact piling, whereas continuous thresholds are used for vibropiling and dredging.

Table 2-7: $L_{p,RMS}$ criteria for continuous and impulsive/intermittent sources in marine mammals (NOAA 2005)

Source Type	$L_{p,RMS}$ (dB re 1 μ Pa)
Continuous	120
Impulsive or Intermittent	160

2.3.2 Fish

2.3.2.1 Popper *et al.* (2014): Mortality, injury and behavioural effects

The Popper *et al.* (2014) guidelines are a reliable reference for underwater noise impacts on marine fauna, excluding marine mammals. Unlike previous studies based on limited or irrelevant data, Popper *et al.* (2014) provides updated research and guidelines, using fish categories that include species found in the UK.

Popper *et al.* (2014) provides specific criteria for common anthropogenic underwater sound sources. If a source is not listed, it is common practice to use the criteria which is the best fit to the source required in the assessment. Across all sources, marine faunae are categorised into sea turtles, eggs and larvae, and fish. Fish are further divided into three groups based on their hearing capabilities, determined by the presence and role of a swim bladder:

- Fish: no swim bladder
- Fish: swim bladder not involved in hearing
- Fish: Swim bladder involved in hearing.

Popper *et al.* (2014) then provides impact thresholds for each marine faunae category related to sound exposure, including:

- Mortality and potential mortal injury: immediate or delayed death.
- Impairment, such as:
 - Recoverable injury: injuries unlikely to result in mortality.
 - Temporary Threshold Shift (TTS): short or long-term changes in hearing sensitivity that may or may not reduce fitness.
 - Masking: Reduction in sound detectability due to the simultaneous presence of another sound.
- Behavioural effects: substantial change in behaviour for the animals exposed to a sound (long or short term).

Despite emerging evidence of fish sensitivity to particle motion (see Section 1.2.2), the Popper *et al.* (2014) criteria provide a quantitative criterion as thresholds for impact onsets in terms of sound pressure related functions (e.g., SPL_{peak} , SPL_{rms} , SEL_{ss} , SEL_{cum}). For fish, both stationary and fleeing animal models are used for SEL_{cum} thresholds to account for species diversity and varying responses to noise. Most species in Popper *et al.* (2014) are likely to swim away from harmful sounds (Dahl *et al.*, 2015), and these speeds are likely to vary widely across species. Therefore, a conservative swim speed of 1.5 ms^{-1} (Hirata, 1999) is used in fleeing animal models. However, some species in Popper *et al.* (2014) have lower sensitivity to sound, such as benthic or swim bladderless species, remain stationary even when exposed to high intensity sounds (e.g., Goertner *et al.*, 1994, 1978; Stephenson *et al.*, 2010; Halvorsen *et al.*, 2012). Therefore, to avoid overestimating risk, a combined approach, which presents both fleeing and stationary models, is used in this report.

When data is insufficient to provide a quantitative criterion, Popper *et al.* (2014) provides a relative risk, which describes the risk of an effect on a receptor occurring in either the near-field (tens of meters), intermediate-field (hundreds of meters) or far-field (thousands of meters) from the sound source, as high, moderate or low.

For impact piling, this study uses the criteria from Popper *et al.* (2014) for pile driving, summarised in Table 2-8. Since vibropiling and dredging are non-impulsive, continuous sound sources, this study uses the criteria from Popper *et al.* (2014) for shipping and continuous sounds, summarised in Table 2-9.

Table 2-8: Recommended guidelines for pile driving according to Popper et al. (2014) for species of fish, sea turtles and eggs and larvae (N = Near-field; I = Intermediate-field; F = Far-field).

Popper et al. (2014) criteria for Pile Driving					
Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	>219 $L_{E,p}$ >213 $L_{p,pk}$	>216 $L_{E,p}$ >213 $L_{p,pk}$	>>186 $L_{E,p}$	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	210 $L_{E,p}$ >207 $L_{p,pk}$	203 $L_{E,p}$ >207 $L_{p,pk}$	>186 $L_{E,p}$	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Fish: swim bladder involved in hearing	207 $L_{E,p}$ >207 $L_{p,pk}$	203 $L_{E,p}$ >207 $L_{p,pk}$	186 $L_{E,p}$	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Sea Turtles	210 $L_{E,p}$ >207 $L_{p,pk}$	(N) High (I) Low (F) Low	(N) High (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) High (I) Moderate (F) Low
Eggs and Larvae	>210 $L_{E,p}$ >207 $L_{p,pk}$	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Table 2-9: Recommended guidelines for shipping and continuous sounds according to Popper et al. (2014) for species of fish, sea turtles and eggs and larvae (N = Near-field; I = Intermediate-field; F = Far-field).

Popper et al. (2014) criteria for Shipping and Continuous sounds					
Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	170 $L_{p,48h}$	158 $L_{p,12h}$	((N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea Turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Eggs and Larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

3 Underwater Noise Modelling: Methodology

Modelling of underwater noise is complex and can be approached in several different ways. Measurements are only possible at limited locations, so modelling has been undertaken to provide a more comprehensive set of results. To estimate the noise levels generated by impact piling, vibropiling and dredging, Subacoustech have chosen to utilise the dBSea noise modelling software (www.dbsea.co.uk), which uses various numerical solvers to calculate underwater noise. This assessment uses two different solvers:

- A parabolic equation (PE) method for lower frequencies (12.5 Hz to 250 Hz).
 - Widely used within the underwater acoustics community but has computational limitations at high frequencies.
- A ray tracing method for higher frequencies (315 Hz to 100 kHz).
 - More computationally efficient at higher frequencies but is not suited to low frequencies (Etter, 1991).

These solvers account for a wide array of environmental input parameters within the study area, including bathymetry, sediment data and sound speed, as well as the characteristics of the noise source, such as source frequency content, to ensure as detailed results as possible. The input parameters used in this study are described in the following sections.

The results of the modelling will be presented as noise contour plots. It should be noted that noise levels and propagation paths in reality will not be as clearly defined or linear as shown in these plots. This is an artifact of the modelling approach. Scattering, reflection, and diffraction can cause sound to propagate around and behind obstacles like protruding landmasses (although to a much lesser degree than when there is line-of-sight), but the model cannot accurately account for these effects, so they are not represented in the plots.

3.1 Input Parameters

3.1.1 Modelling Location

Two worst-case locations were selected for modelling based on the different planned activities: one is suitable for piling for both impact and vibropiling, and a separate dredging site for dredging activities. Piling was modelled at mid-water depth, whereas CSD was modelled at the maximum depth of the modelling location at the seabed. Derivation of the piling source level used in modelling was based on empirical data from piling in harbours (e.g. Midforth and East, 2019). A location to the seaward side of the dredged area was selected for CSD. Details of the locations used for modelling are presented in Table 3-1, and the location of each modelling area is shown in Figure 3-1.

Table 3-1: Details of the modelling locations. Eastings/Northings are in WGS84, UTM Zone 30N.

Modelling location	Latitude (DD)	Longitude (DD)	Depth of Source (m)	Depth at source location (m)
Piling Site	57.600417°N	004.009850°W	4	9
Dredging Site	57.602553°N	004.008732°W	5	5

3.1.2 Bathymetry

The bathymetry data used in the modelling was a combination of bathymetry of the wider area obtained from the European Marine Observation and Data Network (EMODnet, 2018), and bathymetry provided by the client on the dredged area (not available from EMODnet) close to the modelling location. The EMODnet data has a resolution of 1/16th arcminutes (approximately 115 × 115 m). The bathymetry used for modelling covers an area of 10 km × 20 km surrounding the survey area, and represents depths associated with mean high-water springs (MHWS). The extent of the bathymetry is shown in the “Port Overview” map in Figure 3-1.

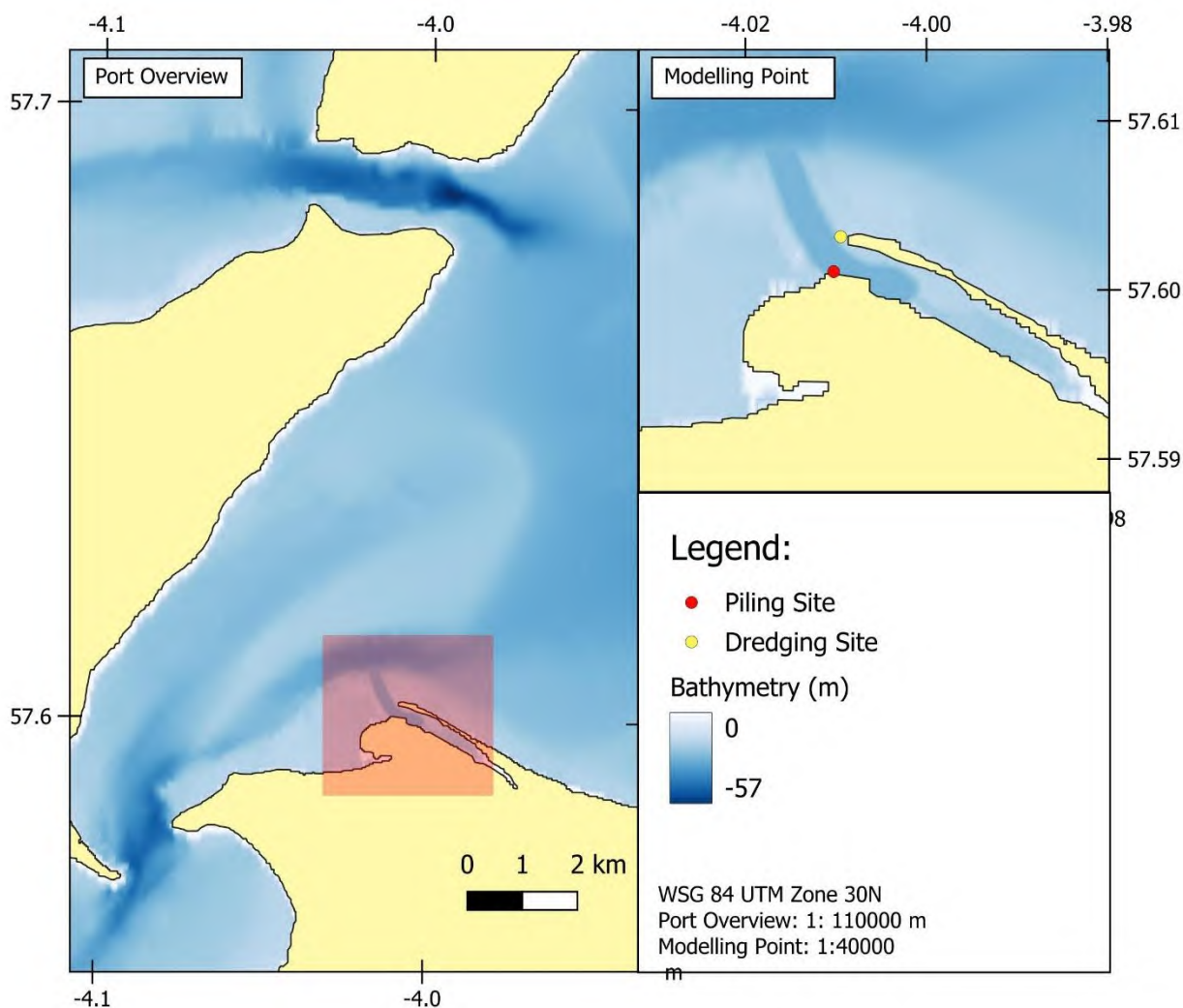


Figure 3-1: Overview of the modelling locations selected for each activity. The impact piling and vibropiling modelling location are marked by the “Piling Site” and the CSD modelling location is marked by “Dredging Site”.

3.1.3 Seabed Properties

Seabed characteristics were based on local data provided from the project scoping report. At the Port of Ardersier, the seabed was assumed to consist of 20 m of gravelly sand overlying sandstone bedrock. Geoacoustic properties were taken from Jensen *et al.* (1994, 2011) as listed in Table 3-2.

Table 3-2: Seabed geo-acoustic properties of the area.

Material	Compressive sound speed profile in substrate (m/s)	Density profile in substrate (kg/m ³)	Attenuation profile in substrate (dB/wavelength)
Gravelly Sand	1,725	1,950	0.7
Sandstone	3,000	2,500	0.1

3.1.4 Sound Speed Profile

The speed of sound in the water has been calculated for the average annual temperature and salinity using the Mackenzie (1981) equation, with data from the National Marine Plan Interactive (Marine Scotland, 2025) for the modelling location. The resulting profile is shown in Figure 3-2.

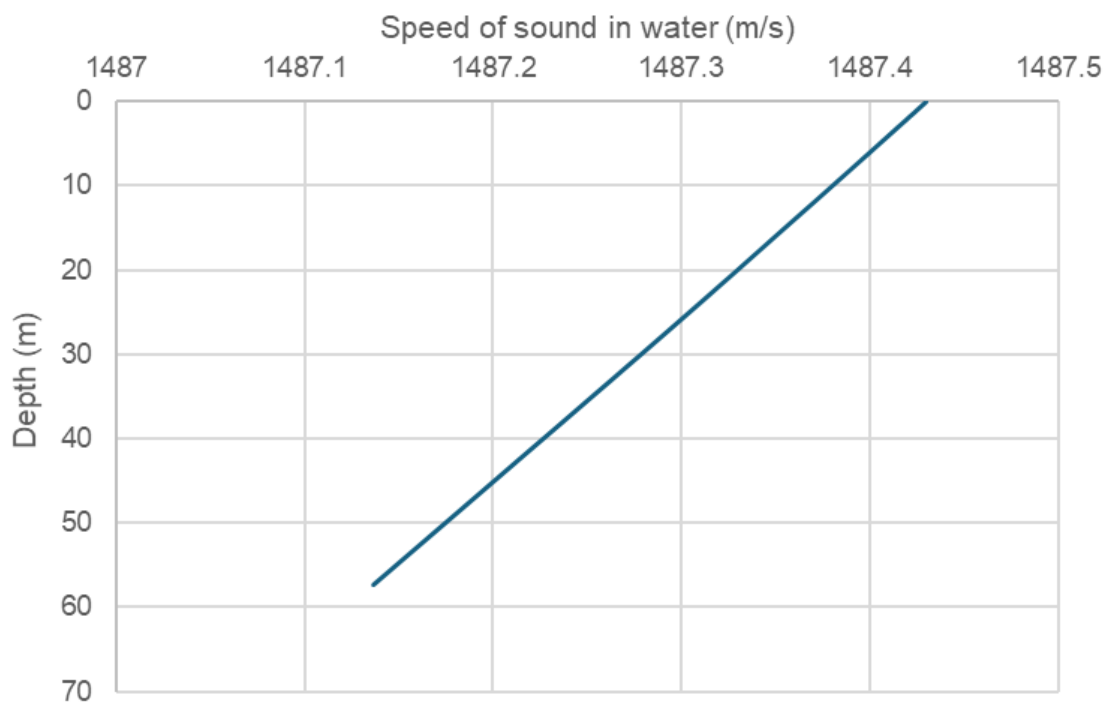


Figure 3-2: Sound speed profile used for detailed modelling of the area.

3.1.5 Noise Source

At the time of writing, the following information has been provided:

- Impact piling:
 - Pile: Steel Tubular Piles 1200 mm diameter.
 - Strike rate: 34 blows per minute.
 - Piling time per pile: 10 hours (including surveying and pile positioning etc.).
 - Includes Soft Start: 20 minutes (assumed at 20% energy).
 - Maximum Energy: 294 kJ.

- Vibropiling
 - Equipment: No detailed information has been provided. The equipment proxy used in modelling is described below.
 - Piling time per pile: 10 hours (including surveying and pile positioning etc.).
- Dredging
 - Equipment: No detailed information has been provided. The equipment proxy used in modelling is described below.
 - Although TSHD and CSD are proposed to be used, CSD is louder than TSHD, and therefore, only CSD was considered in the assessment, as a worst-case scenario.

Source spectrums for each activity were obtained from Subacoustech’s measurement library. For impact and vibropiling, data was measured from 1067 mm diameter piles driven in Portsmouth Harbour, UK using a 260 kJ hammer (Midforth and East, 2019). For CSD, recordings were obtained from the 112.6 m dredger *Taurus II* operating in the Persian Gulf, Qatar, with 24,610 kW total power and 2 × 3380 kW dredge pump power (Collett and Mason, 2015).

Source levels for $L_{p,pk}$, $L_{E,p,ss}$ and $L_{p,RMS}$ metrics were then calculated from the obtained source spectrums. For impact and vibropiling, the source level was scaled to reflect the provided pile specifications relevant to the project. Since no project specific details were provided for CSD equipment, the source levels used were those calculated directly from the recordings of *Taurus II*. The source levels used in modelling for each activity are presented in Table 3-3.

Table 3-3: Summary of the calculated $L_{p,pk}$, $L_{E,p,ss}$ and $L_{p,RMS}$ source levels for the impact piling, vibropiling and CSD.

Equipment	Estimated source level @ 1 m		
	$L_{p,pk}$ (dB re 1 μ Pa)	$L_{E,p,ss}$ (dB re 1 μ Pa ² s)	$L_{p,RMS}$ (dB re 1 μ Pa)
Impact Piling	222.9	195.1	202.1
Vibropiling	-	-	183.0
CSD	-	-	181.4

The 1/3rd octave levels in each source spectra were then adjusted to achieve the required source levels for each source type (values stated in Table 3-3). The 1/3rd octave source spectrums used for modelling is shown in Figure 3-3 for impact piling, Figure 3-4 for vibropiling and Figure 3-5 for CSD.

Where $L_{E,p,24h}$ exposure levels are required for continuous noise sources, this is based on an equivalence of 1-second $L_{E,p}$ and $L_{p,RMS}$ values for this type of noise. For piling, since the active piling time is unknown at the time of writing, 10 hours of continuous piling is assumed as a worst-case scenario to remain precautionary. CSD was assumed to take place continuously for 24-hours.

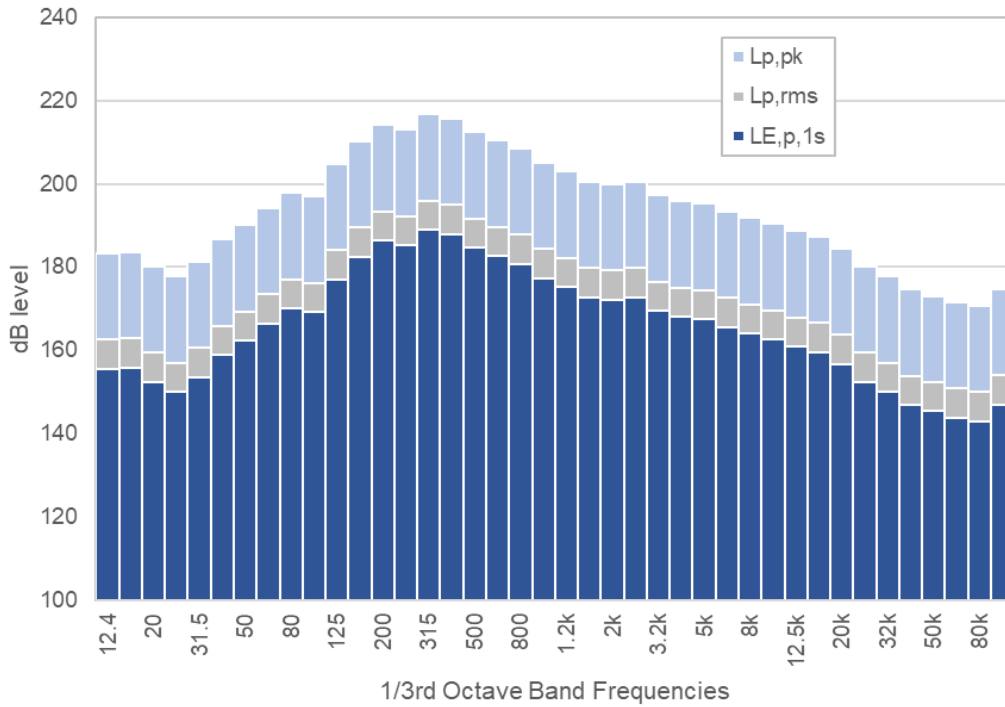


Figure 3-3: The $L_{p,pk}$, $L_{p,RMS}$ and $L_{E,p,1s}$ source spectrums containing $1/3^{rd}$ octave band levels used to model impact piling.

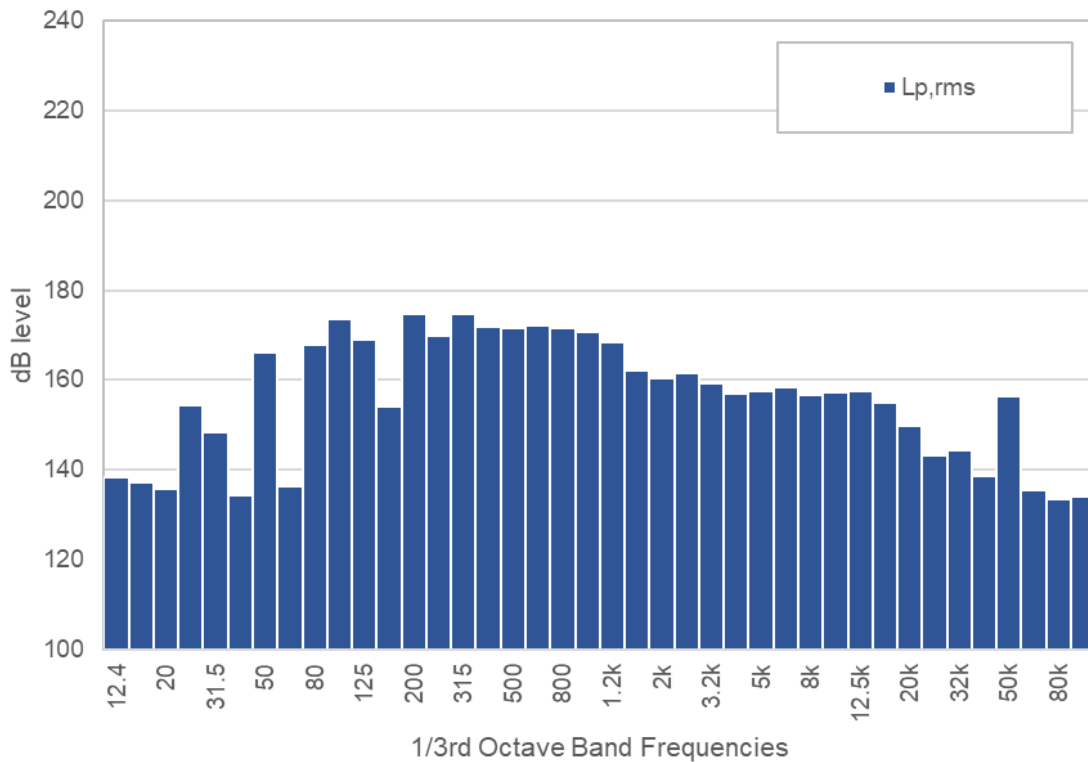


Figure 3-4: The $L_{p,RMS}$ source spectrum containing $1/3^{rd}$ octave band levels used to model vibropiling.

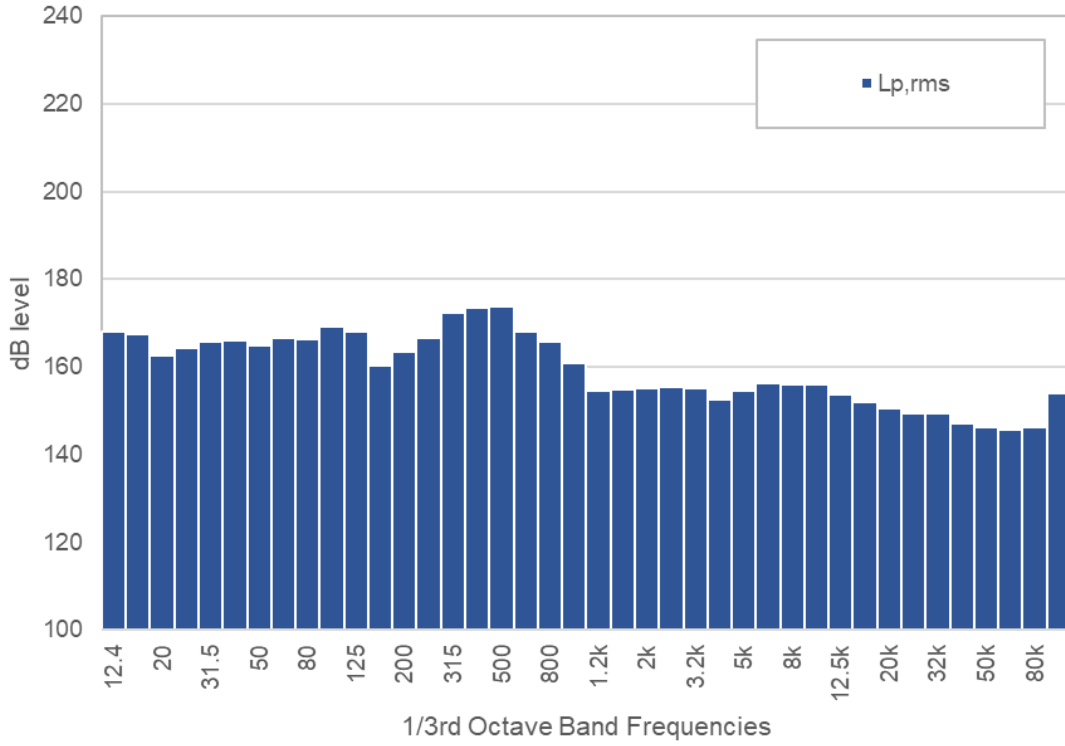


Figure 3-5: The $L_{p,RMS}$ source spectrum containing 1/3rd octave band levels used to model CSD.

4 Underwater Noise Modelling: Results

The distribution of noise from impact piling, vibropiling and CSD are presented as noise contour plots in the following section. These noise contours were then interpreted into impact ranges using the relevant criteria from Southall *et al.* (2019), NMFS (2024) and NOAA (2005) for marine mammals, and Popper *et al.* (2014) for fish.

For single strike criteria ($L_{p,pk}$, $L_{p,RMS}$), the maximum, mean and minimum impact ranges are presented across all transects. For $L_{E,p,t}$ metrics only the maximum impact ranges are presented, based on transects that are not constrained by land limitations near the noise source. These transects represent worst-case fleeing directions.

For impact piling and vibropiling, the relevant transects were:

- North Northwest (NNW): out to the mouth of the Moray Firth between bearings 312° - 010°.
- West (W): out to the mouth of the Moray Firth between bearings 270° - 278°.
- Southeast (SE): within the harbour between bearings 102° - 108°.

And for CSD, the relevant transects were:

- Northwest (NW): out to the mouth of the Moray Firth between bearings 256° - 46°.

Due to the complexity in noise conditions at close range to the source, estimated impact ranges are limited to a resolution of 10 m from the sources, and as such, any modelled ranges that would be smaller than this have been presented as “< 10 m”. Any impact range noted as “–” indicates that no exceedance is expected for the given criteria based on the results of the modelling, due to relatively low source levels.

4.1 Impact Piling

4.1.1 Predicted Noise Levels

The distribution of noise from the impact piling at the Port of Ardersier is presented as noise contour plots in Figure 4-1, Figure 4-2 and Figure 4-3. These plots show the maximum predicted noise level in the water column.

Note that the break in the modelled contours that can be seen to the WNW of the modelling locations is due to the presence of a small, submerged island that blocks the propagation path along these transects.

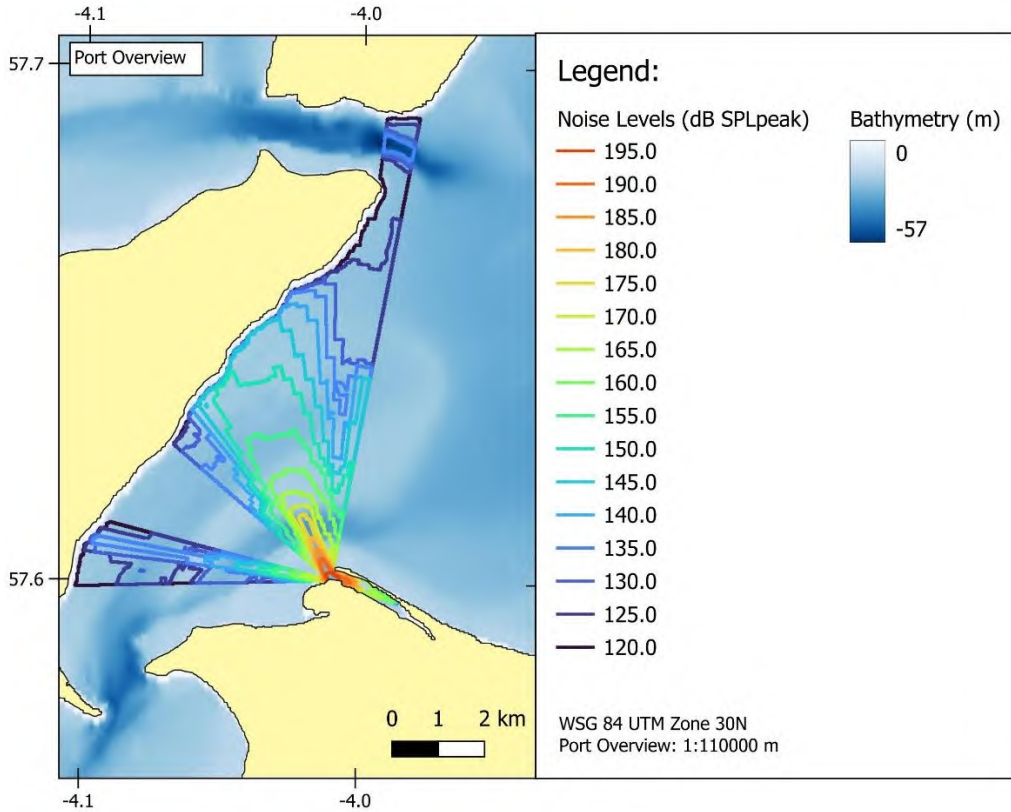


Figure 4-1: $L_{p,pk}$ noise level contours predicted for impact piling at the Port of Ardersier.

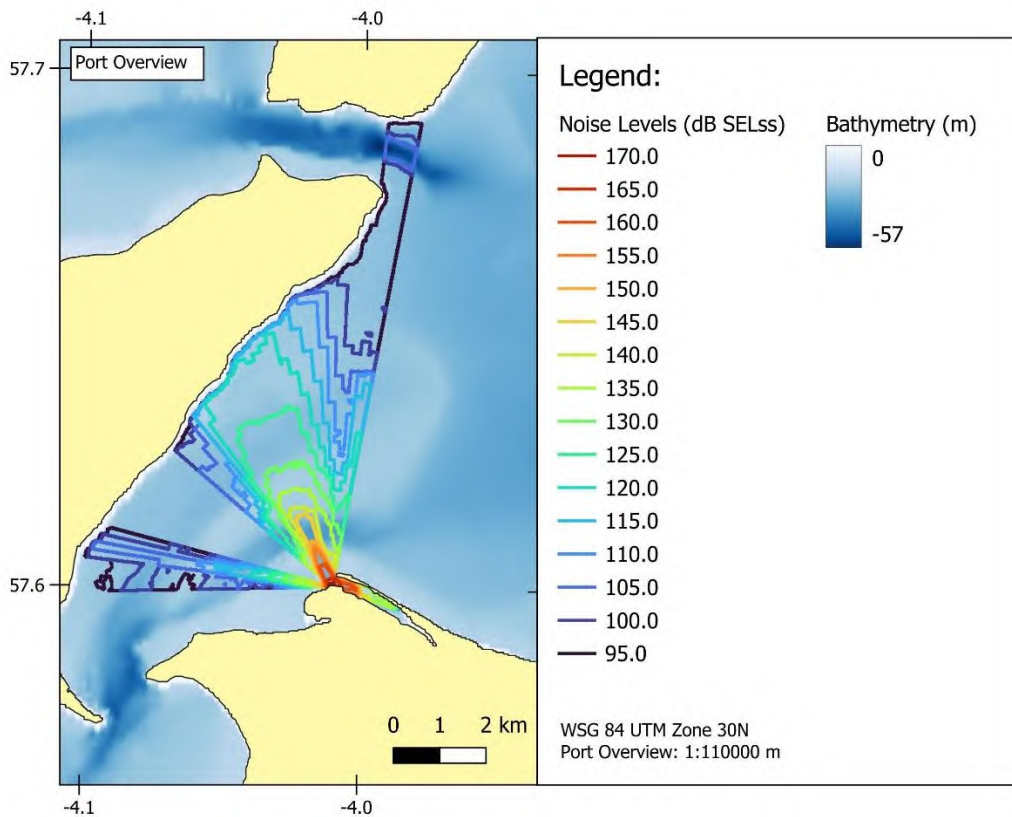


Figure 4-2: $L_{E,p,ss}$ noise level contours predicted for impact piling at the Port of Ardersier.

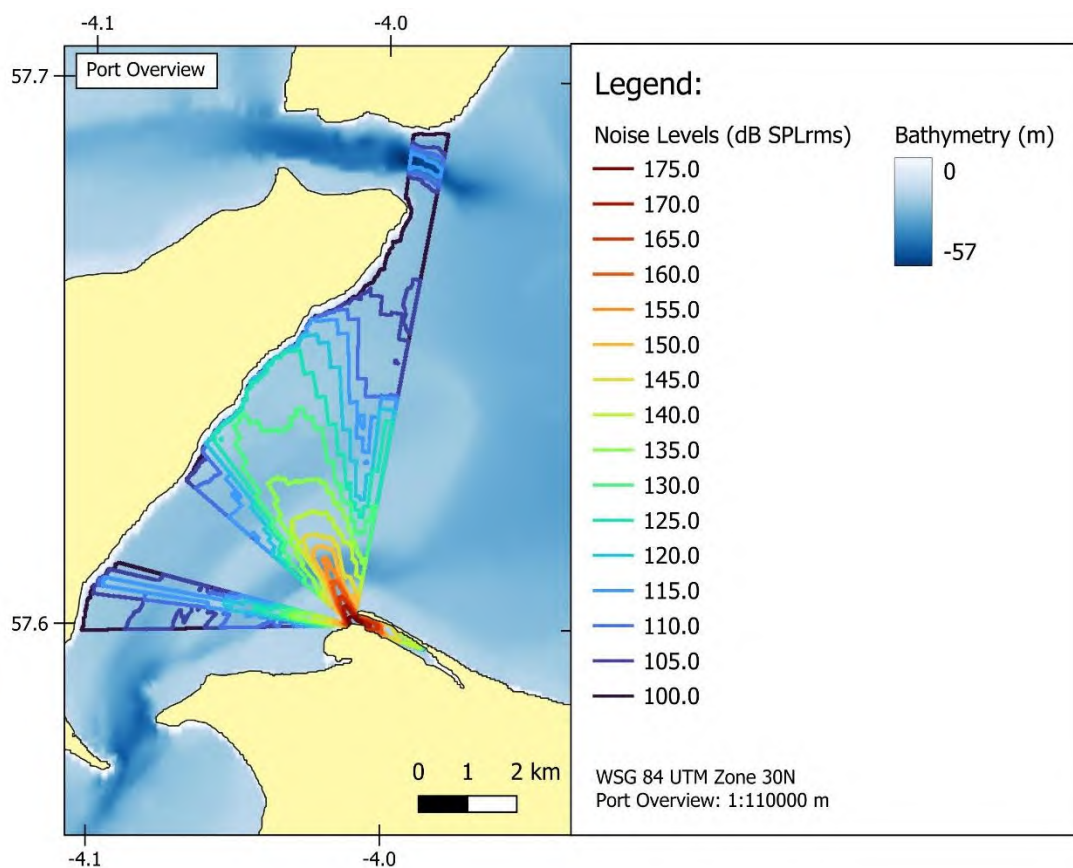


Figure 4-3: $L_{p,RMS}$ noise level contours predicted for impact piling at the Port of Ardersier.

4.1.2 Interpretation

4.1.2.1 Marine Mammals: Southall *et al.* (2019)

The noise level results from Section 4.1.1 were weighted (where appropriate) according to Southall *et al.* (2019) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the Southall *et al.* (2019) $L_{p,pk}$ criteria applied to the predicted noise contours, the largest PTS ranges are associated with VHF cetaceans. Animals will exceed the VHF PTS threshold if they are within 60 m from the piling activities. These results, along with the PTS and TTS impact ranges predicted across all groups, are presented in Table 4-1.

Table 4-1: Predicted impact ranges associated with impact piling, using the Southall et al. (2019) $L_{p,pk}$ PTS and TTS criteria in marine mammals for impulsive noise sources.

Southall et al. (2019) criteria $L_{p,pk}$ (Impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
LF Cetaceans	PTS	219 dB	< 10	< 10	< 10
	TTS	213 dB	20	< 10	< 10
HF Cetaceans	PTS	230 dB	-	-	-
	TTS	224 dB	-	-	-
VHF Cetaceans	PTS	202 dB	60	40	20
	TTS	196 dB	170	90	20
PCW Pinnipeds	PTS	218 dB	< 10	< 10	< 10
	TTS	212 dB	20	10	< 10

- = No predicted exceedance

By applying the Southall et al. (2019) weightings to the predicted $L_{E,p,24h}$ noise contours, and comparing these against the impulsive criteria for marine mammals, it is unlikely that any animal will exceed its PTS threshold at any range from the impact piling activities. This is based on a $L_{E,p,24h,wtd}$ calculated over the maximum potential impact piling period (10 hours) and the animals fleeing at a constant speed. These results, along with PTS and TTS impact ranges predicted across all groups, are presented in Table 4-2.

Table 4-2: Predicted impact ranges associated with impact piling, using the Southall et al. (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for impulsive noise sources, assuming a fleeing receptor.

Southall et al. (2019) criteria $L_{E,p,24h,wtd}$ (Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	PTS	183 dB	< 10	< 10	< 10
	TTS	168 dB	380	30	60
HF Cetaceans	PTS	185 dB	< 10	< 10	< 10
	TTS	170 dB	< 10	< 10	< 10
VHF Cetaceans	PTS	155 dB	< 10	< 10	< 10
	TTS	140 dB	360	40	50
PCW Pinnipeds	PTS	185 dB	< 10	< 10	< 10
	TTS	170 dB	< 10	< 10	< 10

4.1.2.2 Marine Mammals: NMFS (2024)

The noise level results from Section 4.1.1 were weighted (where appropriate) according to NMFS (2024) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the NMFS (2024) $L_{p,pk}$ criteria applied to the predicted noise contours, the largest AUD INJ ranges are associated with VHF cetaceans. Animals will exceed the VHF AUD INJ threshold if they are within 60 m from the piling activities. These results, along with the AUD INJ and TTS impact ranges predicted across all groups, are presented in Table 4-3.

Table 4-3: Predicted impact ranges associated with impact piling, using the NMFS (2024) $L_{p,pk}$ auditory injury (AUD INJ) and TTS criteria in marine mammals for impulsive noise sources.

NMFS (2024) criteria $L_{p,pk}$ (Impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
LF Cetaceans	AUD INJ	222 dB	< 10	< 10	< 10
	TTS	216 dB	20	< 10	< 10
HF Cetaceans	AUD INJ	230 dB	-	-	-
	TTS	224 dB	-	-	-
VHF Cetaceans	AUD INJ	202 dB	60	40	20
	TTS	196 dB	170	90	20
PW Pinnipeds	AUD INJ	223 dB	-	-	-
	TTS	217 dB	< 10	< 10	< 10

- = No predicted exceedance

By applying the NMFS (2024) weightings to the predicted $L_{E,p,24h}$ noise contours, and comparing these against the impulsive criteria for marine mammals, it is unlikely that any animal will exceed its AUD INJ threshold at any range from the impact piling activities. This is based on a $L_{E,p,24h,wtd}$ calculated over the maximum potential impact piling period (10 hours) and the animals fleeing at a constant speed. These results, along with AUD INJ and TTS impact ranges predicted across all groups, are presented in Table 4-4.

Table 4-4: Predicted impact ranges associated with impact piling, using the NMFS (2024) $L_{E,p,24h,wtd}$ auditory injury (AUD INJ) and TTS criteria in marine mammals for impulsive noise sources, assuming a fleeing receptor.

NMFS (2024) criteria $L_{E,p,24h,wtd}$ (Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	AUD INJ	183 dB	< 10	< 10	< 10
	TTS	168 dB	380	30	60
HF Cetaceans	AUD INJ	193 dB	< 10	< 10	< 10
	TTS	178 dB	< 10	< 10	< 10
VHF Cetaceans	AUD INJ	159 dB	< 10	< 10	< 10
	TTS	144 dB	380	40	50
PW Pinnipeds	AUD INJ	183 dB	< 10	< 10	< 10
	TTS	168 dB	30	< 10	< 10

4.1.2.3 Marine Mammals: NOAA (2005)

Using the $L_{p,RMS}$ criteria from NOAA (2005) applied to the predicted noise contours, it is estimated that marine mammals will surpass the Level B disturbance threshold if they are at 1000 m on the transect of greatest noise propagation. These results are presented in Table 4-5.

Table 4-5: Predicted impact ranges associated with impact piling, using the NOAA (2005) $L_{p,RMS}$ criteria for disturbance in marine mammals in relation to impulsive noise sources.

NOAA (2005) criteria $L_{p,RMS}$ (impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
All Marine Mammals	Level B Disturbance	160 dB	1000	230	20

4.1.2.4 Fish: Popper *et al.* (2014)

The noise level results from Section 4.1.1 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for pile driving would be exceeded by fish.

Based on the results for $L_{p,pk}$ metric, fish with a swim bladder (both involved and not involved in hearing) are predicted to exceed their mortality/recoverable injury threshold if they are within 30 m from the impact piling activities. These results, along with mortality/recoverable injury thresholds for other fish groups, are presented in Table 4-6.

Table 4-6: Predicted impact ranges associated with impact piling, using the Popper *et al.* (2014) $L_{p,pk}$ criteria for pile driving.

Popper <i>et al.</i> (2014) criteria $L_{p,pk}$ (Pile Driving)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
Fish: no swim bladder	Mortal and potential mortal injury / Recoverable injury	> 213 dB	20	< 10	< 10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury / Recoverable injury	> 207 dB	30	20	20
Fish: swim bladder involved in hearing	Mortal and potential mortal injury / Recoverable injury	> 207 dB	30	20	20

Using the $L_{E,p}$ metric, if the fish are to flee from the source at a constant speed, it is unlikely that the thresholds for any fish species will be exceeded at any range from the impact piling activities. However, if they are assumed to remain stationary for the maximum potential piling duration of 10 hours, animals at up to 420 m of the impact piling activities will exceed the mortality and potential mortal injury threshold, and the recoverable injury threshold for fish with a swim bladder involved in hearing. These results, along mortality and potential mortality injury, recoverable injury and TTS thresholds for other fish species are provided in Table 4-7 and Table 4-8 for stationary and fleeing receptors respectively.

Table 4-7: Predicted impact ranges associated with impact piling, using the Popper et al. (2014) $L_{E,p,24h}$ criteria for pile driving, assuming a stationary receptor.

Popper et al. (2014) criteria $L_{E,p,24h}$ (Pile Driving)			Maximum Estimated Stationary Impact Ranges (m)		
			NNW	W	SE
Fish: no swim bladder	Mortal and potential mortal injury	> 219 dB	40	30	30
	Recoverable injury	> 216 dB	60	40	50
	TTS	>> 186 dB	1760	240	730
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	210 dB	180	60	90
	Recoverable injury	203 dB	520	70	340
	TTS	> 186 dB	1760	240	730
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	420	70	150
	Recoverable injury	203 dB	520	70	340
	TTS	186 dB	1760	240	730

Table 4-8: Predicted impact ranges associated with impact piling, using the Popper et al. (2014) $L_{E,p,24h}$ criteria for pile driving, assuming a fleeing receptor.

Popper et al. (2014) criteria $L_{E,p,24h}$ (Pile Driving)			Maximum Estimated Fleeing Impact Ranges (m)		
			NNW	W	SE
Fish: no swim bladder	Mortal and potential mortal injury	> 219 dB	< 10	< 10	< 10
	Recoverable injury	> 216 dB	< 10	< 10	< 10
	TTS	>> 186 dB	< 10	< 10	< 10
Fish: swim bladder not involved in hearing	Mortal and potential mortal injury	210 dB	< 10	< 10	< 10
	Recoverable injury	203 dB	< 10	< 10	< 10
	TTS	> 186 dB	< 10	< 10	< 10
Fish: swim bladder involved in hearing	Mortal and potential mortal injury	207 dB	< 10	< 10	< 10
	Recoverable injury	203 dB	< 10	< 10	< 10
	TTS	186 dB	< 10	< 10	< 10

4.2 Vibropiling

4.2.1 Predicted Noise Levels

The distribution of noise from the vibropiling at the Port of Ardersier is presented as noise contour plots in Figure 4-4. These plots show the maximum predicted noise level in the water column.

As in section 4.1, the break in the modelled contours that can be seen to the WNW of the modelling location is due to the presence of a small, submerged island that blocks the propagation path along these transects.

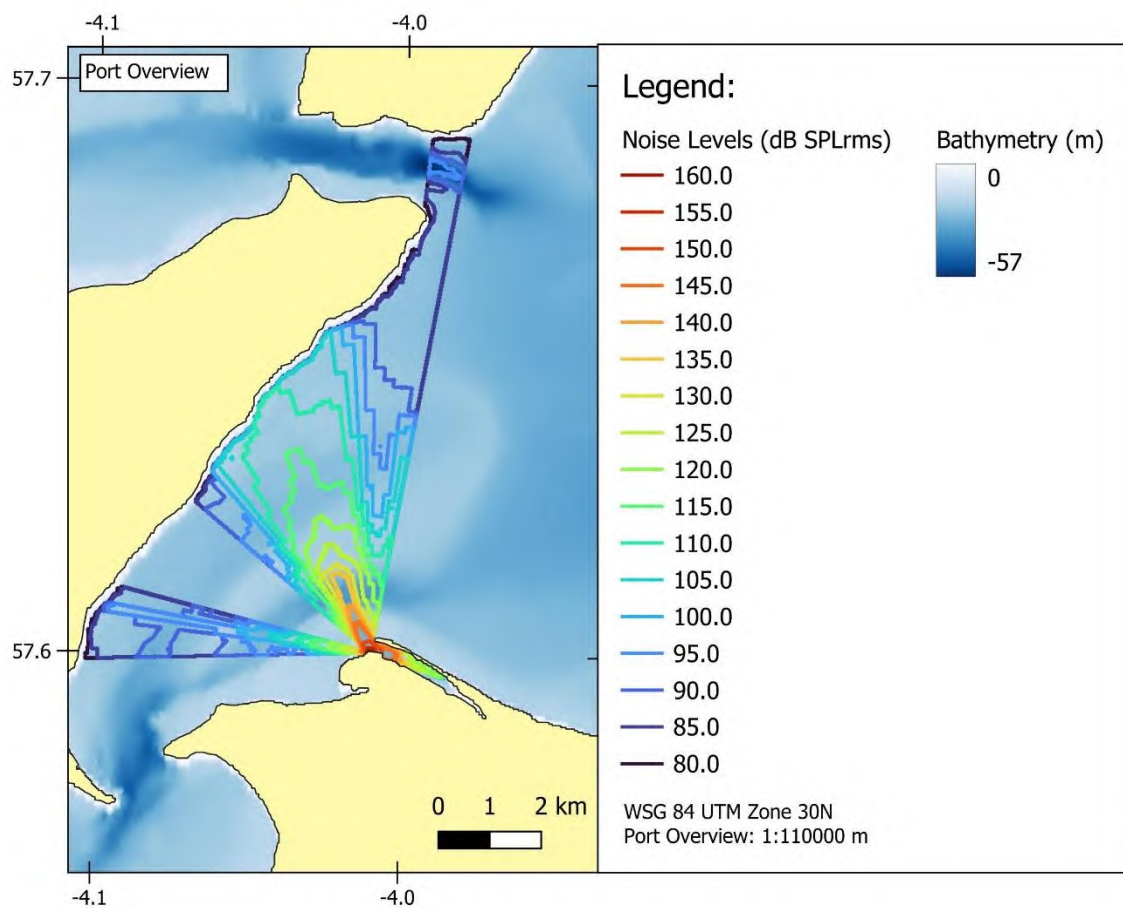


Figure 4-4: $L_{p,RMS}$ noise level contours predicted for vibropiling at the Port of Ardersier.

4.2.2 Interpretation

4.2.2.1 Marine Mammals: Southall *et al.* (2019)

The noise level results from Section 4.2.1 were weighted (where appropriate) according to Southall *et al.* (2019) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the Southall *et al.* (2019) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely in practice that any animal will exceed the PTS threshold at any distance from the vibropiling activities. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-9.

Table 4-9: Predicted impact ranges associated with vibropiling, using the Southall *et al.* (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

Southall <i>et al.</i> (2019) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	PTS	199 dB	< 10	< 10	< 10
	TTS	179 dB	20	< 10	< 10
HF Cetaceans	PTS	198 dB	< 10	< 10	< 10
	TTS	178 dB	< 10	< 10	< 10
VHF Cetaceans	PTS	173 dB	< 10	< 10	< 10
	TTS	153 dB	140	30	30
PCW Pinnipeds	PTS	201 dB	< 10	< 10	< 10
	TTS	181 dB	< 10	< 10	< 10

4.2.2.2 Marine Mammals: NMFS (2024)

The noise level results from Section 4.2.1 were weighted (where appropriate) according to NMFS (2024) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the NMFS (2024) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely that any animal in practice will exceed the AUD INJ threshold at any distance from the vibropiling activities. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-10.

Table 4-10: Predicted impact ranges associated with vibropiling, using the NMFS (2024) $L_{E,p,24h,wt d}$ auditory injury and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

NMFS (2024) criteria $L_{E,p,24h,wt d}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)		
			NNW	W	SE
LF Cetaceans	AUD INJ	197 dB	< 10	< 10	< 10
	TTS	177 dB	40	10	10
HF Cetaceans	AUD INJ	201 dB	< 10	< 10	< 10
	TTS	181 dB	< 10	< 10	< 10
VHF Cetaceans	AUD INJ	181 dB	< 10	< 10	< 10
	TTS	161 dB	20	10	< 10
PW Pinnipeds	AUD INJ	195 dB	< 10	< 10	< 10
	TTS	175 dB	10	< 10	< 10

4.2.2.3 Marine Mammals: NOAA (2005)

Using the $L_{p,RMS}$ criteria from NOAA (2005) applied to the predicted noise contours, it is estimated that marine mammals will surpass the Level B disturbance threshold if they are within 2900 m. These results are presented in Table 4-11.

Table 4-11: Predicted impact ranges associated with vibropiling, using the NOAA (2005) $L_{p,RMS}$ criteria for disturbance in marine mammals for non-impulsive noise sources.

NOAA (2005) criteria $L_{p,RMS}$ (Non-Impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
All Marine Mammals	Level B Disturbance	120 dB	2900	500	20

4.2.2.4 Fish: Popper *et al.* (2014)

The noise level results from Section 4.2.1 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for shipping and continuous sounds would be exceeded by fish.

Based on the results for the $L_{p,RMS}$ metric, animals within 20 m of the vibropiling activities may exceed the recoverable injury threshold for fish with a swim bladder involved in hearing. These results, along with TTS impact ranges, are provided in Table 4-12.

Table 4-12: Predicted impact ranges associated with vibropiling, using the Popper *et al.* (2014) $L_{p,RMS}$ criteria for shipping and continuous sounds.

Popper <i>et al.</i> (2014) criteria $L_{p,RMS}$ (continuous sounds)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
Fish: swim bladder involved in hearing	Recoverable injury	170 dB	20	20	10
	TTS	158 dB	80	50	20

Across all species of fish, the relative risk of mortality and potential mortal injury, as well as recoverable injury associated with vessel noise is low in the near-field, intermediate field and far field distance. Of all the potential impacts, the impact associated with the highest relative risk for all species of fish is masking, which is deemed as high in the near-field and intermediate field, and moderate in the far-field. These details are presented in Table 4-13.

Table 4-13: The relative risk of impacts on fish in the near-field (N), intermediate field (I) and far-field (F) for the noise associated with vibropiling using the Popper *et al.* (2014) fish criteria for shipping and continuous sounds.

Popper <i>et al.</i> (2014) criteria for shipping and continuous sounds					
Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	See Table 4-12	See Table 4-12	((N) High (I) High (F) High	(N) High (I) Moderate (F) Low

4.3 Cutter Suction Dredging (CSD)

4.3.1 Predicted Noise Levels

The distribution of noise from the CSD equipment at the Port of Ardersier is presented as noise contour plots in Figure 4-5. These plots show the maximum predicted noise level in the water column.

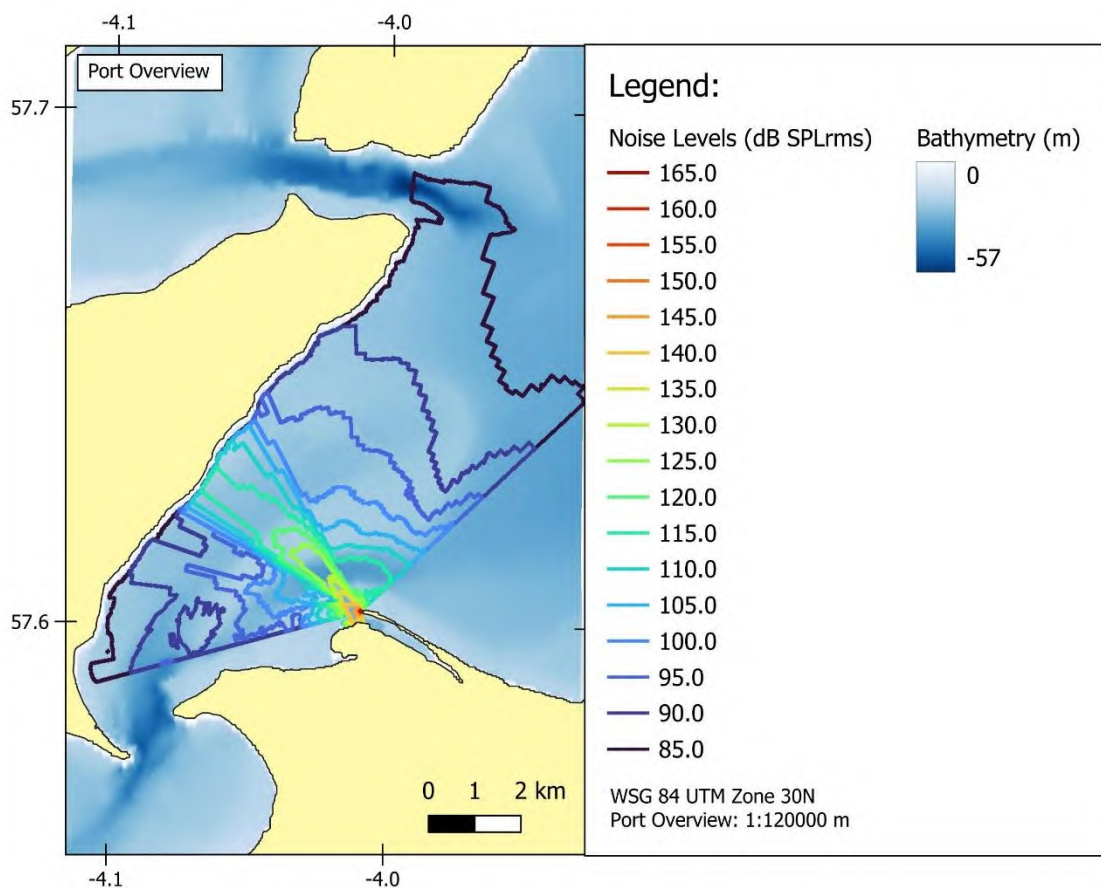


Figure 4-5: $L_{p,RMS}$ noise level contours predicted for CSD at the Port of Ardersier.

4.3.2 Interpretation

4.3.2.1 Marine Mammals: Southall *et al.* (2019)

The noise level results from Section 4.3.1 were weighted (where appropriate) according to Southall *et al.* (2019) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for non-impulsive sounds would be exceeded by marine mammals.

Using the Southall *et al.* (2019) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely that any animal will exceed the PTS threshold at any distance from the CSD equipment. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-14: Predicted impact ranges associated with CSD, using the Southall *et al.* (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor. Table 4-14.

Table 4-14: Predicted impact ranges associated with CSD, using the Southall et al. (2019) $L_{E,p,24h,wtd}$ PTS and TTS criteria in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

Southall et al. (2019) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)
			NW
LF Cetaceans	PTS	199 dB	< 10
	TTS	179 dB	< 10
HF Cetaceans	PTS	198 dB	< 10
	TTS	178 dB	< 10
VHF Cetaceans	PTS	173 dB	< 10
	TTS	153 dB	< 10
PCW Pinnipeds	PTS	201 dB	< 10
	TTS	181 dB	< 10

4.3.2.2 Marine Mammals: NMFS (2024)

The noise level results from Section 4.3.1 were weighted (where appropriate) according to NMFS (2024) and were assessed against the thresholds presented in these guidelines to predict the likely range at which the thresholds for impulsive sounds would be exceeded by marine mammals.

Using the NMFS (2024) $L_{E,p,24h,wtd}$ criteria applied to the predicted noise contours, it is unlikely that any animal will exceed the AUD INJ threshold at any distance from the CSD equipment. These results, along with the TTS impact ranges predicted across all groups, are presented in Table 4-15.

Table 4-15: Predicted impact ranges associated with CSD, using the NMFS (2024) $L_{E,p,24h,wtd}$ auditory injury and TTS criteria for in marine mammals for non-impulsive noise sources, assuming a fleeing receptor.

NMFS (2024) criteria $L_{E,p,24h,wtd}$ (Non-Impulsive)			Maximum Estimated Impact Ranges (m)	
			NW	
LF Cetaceans	AUD INJ	197 dB	< 10	
	TTS	177 dB	< 10	
HF Cetaceans	AUD INJ	201 dB	< 10	
	TTS	181 dB	< 10	
VHF Cetaceans	AUD INJ	181 dB	< 10	
	TTS	161 dB	< 10	
PW Pinnipeds	AUD INJ	195 dB	< 10	
	TTS	175 dB	< 10	

4.3.2.3 Marine Mammals: NOAA (2005)

Using the $L_{p,RMS}$ criteria from NOAA (2005) applied to the predicted noise contours, it is estimated that marine mammals will surpass the Level B disturbance threshold if they are within 2500 m from the CSD equipment. These results are presented in Table 4-16.

Table 4-16: Predicted impact ranges associated with CSD using the NOAA (2005) $L_{p,RMS}$ criteria for disturbance in marine mammals in relation to non-impulsive noise sources.

NOAA (2005) criteria $L_{p,RMS}$ (Non-Impulsive)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
All Marine Mammals	Level B Disturbance	120 dB	2500	410	< 10

4.3.2.4 Fish: Popper *et al.* (2014)

The noise level results from Section 4.3.1 were assessed against the Popper *et al.* (2014) guidelines to predict the likely range at which the thresholds for shipping and continuous sounds would be exceeded by fish.

Based on the results for the $L_{p,RMS}$ metric, animals within < 10 m of the CSD equipment may exceed the recoverable injury threshold for fish with a swim bladder involved in hearing. These results, along with TTS impact ranges are provided in Table 4-17.

Table 4-17: Predicted impact ranges associated with CSD, using the Popper et al. (2014) $L_{p,RMS}$ criteria for shipping and continuous sounds.

Popper et al. (2014) criteria $L_{p,RMS}$ (continuous sounds)			Estimated Impact Ranges (m)		
			Maximum	Mean	Minimum
Fish: swim bladder involved in hearing	Recoverable injury	170 dB	< 10	< 10	< 10
	TTS	158 dB	20	< 10	< 10

Across all species of fish, the relative risk of mortality and potential mortal injury, as well as recoverable injury associated with vessel noise is low in the near-field, intermediate field and far field distance. Of all the potential impacts, the impact associated with the highest relative risk for all species of fish is masking, which is deemed as high in the near-field and intermediate field, and moderate in the far-field. These results are presented in Table 4-18.

Table 4-18: The relative risk of impacts on fish in the near-field (N), intermediate field (I) and far-field (F) for the noise associated with CSD using the Popper et al. (2014) fish criteria for shipping and continuous sounds.

Popper et al. (2014) criteria for shipping and continuous sounds					
Type of fish	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: no swim bladder	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder not involved in hearing	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: swim bladder involved in hearing	(N) Low (I) Low (F) Low	See Table 4-17	See Table 4-17	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low

5 Summary and Conclusion

Subacoustech Environmental has undertaken an underwater noise modelling study in anticipation of planned construction works in the Port of Ardersier, in the Moray Firth, Scotland. The works are proposed to include the use of impact piling and vibropiling for pile installation and dredging to deepen the inner harbour.

The level of underwater noise generated by the works was estimated using a combined parabolic equation and ray tracing modelling approach. The modelling considers a wide array of input parameters including the equipment source level, sound frequency content, seabed properties and the sound speed profile in the water column. Full account is also taken of the bathymetry in the areas surrounding the survey site.

The modelled noise levels were then interpreted in accordance with the guidelines associated with PTS/auditory injury outlined in Southall *et al.* (2019) and NMFS (2024), and guidelines for disturbance outlined in NOAA (2005) for marine mammals in relation to impulsive and non-impulsive noise sources. The guidance outlined in Popper *et al.* (2014) for fish in relation to pile driving and continuous sounds was also considered.

Of all noise sources included in the assessment, the greatest impact ranges associated with PTS/AUD INJ or mortality for both marine mammals and fish were predicted for impact piling.

For marine mammals in relation to impact piling noise:

- the greatest distance where there is a predicted risk of auditory injury according to the $L_{p,pk}$ metric was found for VHF cetaceans that must be within 60 m of the impact piling activity to exceed their PTS (Southall *et al.* 2019) or AUD INJ (NMFS, 2024) criteria.
- Using the $L_{E,p,24h,wt}$ criteria, both PTS (Southall *et al.* 2019) and AUD INJ (NMFS, 2024) is predicted to be unlikely for all groups, as the receptor is modelled to flee from the piling noise and will only be near to the pile during a soft start period.

For fish, using the Popper *et al.* (2014) guidance for pile driving:

- The greatest distance where there is a risk of mortality according to the $L_{p,pk}$ metric was predicted at 30 m from impact piling for fish with a swim bladder involved and not involved in hearing.
- If they remain stationary for 10 hours, the greatest distance associated with a risk of mortality, according to the $L_{E,p,24h}$ metric, was predicted at 420 m from impact piling for fish with a swim bladder involved in hearing.

For disturbance effects, the greatest impact ranges for marine mammals are associated with vibropiling, where marine mammals at up to 2900 m from the vibropiling activities on the maximum transect will exceed their Level B Disturbance criteria (NOAA, 2005). It is predicted that, according to this criterion, marine mammals will be disturbed if they are up to 2500 m from dredging, and up to 1000 m from impact piling. This is based on disturbance noise criteria of 160 dB $L_{p,RMS}$ for impulsive noise and 120 dB $L_{p,RMS}$ for non-impulsive noise.

By its nature, mathematical modelling will produce results that indicate a precise range at which a criterion will be reached, but this does not reflect the inherent uncertainty in the physical processes, including many that change constantly under real world conditions. While the results present specific ranges at which each impact threshold is met based on the modelling results, the ranges should be taken as indicative in determining where environmental effects may occur in receptors during the proposed operations.

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ARDERSIER PORT ENERGY TRANSITION FACILITY PORT EXTENSION



November 2025

Appendix 11.6: RIAA – Marine
Mammal Designated Sites



SMRU Consulting

understand ♦ assess ♦ mitigate

Ardersier Port Extension Report to Inform Appropriate Assessment – Marine Mammal Designated Sites

Authors:	Katarzyna Majewska
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1 Document Purpose

The United Kingdom (UK) maintains a legally designated network of protected sites established for the conservation of important species and habitats, initially legislated under international obligations. The Scottish Government is required to assess the potential impacts of plans and projects on these designated sites through the Appropriate Assessment (AA) process.

Guidance under the Habitats Regulations for assessing plans and projects with potential impacts on European sites, outlines a four-stage process known collectively as the Habitats Regulations Assessment (HRA). Stage one, screening for Likely Significant Effects (LSE) was undertaken as part of the EIA Scoping Report (SCOP-0062), which was issued to consultees in January 2025. The second stage of this process is the AA (see section 2).

This document presents the outcomes of the assessment regarding the potential for LSE on the conservation objectives of the screened-in European sites. Where LSE could not be excluded at the screening stage, the report evaluates the potential for an Adverse Effect on Site Integrity (AEoSI), either alone or in combination with other plans or projects, arising from the proposed development.

The RIAA forms part of the wider suite of documents submitted in support of the consent application for the proposed development. Key sources of information used in this assessment include the following Environmental Impact Assessment Report (EIAR) documents:

- EIAR Chapter 11: Marine Mammals
- EIAR Appendix 11.3: Ardersier ETF Extension Marine Mammal Baseline Characterisation
- EIAR Appendix 11.5: Underwater Noise Modelling
- EIAR Appendix 11.7: Marine Mammal Mitigation Plan (MMMP)

2 HRA Process

The Habitats Directive (92/43/EEC), on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance. Together with Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Directive provides the European Union's legal framework for the protection of wild fauna and flora and birds (see section 3 for more details regarding legislation and policy).

HRA is a multistage process which aims to determine the potential for LSE, assesses the potential for adverse impact on the integrity of a European site, examines alternative solutions and provides

justification of Imperative Reasons of Overriding Public Interest (IROPI), as required. Defra (2021) guidance describes that the process can have up to three stages as outlined below:

- ▶ Screening - the first stage involves a screening for LSE which is a simple assessment to check or screen if, in the absence of mitigation, a proposal:
 - is directly connected with or necessary for the conservation management of a European site; and
 - risks having a significant effect on a European site on its own or in-combination with other proposals.
- ▶ Appropriate Assessment - the second stage is an Appropriate Assessment, which must be carried out if it is decided that there is a risk of a LSE on a European site or if there is not enough evidence to rule out a risk (as required by Article 6(3) of the Habitats Directive). The Appropriate Assessment (AA) should assess the likely significant effects of a proposal on the integrity of the site and its conservation objectives and consider ways to avoid or reduce (mitigate) any potential for an 'adverse effect on the integrity of the site'.
- ▶ Derogations - the third stage is known as a derogation (as outlined in Article 6(4) of the Habitats Directive) where, in certain circumstances, a proposal that has failed the integrity test may be allowed to go ahead. To decide if the proposal qualifies for a derogation, three legal tests must be applied. All three tests must be passed in sequence for a derogation to be granted:
 - there are no feasible alternative solutions that would be less damaging or avoid damage to the site;
 - the proposal needs to be carried out for imperative reasons of overriding public interest; and
 - the necessary compensatory measures can be secured.

Each stage of the HRA process, excluding the third and final stage, defines the prerequisites and scope for the subsequent stage. This report builds upon the stage 1 Screening that has already been completed as part of the EIA Scoping Report (SCOP-0062), and presents the assessment for stage 2 (Appropriate Assessment) of the HRA process.

3 Legislation and Policy Guidance

3.1 Habitats Directive and Habitats Regulations

Designated site legislation in Scotland is derived from both Scottish and broader UK legislative frameworks. The Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora (the 'Habitats Directive'), protect habitats and species of European nature conservation importance. Together with the Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Habitats Directive established a network of internationally



important sites, designated for their ecological status: Special Areas of Conservation (SACs), under the Habitats Directive promote the protection of flora, fauna and habitats; and SPAs, under the Birds Directive in order to protect rare, vulnerable and migratory birds. These sites combined to create a Europe wide 'Natura 2000' network of designated sites, which were referred to as 'European sites'.

These Directives were transposed into UK law through a series of regulations. Terrestrial areas of the UK and inshore waters (out to 12 nautical miles) are covered by the Conservation (Natural Habitats, &c.) Regulations 1994 and the Conservation of Habitats and Species Regulations 2017. Offshore waters, extending beyond 12 nautical miles to the limits of the British Fishery Limits and the UK Continental Shelf Designated Area, are governed by the Conservation of Offshore Marine Habitats and Species Regulations 2017. Collectively, these statutory instruments are referred to in this report as the Habitats Regulations.

In line with Scottish Government policy, Ramsar sites (wetlands of international importance designated under the Convention on Wetlands of International Importance; Ramsar Convention, 1971) are treated as having the same level of protection as SACs and SPAs when assessing the potential impacts of development proposals. This policy also extends equivalent protection to potential SPAs (pSPAs) and candidate SACs (cSACs). The assessment of impacts on Ramsar sites and SPAs have been addressed in Appendix 13.9.

3.2 EU Exit Regulations

The UK left the European Union on Exit Day, 31 January 2020, following Completion Day on 31 December 2020. Although the UK is no longer a member of the EU, the Habitats Directive, along with the transposing Habitats Regulations, continues to serve as the legislative foundation for HRA in the UK via the EU Exit Regulations. The HRA process under the Habitats Regulations remains applicable, with minor modifications introduced by the EU Exit Regulations¹. Consequently, this document has been prepared on the assumption that all pertinent HRA-related legislation is still in effect, adhering to the Habitats Regulations that incorporated European HRA requirements into UK law.

¹ The EU (Withdrawal) Act 2018, as amended as by the EU (Withdrawal Agreement) Act 2020, gives Ministers in the UK Government and in the devolved administrations of Northern Ireland, Scotland and Wales, powers to make subordinate legislation amending laws that otherwise would not work appropriately as a result of the UK leaving EU, or to implement the Withdrawal Agreement.

With respect to marine mammals, the objective of the Habitats Regulations is to maintain Favourable Conservation Status (FCS) for the habitats and species listed in Annex II of the Habitats Directive. Post-EU Exit, the Habitats Regulations continue to reference these annexes, and accordingly, this report refers to the annexes of the Habitats Directive.

European sites, European marine sites and European offshore marine sites within the UK as defined by the Habitats regulations, are now excluded from the EU's Natura 2000 network. Instead, they constitute a nationwide network of protected areas known as the National Site Network (NSN) and continue to benefit from equivalent levels of protection. The term adopted within this report is hereafter European Sites.

3.3 Further Guidance

The Statutory Nature Conservation Bodies (SNCBs) have produced conservation advice for European sites under their statutory remit. This conservation advice provides information on sites and features and guidance on how to achieve FCS. The following guidance documents were used to inform the AA in this report:

- ▶ NatureScot (2025a). Conservation and Management Advice - Dornoch Firth and Morrich More SAC. April 2025.
- ▶ NatureScot (2025b). Conservation and Management Advice - Moray Firth SAC. June 2025.

4 Screening Summary

A screening exercise was carried out as part of the EIA Scoping Report (SCOP-0062) to identify which European Sites are at risk of likely significant effects from the proposed development. The following European Sites with marine mammal qualifying features (for which there is potential connectivity with an impact from the construction) were screened in:

- ▶ Dornoch Firth and Morrich More SAC (harbour seal); and
- ▶ Moray Firth SAC (bottlenose dolphin).

Details about both sites, including COs, are provided in section 5. It was not possible to conclude no LSE for potential effects at the screening stage and therefore all both European Sites were taken forward to the AA (see section 6.3).

5 European Sites

5.1 Dornoch Firth and Morrich Moore SAC

5.1.1 Site overview

The Dornoch Firth and Morrich More SAC lies approximately 30 km north of the Port of Ardersier. The Dornoch Firth is the most northerly large estuary in Britain and the SAC site was initially designated in part for Annex II species harbour seals.

The SAC is located within the Moray Firth Seal Monitoring Unit (SMU). Since data collection began during the 1996/97 period, harbour seal counts in the Moray Firth SMU have declined from 1,409 in 1996/97 to 983 in the latest 2023 counts (SCOS, 2024). This results in the latest population estimate for the entire Moray Firth SMU (scaled to account for those at-sea at the time of the count) of 1,365 harbour seals (95% CIs 1,117 – 1,820). Overall, harbour seal abundance in the Moray Firth SMU is depleted but stable (SCOS, 2023, 2024).

However, SCOS (2024) reported that for the Dornoch Firth and Morrich More SAC is more severely depleted and is still in decline. Trends for the Dornoch Firth and Morrich More SAC show that the population has decreased by 7.5% over 1-year and has decreased by 37.5% over the last 6 years (SCOS, 2024).

5.1.2 Conservation Objectives

The Conservation Objectives associated with the harbour seal feature of the Dornoch Firth and Morrich More SAC are presented in Table 1.



Table 1: Conservation Objectives and Site Specific Advice for Dornoch Firth and Morrich More SAC

Site	Conservation Objectives	Site specific advice
Dornoch Firth and Morrich More SAC	<p>1) To ensure that the qualifying features of Dornoch Firth and Morrich More SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.</p>	<p>Harbour seals are considered to be in unfavourable (inadequate) condition at the Dornoch Firth and Morrich More SAC. The SAC trend is declining.</p> <p>When carrying out appraisals of plans and projects against these Conservation Objectives, it is not necessary to understand the status of qualifying features within each individual SAC in the UK. If the site Conservation Objectives are met then the site’s contribution to FCS across the UK will continue to be achieved. Further advice on how these appraisals should be focussed is provided by Conservation Objective 2.</p>
	<p>2) To ensure that the integrity of Dornoch Firth and Morrich More SAC is maintained or restored in the context of environmental changes:</p> <p>2a - harbour seals are a viable component of the Dornoch Firth and Morrich More SAC;</p> <p>2b - the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance of harbour seals;</p> <p>2c - the supporting habitats and processes relevant to harbour seal are maintained, including prey resources.</p>	<p>This conservation objective is considered to be met if the conditions to support all the species’ essential behaviours and activities are in place. This includes:</p> <ul style="list-style-type: none"> • avoiding effects that could prevent or reduce the ability of the harbour seal population to recover. • avoiding effects within and out with the site that could lead to a permanent reduction in the harbour seal population through mortality, injury, or impacts caused by disturbance, displacement, barrier effects or reduction in mobile prey resources. • maintaining the species’ ability to use all areas of importance within the site (to be considered under conservation objective 2b) • maintaining access to, and availability of, supporting habitats within the site (to be considered under conservation objective 2c). <p>At a site level, harbour seals are considered to be viable if they can carry out their life cycle functions and, for harbour seal, if conditions are right to accommodate a recovery in numbers. The long-term viability of these species in the SAC is intrinsically linked to their ability to access and use habitat and prey resources both on site and in areas of functionally linked sea out with the SAC.</p> <p>The objective 2b seeks to ensure that harbour seals continue to have access to and use all areas of the site by avoiding significant disturbance. The objective 2c seeks to maintain the current extent, quality and distribution of supporting habitats of harbour seals within the site.</p> <p>Given that the activities within the Ardersier EFT Site boundary will not overlap spatially with the Dornoch Firth and Morrich More SAC, there is no potential to directly affect the supporting habitats within the site. As such, conservation objective 2c is not considered further.</p>

5.2 Moray Firth SAC

The Port of Ardersier lies within the Moray Firth SAC, for which the bottlenose dolphin is the primary Annex II species for site selection. This SAC supports the only known resident bottlenose dolphin population in the North Sea.

5.2.1 Site overview

The Moray Firth SAC extends from the inner firths to Helmsdale on the north coast, and Lossiemouth on the south coast, including areas that are regularly utilised by the resident population of bottlenose dolphins along the East coast of Scotland. Bottlenose dolphins associated with this SAC are a part of a wider Coastal East Scotland (CES) Management Unit (MU) population. This population has experienced significant changes in its distribution over the past three decades. During the late 1980s and early 1990s, the inner Moray Firth was identified as the core area of occurrence for the population and distributional pattern formed the basis for defining the boundaries of the Moray Firth SAC (Arso Civil *et al.*, 2025). Since the 1990s, the CES population has been recorded ranging further south in the Tay Estuary and the Firth of Forth and more recently, sightings have been recorded around the coast of northern England (Wilson *et al.*, 2004, Arso Civil *et al.*, 2018a, b, Arso Civil *et al.*, 2021a, Arso Civil *et al.*, 2021b, Arso Civil *et al.*, 2022, Arso Civil *et al.*, 2023, Arso Civil *et al.*, 2025).

Between 2009 and 2022, the proportion of the population utilising the Moray Firth SAC declined, while use of the Tayside and adjacent waters increased (Cheney *et al.*, 2024). However, in most years, more than 50% of the population continued to use both areas. The most recent Mark-recapture analysis of photographs collected during photo-identification surveys indicates that, as of 2022, the Moray Firth SAC supports an estimated number of 94 individuals (Cheney *et al.*, 2024). Despite the number of animals using the SAC declined by 4.9% from 122 individuals in 2017, the number of dolphins using the SAC is still considered stable over longer timescales (2001 - 2022) with some inter-annual variability (Cheney *et al.*, 2024).

Passive acoustic monitoring conducted between 2017 and 2022 revealed that, despite inter-annual and seasonal variability, bottlenose dolphins were present at one long-term monitoring site within the SAC on more than 80% of days from April to December. During these periods, dolphins were acoustically detected for between 3 and 10 hours per day. Further detail on the passive acoustic monitoring results is provided in EIAR Appendix 11.3.

5.2.2 Conservation Objectives

The Conservation Objectives associated with the bottlenose dolphin feature of the Moray Firth SAC are presented in Table 2 .

Table 2: Conservation Objectives and Site Specific Advice for Moray Firth SAC

Site	Conservation Objectives	Site Specific Advice
Moray Firth SAC (NatureScot, 2025b)	1) To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.	As the long-term trend in the number of dolphins using the SAC remains stable, the use of this protected area continues to be high, and the east coast population is increasing, the condition status is Favourable (maintained) (Cheney <i>et al.</i> , 2024, NatureScot, 2025b).
	<p>2) To ensure that the integrity of Moray Firth SAC is maintained or restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for bottlenose dolphin:</p> <p>2a - the population of bottlenose dolphin is a viable component of the site;</p> <p>2b - the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance;</p> <p>2c - the supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.</p>	<p>Objective 2a seeks to minimise the risk to bottlenose dolphins from injury or killing posed by activities. It specifically protects the species from significant risk of incidental killing and injury within and out with the site.</p> <p>Objective 2b seeks to ensure that bottlenose dolphins can continue to use and have access to all areas of the site by avoiding significant disturbance. Interpretation of ‘significant disturbance’ will depend on the context, including the information that is provided through the plan or project, and is then subject to the appraisal to assess risk. It should be interpreted to mean disturbance that affects the integrity of the site through alteration of the distribution of bottlenose dolphin within the SAC such that recovery cannot be expected, or effects can be considered long term. Bottlenose dolphin calves are highly dependent on their mothers for up to 2 years therefore prolonged disturbance is more likely to constitute significant disturbance and to have an impact on site integrity. It is expected that significant disturbance will lead to more than a transient effect on the distribution of bottlenose dolphin. It may result in the following effects:</p> <ul style="list-style-type: none"> • Contributes to the long-term decline in the use of the site by bottlenose dolphin. • Changes to the distribution of bottlenose dolphin on a continuing or sustained basis. • Changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young. <p>Objective 2c seeks to maintain sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site. Relevant activities (e.g. hydraulic dredging, aggregate extraction, dumping) should be considered within appraisals</p>

6 Assessment of potential AEol

6.1 Project Alone

6.1.1 Maximum Design Scenario

Potential LSEs on this European Site were identified for the following potential impacts:

- ▶ Construction phase:
 - Auditory injury (PTS) associated with piling (vibro and impact) for installation of mooring dolphins;
 - Auditory injury (PTS) associated with dredging and spoil disposal activities;
 - Disturbance associated with piling (vibro and impact) for installation of mooring dolphins;
 - Disturbance associated with dredging and spoil disposal activities;
 - Disturbance associated with increased vessel traffic; and
 - Collision risks associated with increased vessel traffic.
- ▶ Operation and maintenance phase:
 - Collision risk impacts associated with increased vessel traffic due to the proposed development during operations and maintenance;
 - Disturbance impacts associated with increased vessel traffic due to the proposed development during operations and maintenance (including disturbance to seal haul-outs); and
 - Long term habitat changes, displacement and/or barrier effects.

The maximum design scenario and a summary of the impacts are provided in sections 6.1.2 and 6.1.3 for construction and maintenance and operation phases, respectively. Detailed project information is provided in the EIAR Chapter 11 (Marine Mammals).

6.1.2 Construction

6.1.2.1 Auditory injury (PTS) associated with piling for installation of mooring dolphins as well as dredging

Impact piling is the only impulsive noise source during construction of the proposed development with the potential to cause auditory injury. Based on the underwater noise modelling, there is no risk for high frequency cetaceans (e.g. bottlenose dolphins) to experience Permanent Threshold Shift (PTS; using the peak Sound Pressure Level (SPL_{peak}) metric) due to impact piling of mooring dolphins. The low risk can be associated with the piling sequence starting with a soft-start and low maximum hammer energy (294 kJ). The maximum instantaneous injury range as a result of impact piling for

harbour seals is <10 m. A piling MMMP will be in place to mitigate the risk of injury to both bottlenose dolphins and harbour seals (see section 6.1.4.1 for a summary and Appendix 11.7 for full details).

The maximum cumulative injury ranges (using the cumulative Sound Exposure Level (SEL_{cum}) metric) across all activities with the potential to cause cumulative PTS (impact piling and dredging) are <10 m for bottlenose dolphins and harbour seals.

Considering the low risk of injury based on underwater noise modelling, coupled with the embedded mitigation measures through the MMMP, the risk of auditory injury (PTS) to both bottlenose dolphins and harbour seals is considered **Negligible**.

6.1.2.2 Disturbance associated with piling for installation of mooring dolphins, dredging and spoil disposal activities as well as increased vessel traffic

The noise sources with a potential to cause behavioural disturbance to marine mammals during the construction phase of the proposed development include piling, dredging and spoil disposal as well as increased vessel traffic. These activities will be taking place at different spatial and temporal scales with respect to both bottlenose dolphin and harbour seal distribution.

Pile driving: The quantitative assessment using a dose-response approach and species-specific density maps (Thompson *et al.*, 2015, Carter *et al.*, 2025) showed that <1 individual dolphin or seal is at risk of experiencing disturbance from piling due to the localised extent of the impacts (see the EIAR Chapter 11 (Marine Mammals) for more details). The mean dolphin group size at Ardersier during boat based surveys was 8 individuals (1-56) (Benhemma-Le Gall and Cheney, 2025). As such, on average, 8 individuals (1 - 56) could experience behavioural disturbance at any given time. It should be however noted that piling will be restricted to only a short duration with 12 piles installed over 12 non-consecutive days, with a maximum of 10 hours of activity per pile.

Dredging: A combination of hydraulic and mechanical dredging will be carried out during the construction phase. The number of interactions between the dredging activity and bottlenose dolphins as well as harbour seals utilising waters surrounding the proposed development shall be minimal for most of the dredging campaign (10-weeks within a 6 month window (March to September)) as dredging activity shall take place deeper into the site boundary. The quantitative assessment was carried out in the EIAR Chapter 11 (Marine Mammals) using the effective deterrence ranges approach (1 km for bottlenose dolphin and 5 km for seals). It was estimated that up to 23 harbour seals (1.71% Moray Firth SMU) and no bottlenose dolphins may be disturbed by dredging activity.

Vessels: For the majority of time during the construction period (2026 – 2028), a maximum of five vessels (primarily barges for material delivery) may operate within the site boundary at any one time. These vessel movements are expected to be dispersed and intermittent and are not anticipated to result in significant spatial overlap with areas of highest dolphin activity (e.g. within the site boundary). The disturbance is most likely to occur during the spoil disposal events and vessel associated with dredging activities (between 2027 – 2029), which would be associated with approximately 450 additional vessel movements within the inner Moray Firth over the ten-week period. The semi-quantitative assessment (see Section 3.4.2.2 of Appendix 11.4) estimated that bottlenose dolphins may be present in the vicinity of the proposed development approximately 14.6% of the total spoil disposal operational time (which represents 66 of the 450 vessel movements) where there is expected to be disturbance to an average of 8 individuals (maximum 56). This higher intensity in vessel movement is short-term but represents a significant temporary increase in marine traffic local to the proposed development and the spoil disposal area(s) (Inverness, the Sutors or Burghead). The anticipated increase in vessel movements may lead to short-term, localised impacts, particularly relating to increased underwater noise, and a higher risk of disturbance to both harbour seals and bottlenose dolphins.

6.1.2.3 Collision risks associated with increased vessel traffic

During construction of the proposed development, there is a risk that increased vessel activity could result in death, or physical trauma from collision with a construction vessel. These injuries include blunt trauma to the body, or injuries consistent with propeller strikes. There is currently limited information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality. The Scottish Marine Animal Stranding Scheme (SMAS) data shows that very few strandings have been attributed to vessel collisions (SMASS, 2018, 2019, 2020, 2021, 2022, 2023), therefore while there is evidence that mortality from vessel collisions can and does occur in Scottish waters, it is not considered to be a key source of mortality highlighted from post-mortem examinations.

During the construction phase of the proposed development, under a worst-case scenario, peak vessel activity is expected to occur during spoil disposal operations between March and September 2028, with up to 13 - 23 barge movements per day and a maximum of approximately 450 additional vessel movements within the inner Moray Firth over a ten-week period. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks of collision. The risk of vessel collision with marine mammals is also influenced by vessel speed and size. While dredging vessels typically operate at low speeds (1–3 knots), project vessels may reach speeds up to 12 knots

during transit. The embedded mitigation of a Navigational Safety Risk Assessment (NSRA) will ensure that vessel traffic moves along predictable routes, set recommended speed and define how vessels should behave in the presence of marine mammals. Consequently, the overall likelihood of a collision is low; in the unlikely event that one does occur, it would be infrequent.

6.1.2.4 Indirect impact on prey availability

The activities associated with construction which could give rise to indirect impacts by affecting prey availability are increases in underwater noise associated with piling, impacts of contaminants and sediment suspension as a result of dredging, and pollution events from the accidental release of hydraulic fluids and oils from the construction plant into the marine environment. Sandeels are of particular importance to harbour seals and cod, saithe and whiting are the main prey items eaten by bottlenose dolphins in Scottish waters (Santos *et al.*, 2001, Pierce *et al.*, 2004, Santos *et al.*, 2004, Wilson and Hammond, 2019). Salmon are also a seasonally important component of the bottlenose dolphin diet, with the presence of bottlenose dolphins in the summer months coinciding with seasonal migrations of Atlantic salmon and sea trout through the Moray Firth (NatureScot, 2025b). The Nairn District Salmon Fisheries Board advise that the Port of Ardersier lies in close proximity to the River Nairn, which is an important river for migratory salmonids (salmon and sea trout), and as such it is likely that migratory fish travel close to the proposed works location while seeking their natal river (MD-LOT, 2025).

With implementation of an appropriate Port Environmental Management Plan (POEMP) and Port Oil Spill Contingency Plans, a major pollution incident that may impact any fish species at a population level is considered very unlikely. The sediment samples tested historically against the Revised Action Levels (RAL) showed low levels of chemical contaminants and organic hydrocarbons present and they have been previously identified as suitable for disposal. Whilst a BPEO has not yet been concluded for the dredging activities as part of the proposed development, any future BPEO that is authored for the proposed development shall take the appropriate measures to ensure that dredged materials meet acceptable environmental standards. Sediment disturbance and habitat loss will occur within the dredged area. Although the temporary and localised exposures to noise associated with construction activity are unlikely to have any long-lasting effects on the fitness and survival of fish and cephalopods, the noise associated with construction activity may cause temporary relocation, communication making, and changes in behaviour of marine mammal prey species. Consequently, sediment disturbance and underwater noise may locally affect marine mammals' access to prey within the site

boundary. Overall, impacts to prey species could result in very slight changes to marine mammal receptors and it is expected that this will not result in any population level change.

6.1.3 Operation and Maintenance

6.1.3.1 Disturbance impacts associated with increased vessel traffic

The area surrounding the proposed development is already subject to high levels of vessel activity with the Port of Ardersier currently experiencing approximately 340 vessel movements per year (Haventus, 2025). The Inner Moray Firth is an area where marine mammals are regularly exposed to commercial vessel activity. During the operational phase of the proposed development, vessel movements associated with the Port of Ardersier are expected to increase to a maximum worst-case scenario of 400 vessel movements per year (increase of ~60 vessels per year compared to current levels (17.65% increase)). The types of vessels expected to operate from the Port of Ardersier are primarily large vessels servicing offshore industries, including heavy load carriers, heavy lift vessels, jack-up barges, general cargo vessels, bulk carriers and semi-submersibles. Vessel activity levels will be sustained over a long-term duration (50 years).

Bottlenose dolphins and harbour seals are likely to exhibit some degree of habituation to vessel noise and presence due to existing high baseline traffic level and thus, the frequency of potential disturbance events is predicted to remain the same. Further, the spatial extent remains of disturbance shall remain localised over the operational phase and does not represent a significant increase in marine traffic over a broad geographical area (e.g., from the port to offshore wind farm sites).

6.1.3.2 Collision risk impacts associated with increased vessel traffic

As discussed in section 6.1.2.3 for construction, vessel activity during the operational phase could result in death or physical trauma to marine mammals from collisions with vessels. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic, as it allows marine mammals to better anticipate and avoid vessels (Nowacek *et al.*, 2001, Lusseau, 2006, New *et al.*, 2020).

Vessel traffic during the operational phase is expected to increase from approximately 340 vessel movements per year (Haventus, 2025) to a maximum worst-case scenario of 400 vessel movements per year (increase of ~60 vessels per year compared to current levels). While some of the vessels expected to operate are capable of reaching speeds up to 13 knots, most are expected to transit at typical speeds around 10 knots. Although vessels may transit over a broad geographical area (e.g.,

from the port to offshore wind farm sites), the physical risk of collision is localised to the immediate vicinity of the moving vessel. The adoption of a NSRA based on best practice vessel handling protocols (e.g., following the Scottish Marine Wildlife Watching Code) will minimise the potential for any impact by ensuring that vessel traffic moves along predictable routes, setting recommended speed and defining how vessels should behave in the presence of marine mammals. Consequently, the overall likelihood of a collision is low; in the unlikely event that one does occur, it would be infrequent.

6.1.3.3 Indirect impact on prey availability

Activities relating to the operations of the proposed development may influence water quality as a result of accidental release of fuels, oils and/or hydraulic fluids. With implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident that may impact any fish species at a population level is considered very unlikely. Consequently, changes in water quality are unlikely, and effects on prey species are not anticipated. Overall, the potential for impacts on prey is low and unlikely to influence marine mammal receptors or lead to any population-level change.

6.1.3.4 Long term habitat changes, displacement and/or barrier effects

Bottlenose dolphins in this region are known to show high site fidelity and regularly use specific coastal corridors, such as the narrow channel between Chanonry Point, Ardersier, and Fort George (Cheney *et al.*, 2013, Benhemma-Le Gall and Cheney, 2025). Harbour seals are known to haul-out at the Ardersier (Whiteness Sands) designated haul-out site, which overlaps with the site boundary.

Although situated within the Moray Firth SAC, the proposed development will not permanently obstruct the Chanonry Point–Fort George–Ardersier channel and the entry to the SAC. All new operational structures associated with the Port of Ardersier are either land-based or positioned within the existing port envelope and inner harbour. For example, Nigg Energy Park and the Invergordon Service Base have undergone significant port expansion, allowing for the fabrication and storage offshore wind turbine structures, the mooring of oil & gas platforms, and the berthing of large vessels such as cruise liners. Despite ongoing operations and vessel activity, marine mammals continue to be regularly sighted in the Inner Moray Firth, including around Nigg Energy Park, Invergordon and the Port of Ardersier (Graham *et al.*, 2017, Benhemma-Le Gall and Cheney, 2025). Long-term surveys in the Moray Firth indicate continued and regular use by dolphins and seals, suggesting that the presence of coastal industrial structures and increased vessel activity have not created permanent or large-scale movement barriers (Cheney *et al.*, 2018, Hague *et al.*, 2019, Cheney *et al.*, 2024, Benhemma-Le Gall

and Cheney, 2025). As such, barrier effects associated with presence of infrastructure is unlikely. However, intermittent displacement during operational vessel activity is expected and is further discussed under disturbance in section 6.1.3.1.

6.1.4 Marine Mammal Mitigation Plans

The draft MMMP is detailed in EIAR Appendix 11.7. The mitigation developed and included as part of the MMMP is to ensure the protection of marine mammals during the installation of three mooring dolphins using impact piling or vibropiling, as well as during dredging and spoil disposal operations.

6.1.4.1 Impact Piling MMMP

A 500 m Mitigation Zone (MZ) will be implemented. This is based on the minimum 500 m MZ recommended by the JNCC (2010) for pile driving activities and will be more than sufficient to mitigate the predicted instantaneous PTS ranges (max 60 m). The MZ will be monitored by a Marine Mammal Observer (MMO) and/or PAM Operator (PAM Obs). A pre-piling search will be conducted for a minimum of 30 minutes prior to the commencement of piling. Following the completion of the pre-piling search, a 20-minute soft-start procedure will commence.

6.1.4.2 Dredging MMMP

A 500 m Mitigation Zone (MZ) will be implemented. This is based on the minimum 500 m MZ recommended by the JNCC (2010) for pile driving activities in the absence of dredging specific guidance. This will be more than sufficient to mitigate the predicted instantaneous PTS ranges (max 10 m). The MZ will be monitored by a MMO and/or PAM Obs. A pre-dredging search will be conducted for a minimum of 30 minutes prior to the commencement of dredging. Once the 30-minute pre-dredging search is complete and MZ is clear of animals, a 20-minute soft-start procedure can commence (where operationally feasible for the suction cutter).

6.1.4.3 Soil Disposal MMMP

The Mitigation Zone (MZ) that should be monitored during spoil disposal operations on the vessel approach to, and at the spoil disposal site, is a 200 m MZ established around the spoil disposal vessel, with mitigation only being implemented for marine mammal visual observations or acoustic detections within the MZ. This shall be conducted for a minimum of 15 minutes. This shall be applied for all marine mammal species.

The JNCC (2010) guidelines for pile driving activities have been adapted here to reduce the duration of the pre-disposal search, and the delay to commencing activities after the last marine mammal

detection. This is due to the reduced area of search when compared with the dredge area itself (i.e., a 200 m MZ versus a 500 m MZ) which is an area that is >80% smaller. However, the timings have only been reduced by 50% as a conservative measure to account for the fact that marine mammals are not always available at the surface for observation and may not be constantly vocalising.

6.2 In-Combination

6.2.1 Project Screening

The in-combination effects are the effects of the proposed development, combined with the effects from other projects, on the same receptor, in case of this report, on the protected feature of a designated site or any supporting habitats and processes. A cumulative impact assessment screening process carried out as a part of the EIAR Chapter 11 (Marine Mammals), has identified the relevant other plans, projects, and activities which are to be included in the assessment. The time period considered in the EIAR and in this report is 2025 to 2034 inclusive to account for projects constructing up to a year on either side of the proposed development construction. This allows for the quantification of impacts prior to, during and post construction.

The screening range in the EIAR was defined as the Moray Firth. For the purposes of this report, only projects with the potential to adversely affect the integrity of SACs in relation to their respective Conservation Objectives were considered. If a project overlaps spatially with the SACs, it has been carried forward to the in-combination assessment. To identify projects which may affect the protected features adversely but are located outside of the SAC, the following EDRs were applied:

- ▶ 26 km for fixed OWF piling;
- ▶ 15 km for floating OWF piling;
- ▶ 5 km for dredging (seals), 1 km for dredging (bottlenose dolphin);
- ▶ 5 km for cables (assuming 5 km low-order UXO clearance EDR), and
- ▶ 5 km for port developments.

For harbour seals, in order to account for behavioural impacts out with the site, the overlap was also considered with respect to the foraging range of 50 km from the SAC. For bottlenose dolphin, the site-specific management advice refers to potential injury and/or killing (conservation objective 2a; see Table 2) as the only potential impacts that should be managed outside of the site. As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently,

the risk of injury is considered highly unlikely, and this assessment focuses solely on projects with the potential to cause adverse effects within the site boundaries, such as disturbance.

As a result of this in-combination screening exercise, the following projects were identified for both SACs:

- ▶ Invergordon Phase 5 (piling between 2026 and 2027; operational from 2028)
- ▶ Port of Cromarty Firth (dredging between 2025 and 2028)
- ▶ Port of Nigg:
 - East Quay - Inner Berthing Structure (piling between 2025 and 2026)
 - Maintenance Dredging and Sea Disposal (dredging between 2025 and 2026)

Timing of each project with respect to the proposed development is presented in Table 3. Impacts associated with piling and dredging will be assessed for species in the assessment against COs in section 6.3 and a summary of vessel impacts is provided in section 6.2.2.

Table 3: Projects screened into the in-combination assessment.

Project	2025	2026	2027	2028	2029
Proposed development	-	Construction Piling	Construction Piling Dredging	Construction Piling Dredging	Dredging
Invergordon	-	Piling	Piling	-	-
Cromarty	Dredging	Dredging	Dredging	Dredging	-
Nigg	Piling Dredging	Piling Dredging	-	-	-

6.2.2 Vessel Impacts

6.2.2.1 Construction

At Nigg East Quay, a total of 482 construction vessel movements are projected over a 6-month period between 2025 and 2026 (EnviroCentre Limited, 2019). At Invergordon, approximately 272 one-way construction vessel movements are anticipated over a 3-year period (2025–2027), translating to an estimated 90–120 movements per year, including transits to and from the dredge disposal site during

2026–2027 (Affric, 2025). The proposed development is expected to contribute significantly to temporary increases in vessel activity, with a worst-case scenario involving up to 11 vessels present simultaneously (including dredging and barge delivery operations). During peak spoil disposal operations over a 10-week period between March and September (sometime between 2027 – 2029), 13–23 barge movements per day may occur, potentially resulting in up to ~450 additional vessel movements within the inner Moray Firth.

Considering the current baseline of >500 movements/km² throughout 2024 in the vicinity of the proposed development and Cromarty Firth (overall annual traffic volume that can approach or exceed 1,000 vessel movements per year (Affric, 2025)), due to the number of projects included within the CEA and the frequency of overlapping timescales, it is likely that the effect will occur at moderate frequency. An assessment of construction timeframes indicates that there is temporal overlap between Nigg South Quay and Invergordon, with both projects expected to be under construction during 2025–2026. This overlap presents the highest potential for cumulative marine mammal disturbance, particularly in the Cromarty Firth area, due to increased vessel movements associated with concurrent dredging and port development activity. In contrast, there is no direct temporal overlap between Invergordon and Ardersier, or between Nigg South Quay and Ardersier, as the Ardersier peak construction period may not commence until 2027.

6.2.2.2 Operation and Maintenance

Recent data for the Moray Firth the current volume of vessel traffic associated with vessel calls at the Cromarty Firth Ports (~1,000) (EnviroCentre Limited, 2019, Affric, 2025), the Port of Ardersier (~340) (Haventus, 2025) and at the Port of Inverness (~200)², baseline vessel movements in the inner Moray Firth amount to approximately ~1,540 movements per year.

At the individual port level, operational vessel movements at Nigg East Quay are projected to increase modestly from a 2019 baseline of approximately 220 movements per year to around 246 - 255 movements per year, representing an increase of 26 - 35 additional vessel calls annually (EnviroCentre Limited, 2019). In contrast, Invergordon is expected to operate at a higher intensity, with a worst-case scenario estimating 468 vessel movements per year, the majority of which (420) are tug operations (Affric, 2025). The same is anticipated for the proposed development, whereby vessel movements are anticipated to increase to 400 vessel calls per year as a maximum worst-case scenario, representing

² <https://portofinverness.co.uk/wp-content/uploads/2023/03/Annual-Report-2022.pdf>

an increase of ~60 additional vessel calls from current annual movements. Taking the combined operational activity across the Port of Ardersier, Nigg South Quay, Invergordon, and those within the Cromarty Firth Harbour Authority Limits (which includes those at Deephaven and the Cromarty (Car Ferry) Slipway), the total annual vessel movements within the inner Moray Firth are expected to reach approximately ~1,635 vessel movements per year. This represents a 6.17% increase on the current baseline of ~1,540 vessel movements per year.

6.3 Assessment against Conservation Objectives

6.3.1 Dornoch Firth and Morrich Moore SAC

In the UK, the harbour seal breeding period occurs between June and July, with moulting taking place from late July to mid-September. During these periods, there is typically a greater number of harbour seals hauled-out during low tide periods than at other times of year. The construction at the proposed development will take place between 2026 and 2028, with dredging activities taking place sometime between 2027 – 2029. As such, overlap with the construction at the proposed development and harbour seal breeding and moulting seasons cannot be discounted.

6.3.1.1 Project Alone

The Project Alone assessment of AEoI of the Dornoch Firth and Morrich Moore SAC with respect to harbour seal COs is presented in sections 6.3.1.1.1 to 6.3.1.1.3 and conclusions are provided in section 6.3.1.1.4.

6.3.1.1.1 Construction

6.3.1.1.1.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

The conservation status of harbour seals at the site is currently assessed as “unfavourable – inadequate” (NatureScot, 2025a). The unfavourable status of the harbour seal population at the Dornoch Firth and Morrich Moore SAC reflects an approximate 90% decline compared to population counts from the 1990s (NatureScot, 2025a). However, this rate of decline is not representative of the wider Moray Firth SMU, which is considered depleted but stable. NatureScot (2025a) recognised that the reasons for the unfavourable condition appear to lie out with the SAC, and that the reasons for harbour seal population variations and fluctuations across Scotland are unclear. Research is indicating that off-site factors such as predation, competition for prey, prey quality and availability, and toxin exposure from harmful algae maybe possible causes of the decline.

The focus of the appraisal should be to understand the impact of the proposed development on site integrity by ensuring that it does not prevent or reduce the potential for recovery. In light of the COs presented in Table 1 and the assessment carried out in sections 6.3.1.1.1.2 to 6.3.1.1.1.4, it can be concluded that the construction of the proposed development will not compromise the ability of the site and the harbour seal designated feature within to recover (e.g. it will not result in a further decline or accelerate the rate of decline).

6.3.1.1.1.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

The risk of auditory injury to harbour seals from all noise sources is negligible due to the extremely small predicted injury ranges as well as the application of mitigation measures (see sections 6.1.2.1 and 6.1.4). Similarly, any risk of death or injury through collision with vessels will be managed via a NSRA (see section 6.1.2.3). As such, killing or injury is highly unlikely and construction activities at the proposed development are not expected to affect harbour seals associated with the Dornoch Firth and Morrich Moore SAC.

In line with the advice provided in NatureScot (2025a), given that there is no site-reference population for harbour seal at this site, the site trend is considered in relation to the wider Moray Firth SMU. The quantitative assessment estimated that less than one harbour seal is expected to be disturbed during piling representing <0.001% of the Moray Firth SMU (Figure 1). As such, although temporary impacts associated with behavioural disturbance out with the site cannot be excluded, this may affect only a very small number of individuals and any displacement is expected to be localised to the immediate vicinity of the proposed development (Figure 1). Additionally, piling duration is not expected to last longer than 12 non-consecutive days.

Increased vessel activity and underwater noise as a result of dredging may also result in seal displacement from foraging areas. The site boundary is located approximately 30 km from the SAC and similarly to piling, it is anticipated that some individuals may be temporarily disturbed from their foraging distributional range out with the SAC. Based on the precautionary EDR of 5 km (McQueen *et al.*, 2020) and the Carter *et al.* (2025) density map (representing distribution during the main foraging season in autumn-winter-spring), up to 23 harbour seals may experience disturbance during dredging at the most seaward location of the dredge footprint (1.71% of the Moray Firth SMU; section 6.1.2.2). The dredging activities will be carried out over a 10-week period within the 6-month window between April and September (sometime between 2027 – 2029). The dredging activity shall take place deeper

into the site boundary and therefore interactions between the dredging activity and harbour seals utilising waters surrounding the proposed development is expected to be minimal for most of the time.

The increase in vessel traffic associated with construction activities, particularly during the 10-week dredging and spoil disposal phase, which will involve approximately 450 additional vessel movements, has the potential to disturb harbour seals, both in the water and while hauled out on land. When considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). The increased vessel activity for dredging and soil disposal may occur anytime between April and September (sometime between 2027 – 2029), thus potentially overlapping with harbour seal breeding and moulting periods when seals spent more time hauled-out than at other times of year. The evidence suggests that seals are more reluctant to enter the water during the annual moult, which may reduce the likelihood of disturbance from vessel movements while seals are hauled out (Henry and Hammill, 2001). However, the SAC distribution map show that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier (Figure 2).

Considering the above, although temporary displacement cannot be excluded, underwater noise from piling and dredging as well as increased vessel traffic is not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

Figure 1: Disturbance contours for piling of mooring dolphins at the proposed development, the Dornoch Firth and Morrich Moore SAC overlain on the Carter *et al.* (2025) at-sea harbour seal density surface (representing distribution during the main foraging season in autumn-winter-spring)

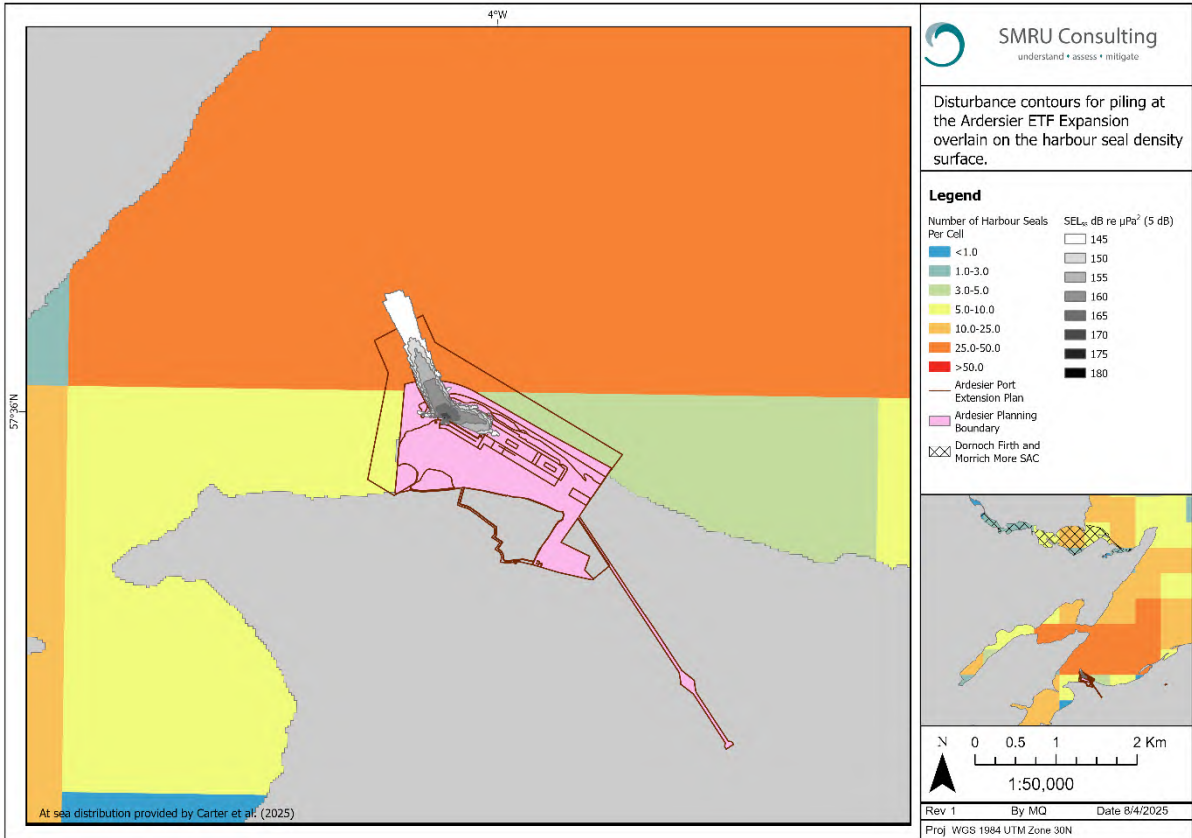
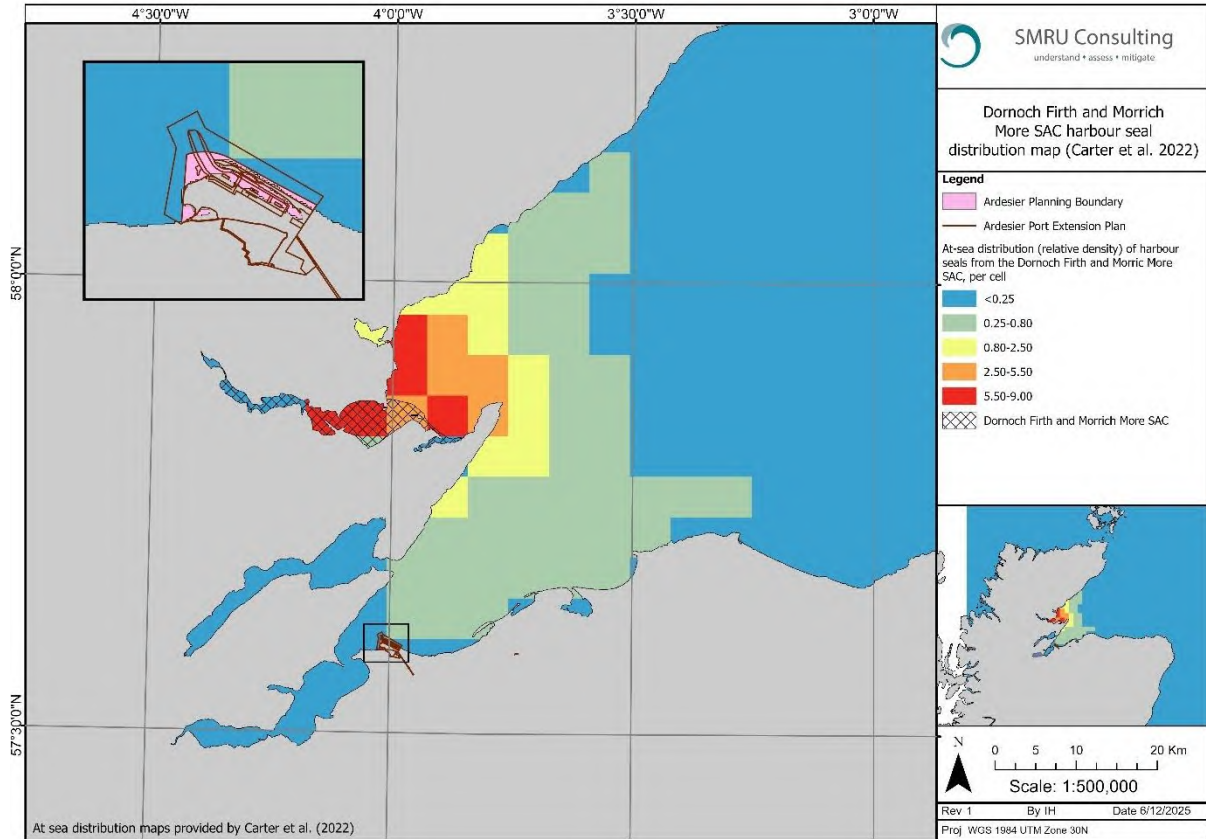


Figure 2: The mean percentage of the SAC population estimated to be present in each 5 km x 5 km grid cell at any one time in the foraging season (spring). Data from Carter et al. (2022).



6.3.1.1.1.3 *The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site).*

The activities within the site boundary will not overlap spatially with the Dornoch Firth and Morrich More SAC. Vessel movements associated with dredging and spoil disposal are also not going to spatially overlap with the SAC. Based on the underwater noise modelling, there will be no overlap of noise contours from pile driving with the SAC (Figure 1). Therefore, underwater noise associated with construction is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.1.1.4 *Conclusions*

Based on the assessment presented in sections 6.3.1.1.1.1 to 6.3.1.1.1.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch Firth and Morrich Moore SAC will not occur as a result of construction activities.



6.3.1.1.2 Operation and Maintenance

6.3.1.1.2.1 *To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS*

As per information presented in section 6.3.1.1.1.1, the conservation status of harbour seal at the site is currently assessed as “unfavourable – inadequate” and the reasons for the unfavourable condition appear to lie out with the SAC (NatureScot, 2025a).

The focus of the appraisal should be to understand the impact of the proposed development on site integrity by ensuring that it does not prevent or reduce the potential for recovery. In light of the COs presented in Table 1 and assessment carried out in sections 6.3.1.1.2.2 to 6.3.1.1.2.4, it can be concluded that the operation and maintenance of the proposed development will not compromise the ability of the site and harbour seal designated feature within to recover (e.g. result in a further decline or accelerate the rate of decline).

6.3.1.1.2.2 *Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)*

The risk of injury through collision with vessels will be managed via a NSRA (see section 6.1.3.2). As such, killing or injury is highly unlikely and operation and maintenance activities at the proposed development are not expected to affect harbour seals associated with the Dornoch Firth and Morrich Moore SAC.

During the operational phase of the proposed development, vessel movements associated with the Port of Ardersier are expected to increase slightly to approximately 400 vessel movements per year. However, when considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). The SAC distribution map show that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier and the hotspots of vessel activity within the Inner Moray Firth (Figure 2).

Considering the above, underwater noise from vessel traffic as well as vessel presence is not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

6.3.1.1.2.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site)

The operation and maintenance activities within the site boundary will not overlap spatially with the Dornoch Firth and Morrich More SAC. Additionally, based on the location of option plan areas available in Scottish leasing rounds (ScotWind³ and INTOG⁴), it is not anticipated that there would be any spatial overlap of vessel movements between the port and offshore wind farms areas and the SAC boundary. Therefore, underwater noise associated with operation and maintenance is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.1.2.4 Conclusions

Based on the assessment presented in sections 6.3.1.1.2.1 to 6.3.1.1.2.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch Firth and Morrich Moore SAC will not occur as a result of operation and maintenance activities.

6.3.1.2 In-combination

The in-combination screening exercise and the list of projects taken forward to the assessment are presented in section 6.2.

6.3.1.2.1 Construction

6.3.1.2.1.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

As per information presented in section 6.3.1.1.1.1, the conservation status of harbour seal at the site is currently assessed as “unfavourable – inadequate” and the reasons for the unfavourable condition appear to lie out with the SAC (NatureScot, 2025a). In light of the COs presented in Table 1 and assessment carried out in sections 6.3.1.2.1.2 to 6.3.1.2.1.4, it can be concluded that the construction of the proposed development in-combination with other projects will not compromise the ability of

³ ScotWind leasing round sites and developers | Offshore Wind Scotland

⁴ INTOG | Innovation and Targeted Oil and Gas leasing round | Offshore Wind Scotland

the site and harbour seal designated feature within to recover (e.g. result in a further decline or accelerate the rate of decline).

6.3.1.2.1.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely.

In line with the advice provided in NatureScot (2025a), given that there is no site-reference population for harbour seal at this site, the site trend is considered in relation to the wider Moray Firth SMU. Based on the assessment for the proposed development alone, less than one harbour seal is expected to be disturbed during piling and up to 23 harbour seals may experience behavioural disturbance due to dredging at any one time (see section 6.1.2; Table 1). Based on information presented in Invergordon Phase 5 project EIA, the disturbance zone associated with piling noise is likely to include a large area of the Cromarty Firth in the vicinity of the project site which may prevent animals transiting to and from the Cromarty Firth harbour seal non-breeding haul-out site, which has been found to be utilised by over 82 individuals (Affric, 2025). The impacts of piling at the berthing structure within the Port of Nigg were not quantified in the project's EIA (EnviroCentre Limited, 2019), therefore this impact has not been assessed quantitatively in this in-combination assessment. Given that the EIA was not available for maintenance dredging and sea disposal at port of Nigg and Port of Cromarty Firth, the number of harbour seals was quantified based on 5 km EDR and Carter *et al.* (2025) at-sea density maps with up to 109 individuals being disturbed at any given time. Therefore, under a worst-case scenario between 2025 and 2029, it is estimated that between 23 and 300 harbour seals could be subject to behavioural disturbance from piling and dredging activities at any given time. This represents approximately 1.71% to 21.98% of the Moray Firth SMU population (Table 4). It should be however noted that this number is highly as the activities at different ports may not occur on the same day.

Table 4: Harbour seal Cumulative Effects Assessment: potential disturbance from underwater noise. Colour key: Pre-construction, Piling, Dredging, Piling & Dredging.

Project	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	EIA?	
Ardersier ETF Extension	Pre-C	0	23	23	23	Operational					Yes	
Invergordon Phase 5	Pre-C	82	82	Operational								Yes
Port of Nigg East Quay - Inner Berthing Structure	-	-	Operational									Yes
Maintenance Dredging and Sea Disposal - Port of Nigg	109	109	Operational									No
Maintenance Dredging - Port of Cromarty Firth	109	109	109	109	Operational						No	

Increased vessel activity may also result in seal displacement from foraging areas. A summary of the magnitude of vessel impacts is provided in section 6.2.2. However, when considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). The evidence suggests that seals are more reluctant to enter the water during the annual moult, which may reduce the likelihood of disturbance from vessel movements while seals are hauled-out (Henry and Hammill, 2001). Most importantly, the SAC distribution map shows that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier and Cromarty Firth (Figure 2).

Considering the above, although temporary displacement as a result of increased vessel movements at the proposed development in-combination with other projects cannot be excluded, it is not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.



6.3.1.2.1.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site)

The activities within the respective project boundaries will not overlap spatially with the Dornoch Firth and Morrich More SAC. Vessel movements associated with dredging and spoil disposal at the proposed development, Port of Nigg, port of Cromarty and Invergordon are not anticipated to spatially overlap with the SAC. Therefore, underwater noise associated with construction of the proposed development in-combination with other projects is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.2.1.4 Conclusions

Based on the assessment presented in sections 6.3.1.2.1.1 to 6.3.1.2.1.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch Firth and Morrich Moore SAC will not occur as a result of construction activities at the proposed development in-combination with other projects.

6.3.1.2.2 Operation and Maintenance

6.3.1.2.2.1 To ensure that the qualifying features of Dornoch Firth and Morrich Moore SAC are in favourable condition and make an appropriate contribution to achieving FCS

As per information presented in section 6.3.1.1.1.1, the conservation status of harbour seal at the site is currently assessed as “unfavourable – inadequate” and the reasons for the unfavourable condition appear to lie out with the SAC (NatureScot, 2025a). In light of the COs presented in Table 1 and assessment carried out in sections 6.3.1.2.2.2 to 6.3.1.2.2.4, it can be concluded that the operation and maintenance of the proposed development in-combination with other projects will not compromise the ability of the site and harbour seal designated feature within to recover (e.g. result in a further decline or accelerate the rate of decline).

6.3.1.2.2.2 Harbour seal is viable component of the Dornoch Firth and Morrich More SAC (ensure the harbour seal population has the ability to recover and can move safely between the site and important areas of functionally linked sea out with the site)

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely.

Increased vessel activity throughout the operational and maintenance phase may result in seal displacement from foraging areas. A summary of the magnitude of vessel impacts is provided in section 6.2.2. The vessel activity may increase by 6.17% above estimated baseline conditions. When considering the impact of disturbance on seals at-sea from vessel noise, telemetry and observational studies in the Moray Firth have shown that harbour seals exhibit a high degree of tolerance to vessel traffic, with no observed reductions in habitat use or presence near areas of concentrated shipping activity (Mathews *et al.*, 2016, Onoufriou *et al.*, 2016, Jones *et al.*, 2017a, Jones *et al.*, 2017b). Most importantly, the SAC distribution map show that SAC seals seem to be using predominantly areas northeast from the SAC, with comparatively little at-sea usage at and around Ardersier and Cromarty Firth (Figure 2).

Considering the above, underwater noise from vessel traffic as well as vessel presence from the proposed development and other in-combination projects are not expected to affect the ability of the harbour seal population to move safely between the site and important areas of functionally linked sea out with the site.

6.3.1.2.2.3 The distribution of harbour seal throughout the site is maintained by avoiding significant disturbance (ensure harbour seal continue to have access to and can utilise all habitats suitable for haul-outs and breeding associated within the site)

The activities within the respective project boundaries will not overlap spatially with the Dornoch Firth and Morrich More SAC. Additionally, based on the location of option plan areas available in Scottish leasing rounds (ScotWind⁵ and INTOG⁶), it is not anticipated that there would be any spatial overlap of vessel movements between the port and offshore wind farms areas and the SAC boundary. Therefore, underwater noise associated with operation and maintenance of the proposed development as well as other in-combination projects is not expected to affect the ability of harbour seals to use the site nor change the distribution or behaviour of harbour seals within the SAC.

6.3.1.2.2.4 Conclusions

Based on the assessment presented in sections 6.3.1.1.2.1 to 6.3.1.1.2.3, adverse effects on the qualifying Annex II marine mammal species, harbour seal, which undermine the COs of the Dornoch

⁵ ScotWind leasing round sites and developers | Offshore Wind Scotland

⁶ INTOG | Innovation and Targeted Oil and Gas leasing round | Offshore Wind Scotland

Firth and Morrich Moore SAC will not occur as a result of operation and maintenance activities at the proposed development in-combination with other projects.

6.3.2 Moray Firth SAC

Bottlenose dolphins are present within the Moray Firth SAC throughout the year, with May to September being important for breeding and calving (NatureScot, 2025b). The construction at the proposed development will take place between 2026 and 2028, with dredging taking place sometime between 2027 – 2029. As such, overlap with the construction at the proposed development and bottlenose dolphin breeding and calving cannot be discounted.

6.3.2.1 Project Alone

The Project Alone assessment of AEoI of the Moray Firth SAC with respect to bottlenose dolphin COs is presented in sections 6.3.2.1.1.1 to 6.3.2.1.1.3 and conclusions are provided in section 6.3.2.1.1.5.

6.3.2.1.1 Construction

6.3.2.1.1.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). The focus of the appraisal should be to understand whether the integrity of the Moray Firth SAC would be maintained. In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.1.1.2 to 6.3.2.1.1.5, it can be concluded that the construction of the proposed development will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.1.1.2 The population of bottlenose dolphin is a viable component of the site.

The risk of auditory injury (PTS) to bottlenose dolphins from all noise sources is negligible due to extremely small predicted injury ranges as well as the application of mitigation measures (see sections 6.1.2.1 and 6.1.4). Similarly, any risk of injury through collision with vessels will be managed via a NSRA (see section 6.1.2.3). As such, killing or injury is highly unlikely and construction activities at the proposed development are not expected to affect the Moray Firth SAC bottlenose dolphin population.

6.3.2.1.1.3 *The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.*

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphins are likely to be impacted.

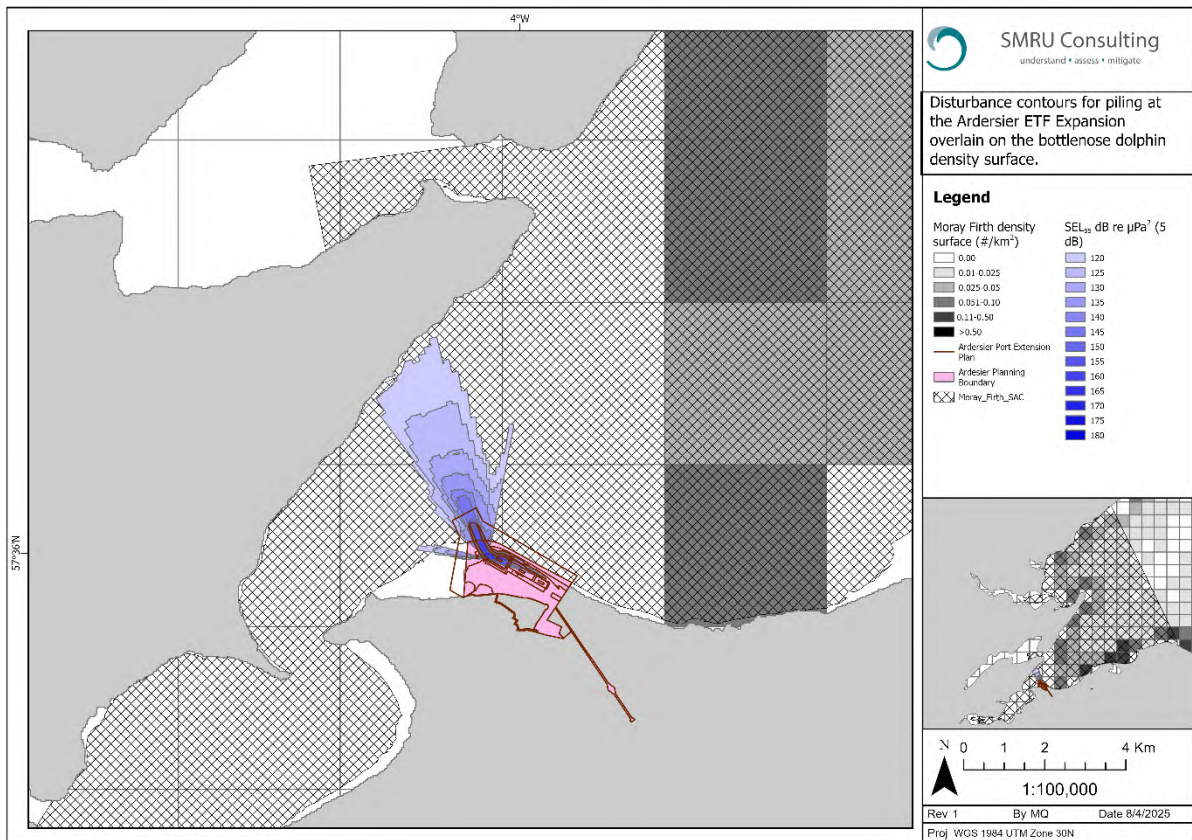
Type of disturbance

Underwater noise associated with piling, dredging, spoil disposal and vessel movements may result in behavioural response and lead to individuals being displaced from the affected area. There is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by offshore construction activities; for example, avoidance behaviour in bottlenose dolphins has been shown in relation to dredging activities, piling and vessel activity (Pirodda *et al.*, 2013, Graham *et al.*, 2017, Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as an important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

Bottlenose dolphin occurrence was studied at three acoustic monitoring stations in the vicinity of the proposed development - east, west and entrance to the port of Ardersier (Benhemma-Le Gall and Cheney, 2025). Typically, bottlenose dolphins were detected for a median of 3 - 6 hours per day at the PAM sites around Ardersier, with a peak occurrence in July and with significantly higher acoustic occurrence at the entrance of the Port of Ardersier channel. Considering the extent of the Moray Firth SAC, the area within which bottlenose dolphins could experience behavioural disturbance as a result of piling is localised (Figure 3). Similarly for dredging and vessel movements, both activities are likely to exclude dolphins from approximately a 1 km radius (Pirodda *et al.*, 2013, Pirodda *et al.*, 2015, Puszka *et al.*, 2021, Mills *et al.*, 2023). Some of the activities, such as dredging, will take place deeper into the site boundary for most of the time and therefore interactions with bottlenose dolphins will be limited. However, spoil disposal and associated vessel activity will be taking place outside of the site boundary with more potential to displace bottlenose dolphins from the areas that they use daily, including the potential for intermittent barrier effects in movement between the SAC and the rest of the distributional area. Given the extent of the SAC, bottlenose dolphins would still be able to access sufficient food whilst they are subject to disturbance.

Figure 3: Disturbance contours for piling of mooring dolphins at the proposed development, overlain on the scaled Thompson et al. (2015) bottlenose dolphin density surface.



Timing and duration of disturbance

Overall, the construction is anticipated to take place between 2026 to 2028. Piling will be restricted to only a short duration with 12 piles installed over 12 non-consecutive days, with a maximum of 10 hours of activity per pile sometime within the construction timeframe. The dredging and soil disposal activities will be carried out over a 10-week period within the 6-month window between April and September (sometime between 2027 – 2029). The peak vessel activity is expected to occur during spoil disposal operations within this 10-week period. Given that activities such as piling are expected to result in a localised and short-term disturbance footprint, and that dredging will predominantly occur within the existing port limits, disturbance beyond the site boundary is primarily anticipated during the 10-week spoil disposal phase.

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the construction of the proposed development:



- ▶ Is not expected to contribute to the long-term decline in the use of the site by bottlenose dolphins; however, intermittent displacement from the areas used by individuals within the site cannot be excluded over medium-term.
- ▶ Is not expected to result in changes to the distribution of bottlenose dolphins on a continuing or sustained basis; beyond the 10-week period of soil disposal activities.
- ▶ Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young.

As such, although bottlenose dolphin may be deterred temporarily from areas within the SAC intermittently over the short term (10 weeks), the behavioural disturbance during construction is not considered significant (NatureScot, 2025b).

6.3.2.1.1.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

With the implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The dredging and spoil disposal activities are the main impacts that could have a negative effect the characteristics of the seabed and water column relevant to their use by bottlenose dolphin. The dredging activities within the site boundary are predominantly confined to the existing port area, where bottlenose dolphins are generally absent. As discussed in section 6.1.2.4 with respect to sediment contamination, any future BPEO that is authored for the proposed development shall take the appropriate measures to ensure that dredged materials meet acceptable environmental standards. The spoil dumping may be taking place in the vicinity of Burghead, outside of the SAC boundaries. The alternative locations include Inverness and Sutors and therefore the spatial overlap of spoil disposal and SAC cannot be excluded.

When considering sediment disturbance, dumping works are the most likely contributor to sediment disturbance and thus, increased turbidity. The risks of sediment disturbance and fish habitat loss are particularly relevant to demersal spawning species present in the Moray Firth, such as herring and sandeels. Sandeels are highly substrate-specific spawners and spend a large amount of time buried in the sediment, with specific requirements in terms of the silt content of the sediment. They are absent in substrates with a silt content greater than 10% (Wright *et al.*, 2000, Holland *et al.*, 2005). Their eggs remain attached to the seabed during development. However, sandeel eggs are expected to be tolerant to increased sediment deposition and smothering, due to the common resuspension and deposition events which occur in their natural high energy environment. Herring are a mobile species with the capacity to avoid unfavourable areas, but nonetheless rely on the substrate for spawning and

sediment deposition could potentially smother herring eggs and disrupt the development of larvae. When considering the material to be dredged as part of the proposed development, it is expected to be predominantly composed of undisturbed sands and gravels (EnviroCentre Limited, 2024). The sand component is expected to remain suspended for a longer time than the gravel component, but the effects are expected to be temporary and localised due to the short duration of dredging and spoil disposal activity (~6 months). As a result of the short duration of dredging and spoil disposal activity and the localised impacts on fish prey species present in the area, marine mammals are not expected to have reduced access to prey within the SAC. As such, construction activities associated with the proposed development are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.1.1.5 Conclusions

Based on the assessment presented in sections 6.3.2.1.1.1 to 6.3.2.1.1.4, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin, which undermine the COs of the Moray Firth SAC will not occur as a result of construction activities.

6.3.2.1.2 Operation and Maintenance

6.3.2.1.2.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). The focus of the appraisal should be to understand whether the integrity of the Moray Firth SAC would be maintained. In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.1.2.2 to 6.3.2.1.2.5, it cannot be excluded that the operation and maintenance of the proposed development will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.1.2.2 The population of bottlenose dolphin is a viable component of the site.

The risk of death or injury through collision with vessels will be managed via a NSRA (see section 6.1.3.2). As such, killing or injury is highly unlikely and operation and maintenance activities at the proposed development are not expected to affect the Moray Firth SAC bottlenose dolphin population.

6.3.2.1.2.3 *The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.*

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphin are likely to be impacted.

Type of disturbance

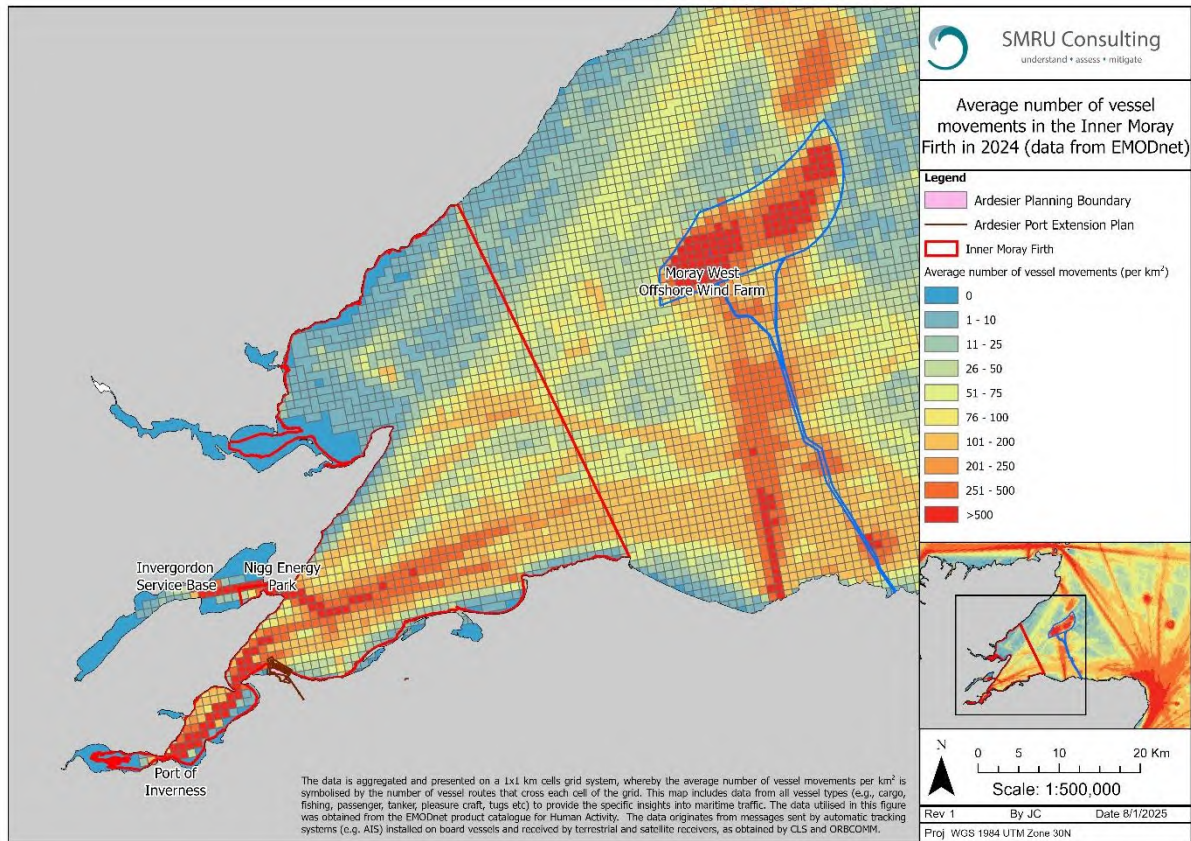
Underwater noise associated with vessel movements will be the main impact during the operational and maintenance phase which may result in behavioural responses and lead to individuals being displaced from the affected area. As presented in section 6.3.2.1.1.3, there is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by vessels (Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

As presented in section 6.3.2.1.1.3, bottlenose dolphins were detected for a median of 3 - 6 hours per day at the PAM sites around Ardersier, with a peak occurrence in July and with significantly higher acoustic occurrence at the entrance of the Port of Ardersier channel (Benhemma-Le Gall and Cheney, 2025). Detailed information about the importance of the areas in the vicinity of the proposed development to bottlenose dolphins is presented in Appendix 11.3.

The area within which bottlenose dolphins could experience behavioural disturbance as a result of vessel movements is localised to the vicinity of the vessel. However, the vessel movements will take place over a broad geographical area (e.g., from the port to offshore wind farm sites). It is likely that in the inner Moray Firth the vessels will follow the existing routes aligned with the hotspots of vessel activity already within the Inner Moray Firth. The existing vessel hotspots presented in Figure 3 overlap with the coastal distribution with bottlenose dolphins. As such, a 17.65% increase in vessel activity has a small potential to displace bottlenose dolphins from the areas within the Moray Firth SAC which bottlenose dolphins use daily, including intermittent barrier effects in movement within the SAC and between the SAC and the rest of the distributional area.

Figure 4: Average number of vessel movements in the Inner Moray, per km², throughout 2024 (data from EMODnet).



Timing and duration of disturbance

Increased activity levels will be sustained over a long-term duration (50 years).

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the operation and maintenance phase of the proposed development:

- ▶ Is not expected to contribute to the continuous decline in the use of the site by bottlenose dolphin; however, intermittent displacement from the areas used by individuals within the site over the long-term cannot be excluded.
- ▶ Is not expected to result in changes to the distribution of bottlenose dolphin on a continuing or sustained basis; however, intermittent changes in the distribution may be caused by increased presence of vessels over long-term period.
- ▶ Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young. However, given that individuals may experience behavioural disturbance intermittently over the long-term, bottlenose dolphins may choose to use alternative areas within the SAC or outside the SAC to survive, breed or rear their young.



Although there remains considerable uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels, current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. Thus, when considering the small increase in vessel traffic movements associated with operations at the proposed development, it is unlikely that the projected rise in vessel traffic may elevate disturbance to a level that could constitute significant disturbance.

6.3.2.1.2.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

As discussed in section 6.1.3.3, with implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The current application does not include dredging or spoil disposal activities during the operational and maintenance phase. Consequently, no activities are anticipated that could negatively affect the characteristics of the seabed (e.g. abrasion) or the water column (e.g. increased suspended sediments) in ways that would impact their suitability for use by bottlenose dolphins. As such, operation and maintenance activities associated with the proposed development are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.1.2.5 Conclusions

Based on the assessment presented in sections 6.3.2.1.2.1 to 6.3.2.1.2.4, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin, which undermine the COs of the Moray Firth SAC will not occur as a result of operational activities.

6.3.2.2 In-combination

The in-combination screening exercise and the list of projects taken forward to the assessment are presented in section 6.2.

6.3.2.2.1 Construction

6.3.2.2.1.1 To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.2.1.2 to 6.3.2.2.1.5, it can be concluded that the construction of the proposed development in-

combination with other projects will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.2.1.2 The population of bottlenose dolphin is a viable component of the site.

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely and construction activities at the proposed development in-combination with other projects are not expected to affect the Moray Firth SAC bottlenose dolphin population.

6.3.2.2.1.3 The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphins are likely to be impacted.

Type of disturbance

Underwater noise associated with piling, dredging, spoil disposal and vessel movements at the proposed development as well as other projects screened into the in-combination assessment may result in behavioural response and lead to individuals being displaced from the affected area. As presented in section 6.3.2.1.1.3, there is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by vessels (Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as important area with calves being recorded throughout the SAC, there is the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

As presented in section 6.3.2.1.1.3, bottlenose dolphins were detected for a median of 3 - 6 hours per day at the PAM sites around Ardersier, with a peak occurrence in July and with significantly higher acoustic occurrence at the entrance of the Port of Ardersier channel (Benhemma-Le Gall and Cheney, 2025). Acoustic occurrence was also studied at Chanonry Point and the Sutors, the latter located at the entrance to the Cromarty Firth and in close vicinity of the Port of Nigg. Bottlenose dolphins were recorded for a greater number of Detection Positive Hours (DPH) per day at the Sutors monitoring site compared to Ardersier, while detections were similar between the Chanonry and Ardersier monitoring

sites (Benhemma-Le Gall and Cheney, 2025). During boat-based surveys, bottlenose dolphin encounters occurred mostly between the North Sutor, Chanonry, and east of the Port of Ardersier.

Considering the extent of the Moray Firth SAC, the area within which bottlenose dolphins could experience behavioural disturbance as a result of piling at port works is expected to be localised (as per the example of the proposed development, Figure 3).

Similarly for dredging and vessel movements, both activities are likely to exclude dolphins from approximately a 1 km radius (Pirodda *et al.*, 2013, Pirodda *et al.*, 2015, Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). For example, the Invergordon Phase 5 EIA included information that the measured underwater sound pressure level resulting from dredging during the phase 3 development did not exceed the NMFS marine mammal disturbance threshold (160 dB rms). Piling and dredging may also take place deeper into the respective project boundaries for most of the time and therefore interactions with bottlenose dolphins will be limited. However, spoil disposal and associated vessel activity at Invergordon and the Port of Nigg between 2025 and 2027, in combination with similar activities associated with the proposed development primarily between 2027 and 2028, have the potential to displace bottlenose dolphins from areas they use daily (Ardersier, Sutors, and Chanonry). This includes the potential for intermittent barrier effects on their movement between the SAC and the wider distributional range.

Given the extent of the SAC, it is expected that bottlenose dolphins would still be able to access sufficient food whilst they are subject to disturbance.

Timing and duration of disturbance

The timings and duration of construction activities at the proposed development is discussed in section 6.3.2.1.1.3. Maintenance dredging and sea disposal at the Port of Nigg as well as inner bething structure and associated piling is expected to take place between 2025 to 2026, as such prior to the commencement of piling and dredging at the proposed development, e.g. 2026 – 2029, respectively. Piling at Invergordon phase 5 is anticipated to take place between 2026 and 2027, therefore overlapping with piling at the proposed development. Maintenance dredging at the Port of Cromarty Firth is planned to take place between 2025 to 2028, therefore overlapping with piling and dredging campaign at the proposed development.

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the construction of the proposed development in-combination with other projects:

- ▶ Is not expected to contribute to the long-term decline in the use of the site by bottlenose dolphins; however, intermittent displacement from the areas used by individuals within the site cannot be excluded over medium-term.
- ▶ Is not expected to result in changes to the distribution of bottlenose dolphins on a continuing or sustained basis; however, intermittent changes in the distribution may be caused by increased presence of vessels over medium-term period.
- ▶ Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young.

As such, although bottlenose dolphin may be deterred temporarily from areas within the SAC intermittently over the medium term, the behavioural disturbance during construction of the proposed development in-combination with other projects is not considered significant.

6.3.2.2.1.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

With the implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The same measures are expected to be followed at all projects as best practice. The dredging and spoil dumping works are the main impacts that could have a negative effect the characteristics of the seabed and water column relevant to their use by bottlenose dolphin. The maintenance dredging at the Port of Nigg and Port of Cromarty, is expected to be predominantly confined to the existing port areas, where bottlenose dolphins are generally absent. The spoil disposal by the proposed development may be taking place in the vicinity of Burghead, outside of the SAC boundaries. The alternative locations include Inverness and the Sutors, and therefore the spatial overlap of spoil disposal and the SAC cannot be excluded. The disposal of excess suitable dredged material at the Port of Nigg will take place within the already licenced disposal site at the Sutors (within the SAC) (EnviroCentre Limited, 2019). The risks of sediment disturbance and fish habitat loss are particularly relevant to demersal spawning species present in the Moray Firth, such as herring and sandeels. As discussed above, most of the dredging / maintenance dredging activity will be predominantly confined to the existing port areas, where bottlenose dolphins are generally absent. Spoil dumping may have localised impacts on fish prey species; however, marine mammals are not expected to have reduced access to prey within the SAC as a whole. As such, construction activities associated with the proposed development in-combination with other projects are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.2.1.5 *Conclusions*

Based on the assessment presented in sections 6.3.1.2.1.1 to 6.3.1.2.1.3, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin, which undermine the COs of the Moray Firth SAC will not occur as a result of construction activities at the proposed development in-combination with other projects.

6.3.2.2.2 **Operation and Maintenance**

6.3.2.2.2.1 *To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.*

Bottlenose dolphins are considered to be in a favourable maintained condition at the Moray Firth SAC (NatureScot, 2025b). In light of the COs presented in Table 2 and assessment carried out in sections 6.3.2.2.2.2 to 6.3.2.2.2.5, it cannot be excluded that the operation and maintenance of the proposed development in-combination with other projects will not compromise the ability of the site to contribute to the favourable conservation status of the protected features in the UK.

6.3.2.2.2.2 *The population of bottlenose dolphin is a viable component of the site.*

As a requirement of European Protected Species legislation, suitable mitigation must be put in place to reduce the injury risk to marine mammals to negligible levels across all projects (JNCC, 2010b, a, 2017). Consequently, the risk of injury across projects is considered highly unlikely.

6.3.2.2.2.3 *The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.*

In line with the recommendation provided in the site-specific management advice (NatureScot, 2025), the assessment presented below will focus on the type of disturbance, its duration and the area over which bottlenose dolphin are likely to be impacted.

Type of disturbance

Underwater noise associated with vessel movements will be the main impact during the operational and maintenance phase which may result in behavioural responses and lead to individuals being displaced from the affected area. As presented in section 6.3.2.1.1.3, there is evidence in the published literature that bottlenose dolphins may be displaced from an area as a result of the noise produced by vessels (Clarkson *et al.*, 2020, Puszka *et al.*, 2021, Mills *et al.*, 2023). Given that the Moray Firth has been identified as important area with calves being recorded throughout the SAC, there is

the potential for behavioural disturbance and displacement to result in disruption in foraging and resting activities and an increase in travel and energetic costs.

Area of disturbance

As presented in section 6.3.2.2.1.3, acoustic monitoring and boat-based surveys showed that bottlenose dolphins use areas of Sutors, Chanonry and Ardersier on a daily basis, with for a median of 3 - 6 hours per day at the PAM sites around Ardersier. Increased vessel activity has the potential to displace bottlenose dolphins from these regularly used habitats. The area within which bottlenose dolphins could experience behavioural disturbance as a result of vessel movements is localised to the vicinity of the vessel. However, the vessel movements will take place over a broad geographical area (e.g., from the ports to offshore wind farm sites). It is likely that the additional vessels will follow the existing routes aligned with the hotspots of vessel activity already within the Inner Moray Firth. A summary of the magnitude of vessel impacts is provided in section 6.2.2. During the operation and maintenance phase, vessel activity, when considered in combination with other projects, may increase by up to 6.17% above baseline levels. Although the existing vessel hotspots presented in Figure 3 overlap with the coastal distribution with bottlenose dolphins (e.g. animals are likely to be habituated to the current level of vessel presence), this constitutes a moderate increase. As such, increased vessel activity has the potential to displace bottlenose dolphins from the areas within the Moray Firth SAC which bottlenose dolphins use daily, including intermittent barrier effects in movement within the SAC and between the SAC and the rest of the distributional area.

Timing and duration of disturbance

Increased activity levels will be sustained over a long-term duration (50 years).

Disturbance summary

Considering the above with respect to the type of disturbance, its duration and area, the operation and maintenance phase of the proposed development:

- ▶ Is not expected to contribute to the continuous decline in the use of the site by bottlenose dolphin; however, intermittent displacement from the areas used by individuals within the site over the long-term cannot be excluded.
- ▶ Is not expected to result in changes to the distribution of bottlenose dolphin on a continuing or sustained basis; however, intermittent changes in the distribution may be caused by increased presence of vessels over long-term period.
- ▶ Is unlikely to result in changes to bottlenose dolphin behaviour such that it reduces the ability of the species to survive, breed or rear their young. However, given that individuals may experience



behavioural disturbance intermittently over the long-term, bottlenose dolphins may choose to use alternative areas within the SAC or outside the SAC to survive, breed or rear their young.

Although there remains considerable uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels, current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. Thus, when considering the small increase in vessel traffic movements associated with operations at the proposed development in-combination with other projects, it is unlikely that the projected rise in vessel traffic may elevate disturbance to a level that could constitute significant disturbance.

6.3.2.2.2.4 The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.

With the implementation of an appropriate POEMP and Port Oil Spill Contingency Plans, a major pollution incident associated with vessel activity that may impact any fish species at a population level is considered very unlikely. The same measures are expected to be followed at all projects as best practice. Based on the timeframes of the projects screened into the assessment (Table 3), no dredging or dumping works are anticipated within the SAC during the operation and maintenance of the proposed development. Consequently, no activities are anticipated that could negatively affect the characteristics of the seabed (e.g. abrasion) or the water column (e.g. increased suspended sediments) in ways that would impact their suitability for use by bottlenose dolphins. As such, operation and maintenance activities associated with the proposed development in-combination with other projects are not expected to affect the maintenance of the prey resources and supporting habitats within the SAC.

6.3.2.2.2.5 Conclusions

Based on the assessment presented in sections 6.3.2.2.2.1 to 6.3.2.2.2.4, adverse effects on the qualifying Annex II marine mammal species, bottlenose dolphin which undermine the COs of the Moray Firth SAC can be excluded as a result of disturbance from vessels during operation and maintenance activities in-combination with other projects. However, there remains uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels even when current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. To better understand and manage these potential vessel disturbance impacts, continued monitoring is essential to ensure that where necessary, additional, adaptive mitigation measures beyond those already prescribed for operational traffic (NSRA) can be implemented to protect sensitive species effectively.



7 Conclusions

This AA has been undertaken for the proposed development in accordance with the Habitats Regulations, following the identification of LSE on designated European Sites. The SACs screened in and considered in this assessment were the Dornoch Firth and Morrich More SAC, designated for harbour seal (*Phoca vitulina*), and the Moray Firth SAC, designated for bottlenose dolphin (*Tursiops truncatus*), both of which are qualifying Annex II marine mammal species.

The assessment considered potential impacts arising from the construction and operation of the proposed development, including underwater noise, vessel traffic, and habitat disturbance, both alone and in-combination with other relevant projects within the Moray Firth region.

The assessment concluded that the construction as well as operation and maintenance of the proposed development, both alone and in-combination with other projects, will **not result in adverse effects** on the integrity of the Dornoch Firth and Morrich More SAC, or the Moray Firth SAC. Embedded mitigation measures, including MMMPs and NSRAs, ensure that impacts on harbour seals remain negligible. However, there remains uncertainty around the behavioural responses of bottlenose dolphins to increased disturbance from vessels even when current vessel activity levels have not led to significant effects to the bottlenose dolphin SAC. To better understand and manage these potential vessel disturbance impacts, continued monitoring is essential to ensure that where necessary, additional, adaptive mitigation measures beyond those already prescribed for operational traffic (NSRA) can be implemented to protect sensitive species effectively.

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