Morven North Offshore Wind Array Project

Environmental Impact Assessment Report

Volume 4, Annex 2: Marine Mammal Mitigation Protocol (MMMP) (Version 1)

MVCNS-J1201-RPS-10063
May 2026

B01

Document status

Version	Purpose of document	Authored by	Checker	Approved by	Date
FINAL	Application	TTRPSEL	TTRPSEL	MvOWL	May 2026

Prepared by:	Prepared for:
TTRPSEL	**Morven Offshore Wind Limited**

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Glossary

Term	Meaning
Acoustic Deterrent Device (ADD)	A device deployed to emit high-frequency sounds to deter marine mammals from areas where their presence may pose a risk, such as construction sites or fishing operations.
The Applicant	The entity making the Applications; Morven Offshore Wind Limited (MvOWL).
Cetacean	Marine mammals that are entirely aquatic. These include whales, dolphins and porpoises.
Environmental Impact Assessment (EIA)	Assessment of the potential likely significant effects of Morven North on the physical, biological, and human environment during construction, Operations and Maintenance (O&M) and decommissioning.
European Protected Species (EPS) Licence	A European Protected Species (EPS) licence is required for activities that may injure and/or disturb protected species, ensuring compliance with the Habitats Regulations
Habitats Directive	Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (the Habitats Directive) is the European Union Directive from which the requirement for the consideration of potential impacts of Morven North upon European sites and sites designated within the National Site Network is derived.
Habitats Regulations	The Conservation (Natural Habitats, & C.) Regulations 1994, the Conservation of Habitats and Species Regulations 2017, and the Conservation of Offshore Marine Habitats and Species 2017.
Marine Directorate (MD)	The body responsible for managing Scotland's seas.
Marine Licence	A licence granted under either the Marine and Coastal Access Act 2009 or the Marine (Scotland) Act 2010 in Scottish territorial waters.
Morven Option Lease Agreement Site (hereafter "Morven Site")	The 859km2 area awarded to the Applicant as a result of the ScotWind leasing round and located in Plan Option area E1. Morven North and Morven South are two distinct projects, located within the Morven Site.
The Morven North Offshore Wind Array Project (hereafter "Morven North")	The Morven North Offshore Wind Array Project which includes the wind turbines and foundations, offshore substation platforms (OSPs) and foundations, inter-array and interconnector cables and associated infrastructure in the Morven North Project Boundary. Consent for the export cables for Morven North will be sought separately.
The Morven South Offshore Wind Array Project (hereafter "Morven South")	The Morven South Offshore Wind Array Project which includes the wind turbines and foundations, offshore substation platforms (OSPs) and foundations, inter-array and interconnector cables and associated infrastructure in the Morven South Project Boundary. Consent for the export cables for Morven South will be sought separately.

Term	Meaning
Phocid	Seals of the family Phocidae, represented in the UK by two species: grey seal (*Halichoerus grypus*) and harbour seal (*Phoca vitulina*).
Sea state	Categories as defined by the Douglas Sea scale, used to give an approximate but concise description of sea condition. Sea states used within the Marine Mammals Technical Report are as follows: 0 = Calm (Glassy), 1 = Calm (Rippled), 2 = Smooth, 3 = Slightly Moderate and 4 = Moderate.
Unexploded Ordnance (UXO)	Explosive weapons that did not explode when they were deployed and still pose a risk of detonation.

Acronyms

Unit	Meaning
ADD	Acoustic Deterrent Device
AUD INJ	Auditory injury
ECoW	Ecological Clerk of Works
EIA	Environmental Impact Assessment
EPS	European Protected Species
HF	High Frequency
JNCC	Joint Nature Conservation Committee
LF	Low Frequency
MBES	Multibeam Echosounder
MDS	Maximum Design Scenario
MD-LOT	Marine Directorate-Licensing Operations Team
NMFS	National Marine Fisheries Service
MMOb(s)	Marine Mammal Observer(s)
MMMP	Marine Mammal Mitigation Plan
MZ	Mitigation Zone
NEQ	Net Explosive Quantity
NMFS	National Marine Fisheries Service
OSP	Offshore Substation Platform
O&M	Operation and Maintenance
PAM	Passive Acoustic Monitoring
PCW	Phocid Carnivores in Water
PK	Peak (refers to Sound Pressure Level)
pUXO	Possible Unexploded Ordnance
SBP	Sub-bottom Profiler

Unit	Meaning
SEL	Sound Exposure Level
SEL_{24h}	Cumulative Sound Exposure Level (over 24 hours)
SPL	Sound Pressure Level
SSS	Side Scan Sonar
UHRS	Ultra High-Resolution Seismic
UXO	Unexploded Ordnance
VHF	Very High Frequency

Units

Unit	Meaning
°	Degrees (angle)
dB re 1 µPa	Decibel re one micro Pascal
kHz	Kilohertz
km	Kilometre
m	Metre

1 Marine Mammal Mitigation Protocol

1.1 Introduction

1.1.1.1 This Marine Mammal Mitigation Protocol (MMMP) has been prepared by Tetra Tech RPS Energy on behalf of Morven Offshore Wind Limited (hereafter referred to as "the Applicant") to support the Offshore Environmental Impact Assessment (EIA) Report.

1.1.2 Purpose

1.1.2.1 The primary purpose of this MMMP is to minimise the risk of auditory injury to marine mammals from noise generating activities resulting from the Morven North Offshore Wind Array Project (hereafter "Morven North"). The relevant noise generating activities are:

- impact piling;
- Unexploded Ordnance (UXO) clearance;
- geophysical site investigation surveys.

1.1.2.2 Other activities associated with Morven North such as vessel movement and construction activities (excluding piling), do not pose a risk of injury to mammal receptors, and are therefore not included within this MMMP.

1.1.2.3 The mitigation detailed in this MMMP draws from the Joint Nature Conservation Committee (JNCC) guidelines (JNCC, 2010, 2017, 2025), together with the Joint Position paper on UXO clearance (Defra, 2025).

1.1.2.4 Finalised MMMP(s) specific to each of the identified noise generating activities, will be refined and agreed in consultation with Marine Directorate-Licensing Operations Team (MD-LOT) and NatureScot post consent to reflect the refined project parameters specific to the activity. Adherence to a finalised MMMP(s) is expected to be a consent condition of the Section 36 Consent/marine licences.

1.1.2.5 The development of mitigation measures and emerging and evolving technologies for marine mammal protection will be actively monitored by the Applicant. Where it is identified that such measures would be appropriate for implementation, the finalised MMMP will be updated accordingly.

1.1.3 Project background

1.1.3.1 Morven North together with the Morven South Offshore Wind Array Project (hereafter, "Morven South") is located within the Morven Option Lease Agreement Site (hereafter, "Morven Site") in Scottish offshore waters (Figure 1.1). Morven North is located approximately 61km from the Aberdeenshire coast (at its closest point). Morven North will comprise wind turbines, Offshore Substation Platforms (OSPs), associated foundations, inter-array and interconnector cables and cable protection. Consent for the offshore export cables of Morven North will be sought separately. This MMMP relates to Morven North only.

1.1.3.2 As shown in Figure 1.1, Morven North is situated northwest of Morven South. The external boundaries of the projects correspond with the boundaries of the Morven Site.

1.1.3.3 This MMMP presents a summary of findings relevant for mitigation as assessed in the Morven North EIA Report. UXO clearance and piling have the potential for impact during the construction phase, whereas site surveys have the potential for impact during both the construction and the Operation and Maintenance (O&M) phases.

1.1.3.4 This MMMP is informed by the following sections of the Morven North EIA Report:

- Volume 2, Chapter 10: Marine Mammals;
- Volume 3, Annex 10.2: Underwater Sound Shared Technical Report.

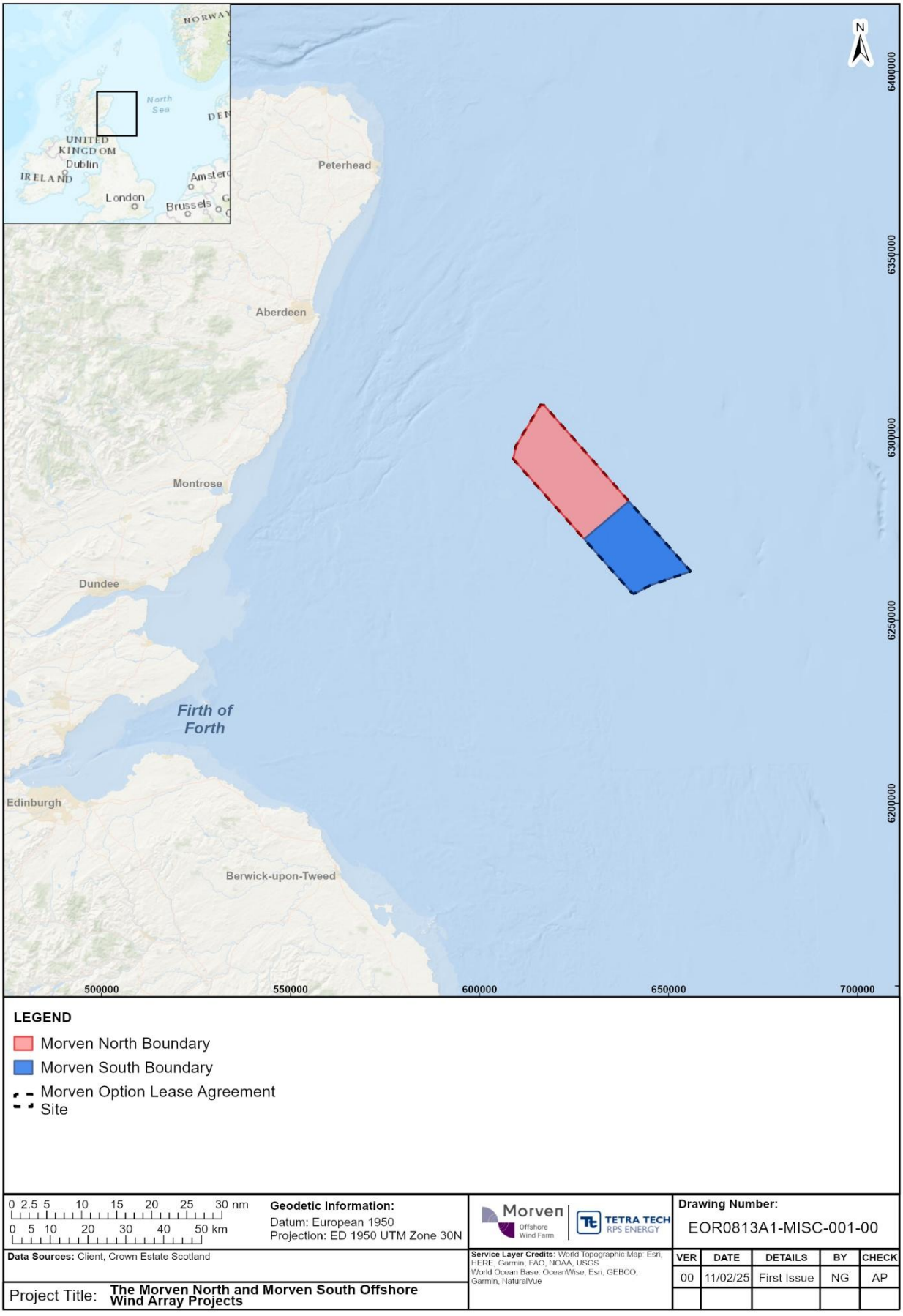

Figure 1.1: The boundaries of Morven North and Morven South within the Morven Option Lease Agreement Site

2 Impact piling

2.1 Scenarios considered

2.1.1.1 A range of piling scenarios were modelled for the EIA assessment: see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report for the full details. The scenarios were based on the Maximum Design Scenarios (MDS) (Volume 2, Chapter 10: Marine Mammals). The greatest injury ranges were predicted for single piling of monopile foundations, and for all pin pile scenarios (i.e. 5.3m and 3.7m diameter) the ranges were smaller than those presented for monopiles.

2.2 Summary of impacts

2.2.1.1 The impact ranges presented in Volume 2, Chapter 10: Marine Mammals (reproduced in Table 2:1) were based on the National Marine Fisheries Service (NMFS) threshold guidance for Auditory Injury (AUD INJ) (NMFS, 2024). Ranges are based on the maximum modelled value over the entire piling sequence.

2.2.1.2 The assessment of injury in the EIA Report was based upon the dual metric approach: instantaneous injury from peak Sound Pressure Level (PK) and cumulative Sound Exposure Level (SEL_{24h}) leading to injury. As per advice from NatureScot (see Volume 2, Chapter 10: Marine Mammals, section 1.4. Consultation) the pre-piling mitigation is, however, based on the instantaneous auditory injury risk. Therefore, for piling, the auditory injury ranges based on PK have been used to inform the Mitigation Zone in this MMMP.

2.2.1.3 The maximum predicted unmitigated instantaneous injury risk range (based on the peak PK metric) was 950m, for the Very High Frequency (VHF) functional hearing group (i.e. harbour porpoise) and based on piling of monopile foundations (Table 2:1). For all other species group the unmitigated predicted injury ranges were 20m or below.

Table 2:1: Potential marine mammal injury ranges for single installation of wind turbine/Offshore Substation Platform foundations, based on the NMFS (2024) Peak metric (N/E denotes AUD INJ threshold not exceeded)

Hearing Group	Species	AUD INJ Threshold, PK (dB re 1 µPa)	Maximum Range (m)		
			Monopile No ADD	5.3m* Pin Pile No ADD	3.7m Pin Pile No ADD
Low Frequency (LF)	Minke whale Humpback whale	222	20	N/E	N/E
High Frequency (HF)	Bottlenose dolphin White-beaked dolphin	230	N/E	N/E	N/E
VHF	Harbour porpoise	202	950	570	760
Phocid Carnivores in Water (PCW)	Grey seal Harbour seal	223	20	N/E	N/E

*Captures the 4.5m pin pile (HVAC collector OSP) and the 5m pin pile (HVDC converter OSP) (see Volume 2, Chapter 10: Marine Mammals).

2.3 Mitigation methods

2.3.1.1 Standard mitigation protocols will be used to reduce the risk of auditory injury from impact piling to negligible levels (JNCC, 2010). Should more than one vessel be on site at the same time, mitigation methods detailed will apply per vessel.

2.3.2 Marine Mammal Observers

2.3.2.1 The Marine Mammal Observers (MMOb(s)) will visually monitor the agreed Mitigation Zone (MZ) before piling can commence. The MZ is defined in JNCC (2010) as the area over which an MMOb keeps watch for marine mammals. JNCC (2010)standard guidance is for the watch period to be no less than 30 minutes pre-piling, with a standard MZ of no less than 500m. The MMOb(s) will visually confirm that the area is clear so that piling can commence. Depending on the final piling scenario and vessels used, multiple MMObs may be required to ensure that the monitoring is not compromised in terms of 360-degree visibility, and/or observer fatigue.

2.3.2.2 The maximum instantaneous AUD INJ onset range predicted is 950m based on the maximum design scenario assessed in the EIA. This is beyond the standard MZ of 500m for piling. However, in addition to visual observations, mitigation will include the use of an Acoustic Deterrent Device (ADD) to move animals away from the injury zone (see Section 2.3.4). Furthermore, with suitable elevation of the survey platform, the MMObs will be able to monitor over larger distance than the standard 500m, particularly for larger species such as minke whale. The MZ will be confirmed once the Piling Strategy has been developed (post consent) and the piling parameters defined.

2.3.2.3 If marine mammals are detected within the MZ during the pre-piling search, piling will not commence until at least 20 minutes after the last visual detection of the animal. The MMObs will track any

marine mammals detected and ensure that they have left the MZ before piling commences as per JNCC (2010) Standard mitigation protocols.

2.3.3 Passive Acoustic Monitoring

2.3.3.1 A Passive Acoustic Monitoring (PAM) system is used by a specialised trained PAM operative to acoustically detect marine mammal presence. This method should be used in conjunction with visual observations, as an alternative during periods of reduced visibility (dusk, night, inclement weather e.g. above sea state 4 (JNCC, 2010)), or both. PAM is used to monitor for 30 minutes prior to piling commencing. It is worth noting the limitations of PAM in relation to detection distances for different species. For harbour porpoise this is typically around 300m, therefore, it is important that a suite of complimentary mitigation methods is used (i.e. MMOb/PAM/ADD).

2.3.3.2 If marine mammals are acoustically detected within the MZ during the pre-piling search, piling will not commence until at least 20 minutes after the last detection of the animal.

2.3.4 Acoustic Deterrent Devices

2.3.4.1 As no one single mitigation method is 100% effective, ADD mitigation can be used to supplement MMOb/PAM and to provide mitigation over a larger MZ than standard. ADD pre-piling mitigation has successfully been employed at other offshore wind developments (Beatrice OWF Limited, 2017, Seagreen Wind Energy Limited, 2020). MMOb and PAM mitigation methods are passive (i.e. the occurrence of marine mammals in the MZ is monitored and if animals are observed, piling is not commenced until the area is clear). ADD pre-piling mitigation is active, such that the sound emitted results in displacement of marine mammals from the MZ in advance of the activity.

2.3.4.2 ADD modelling has been carried out for the cumulative piling scenarios based on the use of an ADD for 30 minutes prior to piling, see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report. For the purposes of modelling, the model selected as a representative ADD was the QTAQ Sealfence as this has proven effectiveness with VHF and LF hearing groups. With 30 minutes of ADD, all species would be able to move a sufficient distance such that the risk of instantaneous injury from exposure to PK would be removed. For example, based on conservative swim speeds, a harbour porpoise could move up to 2,700m (see Volume 2, Chapter 10: Marine Mammals). Thus, the maximum injury range of 950m would be cleared. Furthermore, whilst the focus is on instantaneous injury, the use of an ADD would also reduce the risk of injury from cumulative exposure (SEL_{24h}) (see Table 10.39 in Volume 2, Chapter 10: Marine Mammals).

2.3.4.3 Experience gained in the Moray Firth, Scotland (Thompson *et al.*, 2020) was that harbour porpoises exhibited strong responses to the ADD activation (Lofitech). The ADD was active for 15 minutes, and the harbour porpoise response to the ADD was of a similar extent to reported responses to pile driving noise as described in paragraph 2.3.4.2. Thompson *et al* concluded that the duration of ADD mitigation must be sufficient to allow animals to move away from the nearfield but be minimised to avoid unnecessary disturbance. Phillips *et al.* (2025) provides a summary of different ADDs available for commercial use, alongside an evidence base for their effectiveness in different marine mammal hearing groups/species. The duration of ADD activation (up to a maximum of 30 minutes) and the ADD brand, will be agreed with MD-LOT and NatureScot for the finalised MMMP for impact piling.

2.3.5 Soft start procedure

2.3.5.1 The soft start/ramp up procedure starts following MMOb/PAM/ADD mitigation and is the incremental increase in hammer energy over a set period. Soft start/ramp up is a designed-in measure and required by engineers to initially set the pile into the sediment (Thompson *et al.*, 2020). However, the use of lower hammer energies at the beginning of the installation allows marine mammals longer to move away before maximum hammer energies are reached. The noise generated by the soft start/ramp up process is therefore considered to act as a deterrent effect, effectively reducing the modelled maximum MZ (as assessed at highest hammer energy).

2.3.5.2 If a marine mammal enters the MZ during the soft start then, where possible, the piling operation should either pause, or not increase hammer energy, until the marine mammal leaves the MZ, and there is no further detection for 20 minutes. The feasibility of this approach will be agreed for the finalised MMMP.

3 Unexploded Ordnance clearance

3.1.1.1 The Applicant has committed to the use of low order disposal of UXOs (i.e. deflagration) as default in line with the recent Joint Position paper on UXO clearance (Defra, 2025). However, the current guidance is to retain consideration of high order clearance if, following no less than three unsuccessful low order clearance events, high order may be required. This MMMP details the mitigation required for a low order detonation and discusses mitigation in the event that a high order detonation is unavoidable.

3.1.1.2 The finalised MMMP required for the marine licence and the European Protected Species Licence (EPS) will be tailored to the identified possible UXOs (pUXO) in terms of charge size and clearance methodology. The finalised MMMP will include detail of the UXOs identified in terms of type and location, and depth. Details of the mitigation tool chosen for clearance will be provided, together with supporting evidence as to the chosen clearance tool's efficacy.

3.1.1.3 The Applicant commits to discussions with MD-LOT and NatureScot at the earliest opportunity if, following the UXO surveys, it transpires that a high order detonation is unavoidable. The requirement for a high order detonation may be due to factors relating to the UXO target in terms of suitability for detonation (e.g. safety factors) or its location that far exceed the expected or demonstrated capabilities of the low order clearance tools available.

3.2 Scenarios considered

3.2.1.1 The precise details of any UXO types and sizes that may require clearance is unknown at the time of writing. Therefore, underwater sound modelling was undertaken for a range of charge configurations as set out in Table 3:1.

Table 3:1: Details of Unexploded Ordnance and their relevant charge sizes employed for modelling

Charge size (kg NEQ)	Notes/assumptions
Low order clearance donor charge	
0.25kg	Maximum size of low order donor charge
Potential UXOs (high order disposal)	
132kg	Most likely maximum UXO size
554kg	Likely maximum[1] UXO size

[1] Absolute maximum UXO size modelled and assessed in the EIA for Morven North

3.3 Summary of impacts

3.3.1.1 Auditory Injury ranges for low order clearance donor charge (0.25kg), and for high order disposal (554kg and 132kg), are presented in Table 3:2 for both the PK (dB re 1 µPa) and SEL (dB re 1 µPa^{2}s) metrics (NMFS, 2024). Injury ranges based on the PK metric were greatest for harbour porpoise (VHF cetacean), and those based on the SEL metric were greatest for minke whale (LF cetacean).

Table 3:2: Hearing group-specific AUD INJ thresholds for unweighted PK and hearing-weighted Sound Exposure Level and maximum potential effects ranges (R_{max} for PK and $R_{95\%}$ for hearing-weighted Sound Exposure Level) for low order and high order Unexploded Ordnance disposal

Hearing group	Metric	Auditory threshold[1]	Maximum horizontal distance (m) to threshold[2]		
			0.25kg	132kg	554kg
LF cetaceans	PK	222	40	2,070	2,940
	SEL	183	140	5,040	8,140
HF cetaceans	PK	230	N/E	680	1,650
	SEL	193	N/E	20	20
VHF cetaceans	PK	202	530	9,580	16,400
	SEL	159	20	830	1,520
PCW	PK	223	40	1,890	2,720
	SEL	183	20	1,640	2,730

[1] PK thresholds expressed as dB re 1 µPa, SEL thresholds expressed as dB re 1 µPa^{2}s.

[2] N/E indicates threshold not exceeded.

3.4 Mitigation methods

3.4.1.1 Standard JNCC mitigation guidance is available for UXO mitigation (JNCC, 2025) this follows a similar process to the guidance for piling (MMOb/PAM/ADD) but will be tailored for the injury risk from explosives.

3.4.2 Marine Mammal Observers

3.4.2.1 JNCC (2025) guidance sets out the minimum requirement of a 1km MZ for explosives mitigation. At least two dedicated MMObs should work together to monitor the search area; however, it is possible that three MMObs will be required to fully observe the 1km MZ. The number of personnel required, will depend on the vessel types used for the clearance activity. Often one MMOb is situated on the relatively small boat tasked to deploy the donor charges, located close to the UXO location pre-detonation. The elevation from this platform is unlikely to enable 1 km visibility. The second MMOb is usually positioned on a guard vessel, standing off at a distance of ~1km. Observations from one point on the MZ boundary, means there is an effective 2km range to monitor. Depending on the elevation of the survey platform this may not be possible; therefore, a third MMOb may be required to observe on the boundary opposite the guard vessel to provide full coverage. The specific requirement will be discussed and agreed with MD-LOT and NatureScot for the marine licence and EPS Licence applications.

3.4.3 Passive Acoustic Monitoring

3.4.3.1 All UXO clearance should take place during daylight hours and in good weather conditions. Whilst there are limitations in detectability of certain species using PAM (e.g. harbour porpoise; paragraph

2.3.3.1), PAM may also be considered as supplementary during daylight hours, where species that are difficult to detect visually (e.g. harbour porpoise, beaked whales, etc.) may be present (JNCC, 2025). PAM will not be used as an alternative to visual observations. This will be agreed for the finalised MMMP.

3.4.4 Acoustic Deterrent Devices

3.4.4.1 It is possible to visually monitor the potential impact ranges for the low order scenario. Mitigation supplemented by an ADD is considered best practice where the MZ is greater than 1km or poor sea states where visibility may be reduced. The auditory injury ranges for the low order maximum design scenario were 530m for harbour porpoise (VHF) to less than 150m for all other species, which would result in an applied MZ of 1km as per JNCC (2025).

3.4.4.2 In the maximum design high order scenario, the injury range was 16,400m for harbour porpoise (VHF), 2,940m for minke whale (LF), 2,720m for seals (PCW) and 1,650m for all other species. Therefore, mitigation supplemented by an ADD is considered best practice.

3.4.4.3 Phillips *et al.* (2025) reports a range of deterrence distances for harbour porpoise depending on the device used. A deterrence effect has been shown for harbour porpoise up to 7.5km (Brandt *et al.*, 2013), although it did not result in complete exclusion. Similarly, Thompson *et al.* (2020) found a deterrence effect out to 21.7km, but again not complete exclusion over this whole distance. It is therefore likely that the use of an ADD will significantly reduce the probability of harbour porpoise remaining in the injury zone (particularly in the nearfield), but complete exclusion out to 16,400m (16.4km) cannot be guaranteed.

3.4.4.4 A study looking at the efficacy of an ADD to deter LF cetaceans (minke whale as the focal species) suggested that all individuals were observed to flee from the ADD sound source with 1km being the minimum reaction distance (McGarry *et al.*, 2017). Similarly, displacement of LF cetaceans was reported for the Ace Aquatec over a minimum of 1km with sounds detectable up to 7km (ABPmer, 2014).

3.4.4.5 The maximum design high order auditory injury range predicted for seals was 1,650m. Gordon *et al.* (2019) found that ADDs can result in a behavioural response up to 1km. However, in this study, a "response" was not always a directed movement away from the sound source they found it depended on their activity and direction of travel at the time of the ADD activation. The minimum approach distance to the ADD was 473m.

3.4.4.6 Combined MMOb/PAM/ADD mitigation will fully mitigate the risk of auditory injury for marine mammals where low order clearance methods are employed, regardless of the charge weight of any identified UXOs as the injury range is predicted by the donor charge only.

3.4.4.7 It is possible that the combined MMOb/PAM/ADD mitigation will move animals beyond the impact injury ranges where higher order clearance methods are employed, with the exception of VHF (harbour porpoise) where the risk of auditory injury out to 16,400m may not be fully mitigated. Therefore, any residual risk will be assessed, and mitigation agreed during the preparation of the EPS Licence once the number and size of UXOs is better understood, together with confirmation of the clearance methodology that will be used. Where ADDs are used, conservative swimming speeds will be assumed for relevant species to determine an appropriate duration of ADD activation to deter animals out of the MZ whilst not causing more disturbance than necessary to mitigate auditory injury.

3.4.5 Noise Abatement System

3.4.5.1 Noise abatement works by impeding sound propagation from the source. Whilst there are several Noise Abatement System (NAS) that are commercially available, evidence of efficacy for use with UXO clearance is lacking. At the time of writing, the only feasible NAS that can be deployed for UXO clearance are bubble curtains (JNCC, 2025). However, bubble curtains are highly constrained by the

local oceanographic conditions. The bathymetry for the Morven North Boundary ranges from 64m to a maximum of 75m relative to lowest astronomical tide. At the time of writing bubble curtains have only been effective in water depths of 40m to 45m.

3.4.5.2 Furthermore, bubble curtains are less effective in tidal currents greater than 0.75m (Cefas, 2024, Verfuss *et al.*, 2019). Site specific metocean data collected during 2023 showed the maximum current speeds within the Morven North Boundary reached up to 1m/s, with mean current speeds around 0.26m/s (Volume 2, Chapter 7: Physical Processes).

3.4.5.3 In the event that a high order detonation is unavoidable, a Risk Assessment will be produced to accompany the marine licence and EPS licence for UXO clearance. This will consider the locations of the pUXO in order to determine any additional mitigation requirements and feasibility.

4 Site investigation surveys (geophysical)

4.1 Scenarios considered

4.1.1.1 A detailed underwater sound modelling assessment has been carried out to investigate the potential risk of auditory injury resulting from geophysical survey, using the latest criteria (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report).

4.1.1.2 Several sonar-like sources will potentially be used for the geophysical surveys, including Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS), Sub-Bottom Profiler (SBP (Compressed High-Intensity Radar Pulse (CHIRP) 2kHZ and 3.5kHz)), Single-Beam Echo Sounder (SBES) and Ultra High-Resolution Seismic (UHRS). The equipment likely to be used can typically work at a range of signal frequencies, depending on the distance to the seabed and the required resolution. For sonar-like sources the signal is highly directional, acts like a beam and is emitted in pulses. Sonar-based sources are considered by the NMFS (2018) as intermittent, non-impulsive) because they generally comprise a single (or multiple discrete) frequency. Unlike the sonar-like survey sources, the UHRS is likely to utilise a sparker, which produces an intermittent, impulsive, broadband source signal. The survey parameters, such as source sound levels used in the underwater sound modelling are presented in detail in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report.

4.2 Summary of impacts

4.2.1.1 Table 4:1 details the potential AUD INJ range across all geophysical surveys. The maximum AUD INJ range predicted was 0.181km for the VHF species group (harbour porpoise), based on SEL_{24h} (MBES). The maximum auditory injury range for all other species was predicted to be 0.091km, based on SEL_{24h} (PCW, CHIRP 3.5kHz). However, sonar-like sources have a very strong directivity, therefore there is only a realistic potential for injury should a marine mammal be directly underneath the noise source. Once the animal moves outside of the main beam, there is no potential for injury.

4.3 Mitigation methods

4.3.1.1 Mitigation for geophysical activities typically relies on MMO/PAM mitigation to ensure the AUD INJ onset range is monitored before the geophysical equipment is activated (following JNCC (2017) guidance). Depending on the level of risk it is common practice for this role to be undertaken by a suitably trained crew member (dedicated to the task during the watch period).

4.3.1.2 Based on the maximum predicted injury range the MZ will be the minimum recommend by JNCC, (i.e. 500m). The watch period will be 30 mins prior to the equipment activation.

4.3.1.3 If geophysical survey activities are conducted during periods of low visibility or darkness, where visual monitoring is not possible, the trained/ qualified PAM operator will monitor the MZ for a pre-shooting search of at least 30 minutes.

4.3.1.4 If marine mammals are detected in the MZ during the 30 minute pre-shooting search, the geophysical activities must be delayed until the passage of the marine mammal(s), or transit of the vessel, results in the animals being outside of the MZ. There will be a minimum 20 minute delay from the time of last detection and the commencement of the soft start to allow marine mammals to move out of the MZ.

4.3.1.5 As per the JNCC (2017) guidelines, the soft start will consist of a ramp-up of power from a low energy starting point, in uniform stages. The guidelines acknowledge that this is not possible for all SBP equipment (i.e. it is either on or off) and that if such equipment is to be used, this should be highlighted during any relevant application process.

Table 4:1: Maximum horizontal distances in kilometres from the geophysical sources to maximum-over-depth peak (PK) and maximum-over-depth Sound Exposure Level impact thresholds for marine mammals from NMFS (2024)

Hearing group	Metric	Intermittent non-impulsive						Intermittent impulsive	
		Auditory threshold	Distance (km)					Auditory threshold	Distance (km)
			MBES	SSS	SBES	CHIRP 2.0kHz	CHIRP 3.5kHz		Sparker
LF cetaceans	PK	222	0.015	0.004	0.007	-	0.007	222	-
	SEL	197	-	-	0.002	0.003	0.071	183	0.016
HF cetaceans	PK	230	0.007	0.002	0.002	-	0.003	230	-
	SEL	201	0.016	0.002	0.003	-	0.039	193	-
VHF cetaceans	PK	202	0.105	0.032	0.007	0.006	0.064	202	0.009
	SEL	181	0.181	0.036	0.007	-	0.114	159	-
PCW	PK	223	0.014	0.004	0.005	-	0.006	223	-
	SEL	195	0.058	-	0.005	0.003	0.091	183	0.004

5 Roles and responsibilities

5.1.1.1 As per the JNCC guidance (JNCC, 2010, 2017, 2025), persons involved in implementing and ensuring compliance with the finalised MMMP include:

- the Applicant's Environmental Manager;
- independent Ecological Clerk of Works (ECoW);
- MMOb(s);
- PAM operator;
- ADD Operator;
- Explosive Ordinance Disposal (EOD) or geophysical survey supervisor.

5.1.1.2 All persons will be equipped with the appropriate means of communication between each other in order to ensure that the correct mitigation protocols are undertaken and to allow timely communication if a marine mammal is detected.

5.2 The Applicant's Environmental Manager

5.2.1.1 The Applicant's Environmental Manager is responsible for ensuring all compliance documents, such as the MMMP are included in the construction contract documents. They will report marine mammal monitoring and activities related to piling, UXO clearance, and geophysical surveying.

5.3 Independent Ecological Clerk of Works

5.3.1.1 The independent ECoW will be responsible for completing inductions and toolbox talks to onsite construction teams (including piling and UXO detonation) on the requirements of the MMMP and monitoring that all piling and UXO detonation activities are being completed in accordance with the MMMP, other related consent management plans and all relevant regulations and legislation. The independent ECoW is also responsible for stopping operations (e.g. piling in the event of a non-compliance with the MMMP and/or consent conditions and reporting all non-compliances to MD-LOT).

5.4 Marine Mammal Observers

5.4.1.1 The lead MMOb(s)) will report to the ECoW. All MMOs will be appropriately trained to the requirements set out in the relevant JNCC guidance (JNCC, 2010, 2017, 2025): have completed the JNCC registered marine mammal observer course and have sufficient field experience (at least one year of MMOb experience on offshore projects). The lead MMOb should be experienced (trained observer with three years of field experience observing for marine mammals, and practical experience of implementing the JNCC guidelines).

5.4.1.2 MMOb(s) will be positioned on a suitable platform on a vessel that allows full 360° coverage of the MZ and an observer eye height of at least 5m. They will be equipped with appropriate visual aids (such as reticule binoculars) and will be capable of determining the extent of the various mitigation zones depending on the survey. They will be responsible for recording any marine mammal observations using marine mammal recording forms provided by JNCC[2].

[2] Reporting forms accessible from the JNCC website Marine mammals and noise mitigation JNCC – Advisor to Government on Nature Conservation

5.5 Passive Acoustic Monitoring operator

5.5.1.1 There will be one specialist, trained, and dedicated PAM operator who will be responsible for acoustically tracking vocalising marine mammals using a hydrophone, via appropriate computer software (e.g. PAMGuard). They will report to the ECoW and will also be responsible for deploying and maintaining the hydrophone and any spares. They will be appropriately trained and have sufficient field experience (at least one year of PAM experience on offshore projects).

5.6 Acoustic Deterrent Device operator

5.6.1.1 There will be one ADD Operator responsible for deploying, maintaining, and operating the ADDs and any spares, with the requirements outlined in this MMMP. They will report to the ECoW and will be required to communicate clearly with the MMOb(s), PAM operator and, in the case of UXO disposal, the EOD Supervisor, to confirm commencement and cessation of ADD usage. They will also be required to communicate with the PAM operator to check that ADDs are functioning correctly.

5.7 Explosive Ordinance Disposal supervisor

5.7.1.1 An EOD Supervisor will be required during UXO clearance activities to ensure that the requirements of the MMMP are met. They will report to the ECoW and will be responsible for decisions involving initiating, delaying or pausing detonation and ensuring that no UXO detonation occurs without their explicit consent. They must ensure clear lines of communication between the ECoW, MMOb, PAM operator, ADD Operator and EOD contractors.

6 Reporting

6.1.1.1 The ECoW will collate a detailed record of operations, mitigation procedures and any marine mammal sightings. These records will be prepared and submitted in compliance with consent conditions, licence conditions or both, to MD-LOT and will include completing and submitting marine mammal recording forms provided by the JNCC.

6.1.1.2 All reporting will include the following as per the JNCC guidelines (JNCC, 2010, JNCC, 2017, JNCC, 2025);

- presence, location, and activity of vessels during mitigation activities;
- the mitigation procedures followed, including details of MMOb(s) activities, PAM operation, duration of mitigation activities and ADD duration;
- details of PAM equipment and ADDs used and any relevant observations on their efficacy;
- all marine mammal sightings and PAM detections using standard JNCC Marine Mammal Reporting Forms;
- detailed descriptions of any technical problems encountered and what, if any, actions were taken;
- any instances of non-compliances with the MMMP, and variations from agreed procedures;
- put forward any recommendations based on the project and any marine mammal sightings/behaviour encountered during the mitigation operations which could benefit future projects.

6.2 Impact piling

6.2.1.1 In addition, impact piling reporting will include the following:

- date and location of piling operations;
- a record of all piling activity, including details of the duration of the pre-piling search and soft start/ramp up procedures;
- any occasions when piling activity was stopped or delayed due to the presence of marine mammals.

6.3 Unexploded Ordnance clearance

6.3.1.1 In addition, UXO reporting will include the following:

- operator details (including licence reference number issued by the regulator);
- type of explosive used, including charge weight and TNT equivalent;
- location(s) of clearance event;
- summary of MMOb/PAM monitoring, including the number of personnel, and their experience, where each MMOb/PAM personnel were located (including if location had to move away for safety reasons), confirmation of MMOb elevation and the 360° field of view.

6.4 Site investigation surveys (geophysical)

6.4.1.1 In addition, geophysical reporting will include the following:

- approach taken for each geophysical survey, including dates, times, survey type, equipment used, and coordinates and transects of surveys.

7 Summary of mitigation measures

Table 7:1 7: Summary of mitigation measures

Activity	Impact Range	Mitigation Options/Comments
Impact Piling	950m	Soft start/ramp up procedure MMOb/PAM/ADD standard mitigation protocols Specific details agreed for the finalised MMMP post consent
UXO Clearance (Low Order)	1,000m	MMOb/PAM/ADD standard mitigation protocols Specific details agreed for the finalised MMMP post consent
UXO Clearance (High Order – If Unavoidable)	16,400m	MMOb/PAM/ ADD standard mitigation protocols Residual injury risk for VHF. The residual risk to be assessed and mitigation agreed for the finalised MMMP post consent if the need for high order clearance is established Additional mitigation (e.g. bubble curtains considered) highly dependent on location of UXO An EPS Licence for injury may be required
Site Investigation Surveys (Geophysical)	500m	MMOb/PAM standard mitigation protocols

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