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Appendix 22: Marine Mammal Mitigation Plan

Array EIA Report
2024

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Approval for Issue		
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1. MARINE MAMMAL MITIGATION PLAN

1.1. INTRODUCTION

1. This outline Marine Mammal Mitigation Plan (MMMP) has been prepared by Ossian Offshore Wind Farm Limited (Ossian OWFL), a joint venture partnership between SSE Renewables (SSER) Limited, Copenhagen Infrastructure Partners, and Marubeni Corporation (hereafter referred to as "the Applicant"), to support the Array Environmental Impact Assessment (EIA) Report for the Ossian Array (hereafter referred to as "the Array").

2. The Array is located off the east coast of Scotland, approximately 80 km south-east of Aberdeen from the nearest point (Figure 1.1). The Array covers an area of approximately 859 km^2 and comprises up to 265 floating wind turbines and up to 15 Offshore Substation Platforms (OSPs). Inter-array cables will connect the wind turbines to each other and to the OSPs, while interconnector cables will connect the OSPs to each other.

3. This outline MMMP presents a summary of findings as assessed in the Array EIA Report on the effects of underwater noise during piling (floating foundations), Unexploded Ordnance (UXO) clearance, and pre-construction geophysical surveys, on marine mammals. Piling and UXO clearance have the potential for impact during the construction phase, and geophysical surveys have the potential for impact during both the construction and operation and maintenance phase. This outline MMMP presents mitigation protocols to minimise the risk of injury to marine mammals. This outline MMMP is informed by the following sections of the Array EIA Report:

   - volume 2, chapter 10: Marine Mammals;
   - volume 3, appendix 10.1: Underwater Noise Technical Report; and
   - volume 3, appendix 10.2: Marine Mammal Technical Report.

4. Whilst the assessment of injury in the EIA is based upon the dual metric approach, advice received from NatureScot in response to Marine Mammal Consultation Note 2 (volume 3, appendix 5.1, annex E) advised that "pre-piling mitigation should be based on the instantaneous risk for permanent threshold shift (PTS) onset" and therefore the injury ranges from the Peak Sound Pressure Level (SPL_{pk}) metric form the basis for mitigation (and define the mitigation zone) in this outline MMMP.

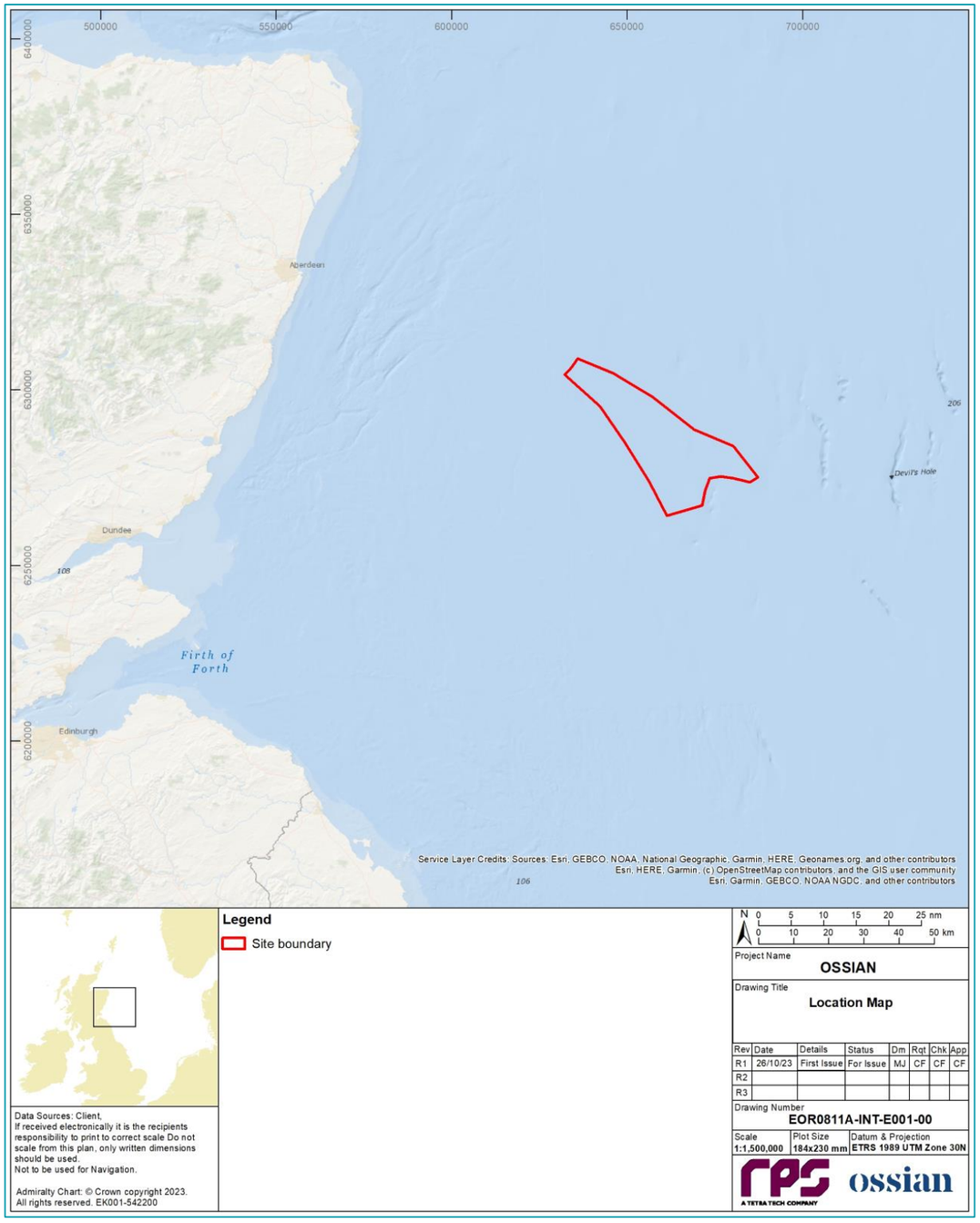

Figure 1.1: Array Area for Ossian Offshore Wind Farm

1.2. PURPOSE OF THE MMMP

5. This outline MMMP has been prepared to secure mitigation strategies which seek to ensure there is no injury to marine mammals as a result of the following activities associated with the Array:

- underwater noise during piling;
- UXO clearance; and
- site investigation surveys (geophysical).

6. Information presented in this outline MMMP is based on volume 2, chapter 10 of the Array EIA Report which considers the potential impacts of the Array during the construction, operation and maintenance, and decommissioning phases. The maximum design scenario (MDS) informing the assessment of potential impacts on marine mammals as a result of elevated underwater noise during piling, UXO clearance, and geophysical site investigation surveys is presented in Table 10.16 of volume 2, chapter 10 of the Array EIA Report.

7. This outline MMMP has been prepared in accordance with the following guidance and it is considered that compliance with these will reduce the risk of injury to marine mammals:

- Joint Nature Conservation Committee (JNCC) (2010a), Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise;
- JNCC (2010b), Guidelines for minimising the risk of injury to marine mammals from using explosives; and
- JNCC (2017), Guidelines for minimising the risk of injury to marine mammals from geophysical surveys.
- These measures may encompass, but are not restricted to, the following:
- Establishment of a designated mitigation zone;
- Monitoring of mitigation zone through visual observation using qualified and trained Marine Mammal Observers (MMO[2]);
- Utilisation of a Passive Acoustic Monitoring (PAM) System;
- Deployment of Acoustic Deterrent Devices (ADDs);
- Establishment of communication channels between MMO[2], PAM and ADD operators; and
- Implementation of a soft start and ramp up procedures.

8. The development of mitigation measures and emerging and evolving technologies for marine mammal monitoring will be actively monitored. Where it is identified that such measures or technologies would be appropriate for implementation as part of the Array, this MMMP will be updated accordingly.

1.3. TARGET SPECIES

9. Marine mammals were characterised based on their abundance and densities at a regional scale (regional marine mammal study area) and local scale (Array marine mammal study area), as detailed in volume 2, chapter 10.

10. Digital aerial surveys (DAS) commenced in March 2021 and continued monthly up to and including February 2023. DAS identified that harbour porpoise *Phocoena phocoena* was the most commonly sighted marine mammal in the Array marine mammal study area. Other marine mammals that were regularly sighted in the surveys include grey seal *Halichoerus grypus*, minke whale *Balaenoptera acutorostrata* and white-beaked dolphin *Lagenorhynchus albirostris*. These species use sound for many aspects of their lives and are sensitive to underwater noise, which can cause permanent damage to their ear tissue. A detailed account on the effects of underwater noise on the marine mammal species presented in this outline MMMP can be found in volume 2, chapter 10.

11. All of the marine mammal species which would potentially be affected by the Array are protected by international legislation and/or are important from a conservation perspective at an international or national context (volume 2, chapter 10). Therefore, the value of marine mammal Important Ecological Features (IEF) at the Array was designated as International (Table 1.1).

Table 1.1 Marine Mammal IEFs and their Importance Within the Marine Mammal Regional Study Area

Species	Protection Legislation
Harbour porpoise	• Annex II species that is a designated feature of Southern North Sea Special Area of Conservation (SAC); • European Protected Species (EPS); • Scottish Priority Marine Feature (PMF); • Oslo and Paris Convention (OSPAR) protected species; • International Union for Conservation of Nature (IUCN) Red List Least Concern; and • Biodiversity Action Plan (BAP) priority species.
Bottlenose dolphin *Tursiops truncatus*	• Annex II species that is a designated feature of Moray Firth SAC. • EPS. • Scottish PMF. • IUCN Red List Least Concern. • BAP priority species.
White-beaked dolphin	• EPS. • Scottish PMF. • IUCN Red List Least Concern. • BAP priority species.
Minke whale	• EPS. • Scottish PMF. • IUCN Red List Least Concern. • BAP priority species. • Southern Trench Nature Conservation Marine Protected Area (ncMPA).
Humpback whale *Megaptera novaeangliae*	• EPS. • IUCN Red List Least Concern. • BAP priority species.
Grey seal	• Annex II species that is a designated feature of Berwickshire and Northumberland Coast SAC. • IUCN Red List Least Concern. • Scottish PMF.

1.4. MEASURES ADOPTED AS PART OF THE ARRAY

12. As part of the Array design process, a number of designed in measures have been proposed to reduce the potential for injury and/or mortality on marine mammals (Table 1.2). As there is commitment to implementing these measures, they are considered inherently part of the design of the Array and represent a standard industry practice for this type of development. As part of designed in measures, a commitment to up to 30 minutes of ADD deployment is included.

13. Secondary mitigation measures, such as extended use of ADDs (over 30 minutes) may be implemented and are further discussed in section 1.6, however these are not considered to be a designed in measure.

Table 1.2: Designed in Measures Adopted as Part of the Array

Designed In Measures Adopted as Part of the Array	Justification
Development of, and adherence to, an EMP (volume 4, appendix 22).	To ensure adequate environmental controls are in place across the project to manage and mitigate any potential risk to the environment. Measures will cover all aspects of environmental management including environmental awareness training, auditing, environmental reporting and waste management. It is anticipated that the MPCP and INNSMP will be appendices to the overarching EMP.
Development of, and adherence to, a MPCP (volume 4, appendix 22, annex A).	To reduce the potential for release of pollutants from construction, operation and maintenance and decommissioning plant is reduced so far as reasonably practicable. These will likely include designated areas for refuelling where spillages can be easily contained, storage of chemicals in secure designated areas in line with appropriate regulations and guidelines, double skinning of pipes containing hazardous substances, and storage of these substances in impenetrable bunds. All vessels associated with the Array will be required to comply with the standards set out by MARPOL.
Development of, and adherence to, a Navigational Safety and Vessel Management Plan (NSVMP) (volume 4, appendix 24).	The NSVMP will include measures to reduce disturbance to marine mammal receptors from transiting vessels, requiring them to: • not deliberately approach marine mammals as a minimum; and • avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride. The NSVMP will be implemented as far as practicable and where it does not compromise the safety of vessels.
The development of, and adherence to a Piling Strategy (PS) (or equivalent) which will set out the following measures: Implementation of initiation stage and soft start during piling. This will involve the use of a low hammer energy with a low number of strikes used initially, followed by lower hammer energies at a higher strike rate at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	These measures will reduce the likelihood of injury from elevated underwater noise to marine life in the immediate vicinity of piling operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. These measures will reduce the likelihood of injury from elevated underwater noise to marine mammals in the immediate vicinity of piling/UXO clearance operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. This is in line with the most up to date guidance for piling/UXO clearance operations (JNCC, 2010a; JNCC, 2010b) and, in most cases, compliance with this guidance reduce the likelihood of injury to marine mammal receptors to negligible levels.
UXO clearance using low order disposal techniques where technically feasible.	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to reduce noise levels and thereby injury and disturbance to sound-sensitive receptors during UXO clearance. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been considered in the assessment of likely significant effects.
Implementation of soft start measures for UXO clearance using a sequence of small explosive charges detonated over set time intervals.	These measures will reduce the likelihood of injury from elevated underwater noise to marine mammals in the immediate vicinity of piling/UXO clearance operations as far as practicable, allowing individuals to move away from the area before sound levels reach a level at which injury may occur. This is in line with the most up to date guidance for piling/UXO clearance operations (JNCC, 2010a; JNCC, 2010b) and, in most cases, compliance with this guidance reduce the likelihood of injury to marine mammal receptors to negligible levels.
The development of, and adherence to an MMMP (this document).	The MMMP will: • mitigate for the risk of permanent auditory injury to marine mammals within a pre-defined 'mitigation zone' for each activity. The mitigation zone is determined considering the largest injury zone across all species for each relevant activity; and • reduce the potential for collision risk, or potential injury to, marine mammals and other marine megafauna (e.g. basking shark) as far as practicable; and detail the visual and acoustic monitoring required as a minimum over the defined mitigation zones so that animals are clear before the activity commences. Additional measures to deter animals from injury risk zones may be applied in some instances (e.g. ADDs or soft start charges). This outline MMMP has been developed on the basis of the most recent published statutory guidance (JNCC, 2010a, JNCC, 2010c, JNCC, 2017).
Routine inspections of the inter-array cables and mooring lines.	Mooring lines and dynamic inter-array cables in the water column will undergo regular inspections during the operation and maintenance phase with inspection frequency more frequent initially for the first two years and then decreasing to an annual schedule. The removal of marine debris from mooring lines and inter-array cables will be undertaken as necessary following monitoring and further relevant action taken if required, based on findings from the inspections. The removal of debris from mooring lines and cables further reduces the likelihood of secondary entanglement.
Development of, and adherence to a Decommissioning Programme (DP[2]).	The aim of this plan is to adhere to the existing UK and international legislation and guidance (at the time of writing) during the decommissioning phase. This will reduce the amount of long-term disturbance to the environment as far as reasonably practicable.

1.5. SUMMARY OF THE ARRAY EIA

1.5.1 PILING

14. Pile driving during the construction phase of the Array has the potential to result in injury to marine mammals through increased underwater noise levels. A detailed underwater noise modelling assessment was carried out to investigate these effects (volume 3, appendix 10.1). Injury, in the form of a PTS was investigated with respect to two metrics over the entire piling sequence from hammer initiation to maximum hammer energy (of 3,000 kJ for wind turbines or 4,400 kJ for OSPs). SPL_{pk} was used to determine ranges for instantaneous injury at the highest point over the piling sequence whilst cumulative Sound Exposure

Level (SEL_{cum}) was modelled to estimate the injury range from cumulative exposure as an animal flees the area (Table 1.3). The instantaneous injury (based on SPL_{pk} metric) could occur out to a maximum range of 1,600 m across all species during single pile installation at OSPs, with the maximum range predicted for harbour porpoise. Considering cumulative exposure using the SEL_{cum} metric, the risk of PTS was estimated to occur out to a maximum range of 7,200 m and was predicted for minke whale during single pile installation at OSPs.

15. The maximum spatial effect was estimated using two different concurrent piling scenarios, at wind turbines with a hammer energy of 3,000 kJ with either a wind turbine with a hammer energy of 3,000 kJ or an OSP with hammer energy of 4,400 kJ, respectively. Considering cumulative exposure using the SEL_{cum} metric, the risk of PTS was estimated to occur out to a maximum range of 9,740 m and was predicted for minke whale during concurrent pile installation at wind turbine and OSP. A summary of the injury ranges without ADD and significance of the effect assessed in marine mammal impact assessment is provided in Table 1.3.

16. As discussed in paragraph 14, mitigation is based upon SPL_{pk} in this outline MMMP following consultation with NatureScot on Marine Mammal Consultation Note 2 (volume 3, appendix 5.1, annex E). Therefore, across all species, the maximum range without ADD (based on SPL_{pk}) over which injury could occur was predicted to be 1,600 m, which is greater than the standard 500 m mitigation zone proposed by JNCC (2010a). For SEL_{cum}, the maximum injury range was up to 9,740 for minke whale, but this was considered to be highly precautionary as the SEL_{cum} metric can lead to overestimates in effect ranges due to the assumptions included in the model for cumulative exposure, including:

- the sound retains its impulsive character at all distances;
- animals flee from the sound at constant and conservative swim speeds;
- the same shift in hearing could occur regardless of how energy is distributed over time (equal-energy rule);
- the soft-start procedure does not allow for short pauses in piling (e.g. for realignment) when exposure would be reduced; and
- the maximum hammer would be reached and maintained.

17. The modelled ranges suggest that injury could occur well below the maximum range, particularly with respect to SPL_{pk} ranges. This is typical for underwater noise modelling results for piling and for this reason, mitigation zones have previously been based on SPL_{pk} ranges only. To adopt a conservative approach in the EIA assessment, the risk of injury and subsequently the ability to mitigate for this risk was investigated with respect to the maximum possible ranges; thus, adopting the dual metric approach as recommended in Southall *et al.*, (2019). A maximum mitigation zone of 1,600 m has therefore been presented here based on SPL_{pk}, but final agreement on the appropriate mitigation zone will be agreed with Marine Directorate – Licensing Operations Team (MD-LOT) following consultation with Marine Directorate – Science, Evidence, Data and Digital (MD-SEDD) and NatureScot post-consent.

Table 1.3 Potential Maximum Ranges of Effect of Piling (without ADD) on Six Marine Mammal Species as Presented in the Volume 2, Chapter 10. Injury Ranges for SEL_{cum} are Shown for Single Piling (Lower) to Concurrent Piling (Higher). Designed in Measures Includes up to 30 Minutes ADD

Species	Threshold	Potential PTS Onset Range (m) 3,000 kJ (wind Turbines) (Without ADD)	Potential PTS Onset Range (m) 4,400 kJ (OSPs) (Without ADD)	Magnitude of Impact with Designed in Measures (including 30 minutes ADD)	Sensitivity of Receptor	Injury Risk Reduced by Designed in Mitigation A	Significance of Effect in EIA Terms
Harbour porpoise	SPL_{pk}	665	1,600	Negligible	High	Yes – up to 30 minutes ADD	Minor
	SEL_{cum}	10–11	70–203				
Bottlenose dolphin	SPL_{pk}	95	171	Negligible	High	Yes – up to 30 minutes ADD	Minor
	SEL_{cum}	N/E	N/E				
White-beaked dolphin	SPL_{pk}	95	171	Negligible	High	Yes – up to 30 minutes ADD	Minor
	SEL_{cum}	N/E	N/E				
Minke whale, Humpback whale	SPL_{pk}	180	353	Low	High	Yes – up to 30 minutes ADD	Minor
	SEL_{cum}	990 – 1,445	7,200–9,740				
Grey seal	SPL_{pk}	192	379	Negligible	High	Yes – up to 30 minutes ADD	Minor
	SEL_{cum}	N/E	N/E				

[1] N/E = Threshold not exceeded

18. Although the potential for injury in terms of PTS were predicted to be minor in EIA terms (volume 2, chapter 10), there is the potential for auditory injury to marine mammals (which are all international IEFs). Therefore, designed in mitigation in the form of ADDs (up to 30 minutes, with any duration longer than 30 minutes considered secondary mitigation), in addition to other designed in protocols, is included (i.e. use of marine mammal observers and passive acoustic monitoring operators) (JNCC, 2010a). Mitigation will be applied by deploying an ADD to deter marine mammals from the area of impact prior to commencement of construction-related "noisy" activities. The JNCC (2010a) guidance for mitigating the effects of piling recommends usage of ADDs in addition to MMO[2] and PAM operators, particularly in low visibility or at night. This is because there are inherent uncertainties in these visual and acoustic techniques, as they can be unreliable in detecting animals in high sea state and/or in low visibility. More details about required duration of ADD activation is provided in paragraph 20 *et seq*.

19. There are numerous ADDs with different sound characteristics available (McGarry *et al*., 2020) and a suitable device will be selected based on the key species requiring mitigation, following discussion with relevant stakeholders. It is expected that key species to consider will be minke whale and harbour porpoise, however this will be agreed with stakeholders' post-application. The sound emitted by the ADD will not

injure marine mammals but will be loud enough to deter them from the sound source (hence their effectiveness as an additional mitigation measure).

20. Results from the Array underwater noise modelling (volume 3, appendix 10.1) suggest that use of an ADD for 30 minutes prior to commencement of piling would further reduce the potential to experience injury to marine mammal receptors (Table 1.4 and Table 1.5). The maximum injury zones for species predicted using the SPL_{pk} metric for piling (used to define the mitigation zone) at a maximum hammer energy of 4,400 kJ (as presented in the volume 2, chapter 10), are illustrated in Table 1.4. Assuming conservative swimming speeds (agreed via consultation with key stakeholders on the Marine Mammal Methodology Note, volume 3, appendix 5.1, annex B), the Array marine mammal impact assessment demonstrated that use of an ADD for 30 minutes prior to commencement of piling would deter all animals beyond the maximum modelled injury zones. This is in line with previous studies which reported that ADDs were able to deter marine mammal species over several kilometres (McGarry *et al*., 2020).

Table 1.4: Summary of Maximum Potential PTS Ranges due to Single Pile Installation (at OSPs, Hammer Energy 4,400 kJ) Using SPL_{pk} Metric, Indicating Whether the Individual Can Move Beyond the Injury Range During the 30 minutes of ADD Activation

Species	Threshold (Unweighted Peak)	Potential PTS Range (m)	Swim Speed (m/s)	Swimming Distance (m)	Move Away Beyond the Maximum Injury Zone?
Harbour porpoise	PTS - 202 dB re 1 µPa (pk)	1,600	1.5 (Otani *et al.,* 2000)	2,700	Yes
Bottlenose dolphin, white-beaked dolphin	PTS - 230 dB re 1 µPa (pk)	171	1.52 (Bailey and Thompson, 2010)	2,736	Yes
Minke whale	PTS - 219 dB re 1 µPa (pk)	353	2.3 (Boisseau *et al.,* 2021)	4,140	Yes
Humpback whale	PTS - 219 dB re 1 µPa	353	0.3	540	Yes
Grey seal	PTS - 218 dB re 1 µPa (pk)	379	1.8 (Thompson, 2015)	3,240	Yes

21. Similarly, modelling using the SEL_{cum} metric demonstrated that the use of an ADD is useful for reducing PTS injury ranges for minke whale and harbour porpoise. The activation of an ADD 30 minutes prior to commencement of piling (a designed in measure) effectively reduced PTS (Table 1.5). As discussed in paragraph 14, in response to Marine Mammal Consultation Note 2 (volume 3, appendix 5.1, annex E), NatureScot clarified that the mitigation should be based on the SPL_{pk} metric, but the assessment of significance in the EIA chapter should consider the dual metric approach (i.e. both SPL_{pk} and SEL_{cum}). It is recognised that additional noise sources, including the use of ADDs, should be minimised and therefore, subject to final agreement on the mitigation zone post-consent, the duration of ADD activation will be agreed as part of the final MMMP.

Table 1.5: Injury Ranges for Minke Whale due to Concurrent Piling at Wind Turbine and OSP, Hammer Energies of 3,000 kJ and 4,400 kJ Using SEL_{cum} Metric with and without 30 Minutes of ADD

Species	Threshold (Weighted SEL)	Range (m)	
		Without ADD	With ADD
Harbour porpoise	PTS - 155 dB re 1 μPa^2s	203	N/E
Minke whale	PTS - 183 dB re 1 μPa^2s	9,740	5,610

[1] N/E = Threshold not exceeded

1.5.2 UXO CLEARANCE

22. Low order clearance techniques will be applied as the intended methodology for UXO clearance, noting the position statement from statutory authorities on UXO clearance that low order alternatives should be prioritised when clearing UXO (UK Government *et al.,* 2022). However, there is a small inherent risk with low order clearance methods that the UXO may result in a high order detonation. In addition, some UXOs may not be stable enough to warrant a low order approach and therefore would need to be cleared using high order methods for safety reasons. This will not be known until a UXO pre-construction survey is carried out, but as a precautionary approach, high order is included as part of the MDS.

23. High order detonation of UXO has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater noise sources (von Benda-Beckmann *et al*., 2015). Underwater noise from high order UXO detonation could result in physical and/or auditory injury, or death for marine mammals.

24. Low order techniques of UXO clearance uses a single charge of up to 80 g Net Explosive Quantity (NEQ) which is placed in close proximity to a UXO to target a specific entry point. When detonated, a shaped charge penetrates the UXO's casing to introduce a small, clinical plasma jet into the main explosive filling. The intention is to excite the explosive molecules within the main filling to generate enough pressure to burst the UXO casing, producing a deflagration of the main filling and neutralising the UXO. Recent controlled experiments showed low-order clearance using deflagration to result in a substantial reduction in acoustic output over traditional high-order methods, with SPL_{pk} and SEL_{cum} being typically significantly lower for the low order techniques of the same size munition, and with the acoustic output being proportional to the size of the shaped charge, rather than the size of the UXO itself (Robinson *et al*., 2020).

25. It is estimated that up to 15 UXOs are likely to require clearance within the Array area. Furthermore, it has been assumed that the maximum design scenario will be clearance of UXOs up to 698 kg NEQ, with the most realistic maximum size being 227 kg. The maximum frequency would be up to two detonations within 24 hours. The clearance activities will be tide and weather dependant as detonations will take place during daylight hours and slack water only. The aim is to allow clearance of at least one UXO per tide, during daylight hours only.

26. For bottlenose dolphin, white-beaked dolphin, minke whale, humpback whale and grey seal, the magnitude of impact was deemed to be low and the sensitivity of receptors to be high. As the estimated number of individuals with the potential to be injured was low (presented in volume 2, chapter 10), the potential effect was assessed as of minor significance, which is not significant in EIA terms (Table 1.6).

27. For harbour porpoise however, the magnitude of impact was deemed to be medium as the estimated number of animals with the potential to be injured was higher. Additionally, the sensitivity of receptor for harbour porpoise was deemed to be high, resulting in a potential effect of moderate significance, which is significant in EIA terms (Table 1.6). As the predicted injury zone (14,450 m) is too extensive to be effectively mitigated by standard designed in measures (marine mammal observers and PAM operators), the use of mitigation in the form of ADDs (up to 30 minutes) and soft start charges (see paragraph 49),

has been proposed as designed in mitigation and is detailed in this outline MMMP. Maximum injury ranges in this outline MMMP are based on SPL_{pk} are based on the dual-metric approach, as detailed in volume 2, chapter 10.

28. If required, secondary mitigation (i.e. ADD use with a duration over 30 minutes) will be applied to further reduce the potential for injury to harbour porpoise occurring during UXO clearance. Final mitigation required will be addressed post consent, in consultation with stakeholders, following more detailed information such as the size, number and quality of UXOs to be cleared (following site-investigation surveys), noting that it may be possible to reduce the ADD activation period and soft start procedure depending on the size and number of UXOs located within the Array. Volume 2, chapter 10 details a worked example for mitigation based on the most significant predicted effect and focused on harbour porpoise (as this is the species with a potential residual risk of injury), which considers the different timescales that would be required to clear the injury zone if ADD and soft-start is required.

29. Therefore, prior to the commencement of UXO clearance works, appropriate secondary mitigation measures will be discussed with stakeholders and proposed as a part the final MMMP for UXO clearance works.

Table 1.6: Potential Effect of UXO Clearance on five Marine Mammal Species for High Order Detonation of Maximum case

Species	Potential PTS Range (m) based on SPL_{PK}	Estimated Number of Animals with the Potential to experience PTS	Magnitude of Impact	Sensitivity of Receptor	Risk of Injury Reduced by Designed in Mitigation	Significance of Effect in EIA Terms	Additional Measures	Significance of Residual Effect in EIA Terms
Harbour porpoise	14,540	433	Medium	High	No	Moderate	Use of soft start charges; extended ADD deployment. Other measures as identified following UXO ID survey	Minor
Bottlenose dolphin	840	<1	Low	High	Yes	Minor	Not required	Minor
White-beaked dolphin	840	<1	Low	High	Yes	Minor	Not required	Minor
Minke whale	2,575	<1	Low	High	Yes	Minor	Not required	Minor
Grey seal	2,850	5	Low	High	Yes	Minor	Not required	Minor

1.5.3 GEOPHYSICAL SURVEYS

30. Site investigation surveys during the construction and operation and maintenance phases has the potential to result in direct or indirect effects on marine mammals. The potential impact ranges predicted for injury were the same for both phases. During the construction phase, site investigation geophysical surveys will take place over a period of up to five months within a three-year period. Geophysical surveys are expected to be short-term (up to three months) and occur intermittently over the lifespan of the Array. For example, during the operation and maintenance phase, routine geophysical surveys will take place once every 24 months for wind turbines and OSP foundations as well as wind turbines interior and exterior and annually for the first three years, then every 24 months for inter-array cables and interconnector cables.

31. A detailed underwater noise modelling assessment was carried out to investigate the potential for auditory injury on marine mammals due to geophysical surveys (volume 3, appendix 10.1). Several sonar-based surveys will potentially be used for the geophysical surveying; these include:

- Multibeam Echosounder (MBES);
- 2D Ultra-high Resolution Seismic (UHRS);
- Site-Scan Sonar (SSS); and
- Sub-bottom Profiler (SBP).

32. The equipment used can typically operate at a range of frequencies, depending on the distance to the seabed and the required resolution. Sonar based sources are considered continuous (non-impulsive) as they typically compromise a single frequency instead of a broadband signal with high kurtosis, high peak pressures, and rapid rise times. Unlike the sonar-based surveys, the UHRS survey is likely to use a sparker, which produces an impulsive, broadband source signal.

33. The noise modelling showed that the ranges within which there is potential for marine mammals to experience PTS as a result of geophysical surveys are relatively low (Table 1.7). For harbour porpoise PTS could occur out to 310 m as a result of the SBP survey.

Table 1.7 Potential PTS Impact Ranges for Marine Mammals During the Geophysical Site Investigation Surveys, Based on Comparison to Southall *et al.* (2019) SEL Thresholds

Source Level	PTS Impact Range (m)				
	Harbour Porpoise	Bottlenose Dolphin	White-Beaked Dolphin	Minke Whale, Humpback Whale	Grey Seal
MBES*					
225 dB re 1 µPa re 1 m (rms)	75	65	65	5	5
SSS*					
210 dB re 1 µPa re 1 m (rms)	75	75	75	10	25
SBP*					
248 dB re 1 µPa re 1 m (rms)	310	75	75	75	75
UHRS**					
214 dB re 1 µPa re 1 m (rms)	10	N/E[1]	N/E[1]	N/E[1]	N/E[1]

[1] N/E = Threshold not exceeded

*Non-impulsive threshold from Southall *et al.* (2019)

**Impulsive threshold from Southall *et al.* (2019)

34. Due to low impact ranges for all species (Table 1.7), there is potential for less than one animal to experience PTS (and none when the threshold is not exceeded) as a result of geophysical surveys. Standard designed in measures to reduce the risk of injury will be implemented following JNCC guidance (section 0; JNCC, 2017). With these measures in place, the risk is deemed to be negligible. It should also be noted that as sonar-based systems have strong directivity, there is only potential for injury when the marine mammal is directly underneath the source.

1.6. MITIGATION METHODS AND PROCEDURES

35. The mitigation measures presented in subsections 1.6.1 to 1.6.3 below include designed in measures and secondary mitigation in order to reduce the risk of injury to marine mammals as described in the volume 2, chapter 10.

1.6.1 PILING

36. As per the JNCC (2010a) guidance, a 30 minute pre-piling search will be undertaken using marine mammal observers and a PAM operator to monitor the specified mitigation zone in order to minimise the likelihood of marine mammals being present within this range. In addition to visual and acoustic monitoring, an ADD will be deployed in close proximity to the pile to be installed at the start of the pre-piling search. The ADD will be activated for a maximum period of 30 minutes to allow animals sufficient time to disperse while also minimising the additional noise produced by the device and therefore emitted into the marine environment. Visual and acoustic monitoring will continue throughout the ADD deployment to seek to ensure marine mammals leave the potential impact zone prior to the start of piling.

37. Piling commencement during periods of low visibility or darkness, where visual monitoring is not possible, will involve the PAM of the mitigation zone over the duration of the pre-piling search, which will be conducted for a minimum of 30 minutes.

38. After the 30 minute pre-piling search and ADD activation period has elapsed, the piling initiation, soft start and ramp up designed in measures will commence with hammer initiation at the lowest hammer energy and strike rate (as specified in volume 3, appendix 10.1 of the Array EIA Report). The ADD will be turned off immediately after the piling activity has commenced.

39. The piling soft start and ramp up designed in measures comprise of the three following activity stages:

- initiation (1 minute for both anchor piles and OSP jacket piles);
- soft start (20 minutes for both anchor piles and OSP jacket piles); and
- ramp up (30 minutes for both anchor piles and OSP jacket piles).

40. The initiation stage is a slow start to allow for alignment and to allow marine mammals to leave the area.

41. If marine mammals are detected within the mitigation zone during the pre-piling search, piling will not commence until at least 20 minutes after the last visual or acoustic detection of the animal. The marine mammal observers and PAM operative will track any marine mammals detected and ensure that they have left the mitigation zone before piling commences. If a marine mammal is detected in the mitigation zone during the soft-start procedures, the piling operation should cease, whenever possible, or at least not be increased further until the marine mammal clears the mitigation zone and is not detected again for 20 minutes.

42. If for any reason there is a break in piling activity for over ten minutes, then the pre-piling search and ADD activation should be repeated before piling recommences.

43. If during piling at full power a marine mammal is detected in the mitigation zone, there will be no requirement to cease piling, as the JNCC guidance (2010a) concludes that the animal is deemed to have entered the mitigation zone voluntarily. It may also not be possible to stop piling at full power due to engineering restrictions.

44. The development of and adherence to a PS will set out further details on mitigation (such as soft start, ramp up)

45. The designed in measures detailed in this outline MMMP and the PS reduce the risk of injury to a safe threshold, whereby marine mammals are not at risk of auditory injury, in terms of PTS. With designed in mitigation in place, the potential effect of piling (auditory injury) on marine mammals is considered to be of minor significance, which is not significant in EIA terms.

1.6.2 UXO CLEARANCE

46. The primary technique implemented to reduce the risk associated with UXO clearance will be avoiding the need for the use of explosives, either by leaving the confirmed UXO *in situ* and constructing around it or by relocating it to a safe place and leaving *in situ* in the new location. However, where this is not possible, it is assumed that up to 15 UXO may require clearance. The controlled explosions of the UXOs will be undertaken by specialist contractors using the minimum size of explosive possible in order to safely dispose of the UXOs. The detonations will take place during daylight hours only and in good visibility.

47. A pre-detonation search will be carried out. This will involve two dedicated marine mammal observers and one dedicated PAM operator over a minimum 1 km mitigation zone (standard set by JNCC guidance; JNCC, 2010b) and out as far as possible over the predicted injury range. This will be undertaken for a specified duration based on the JNCC (2010b) guidance (paragraph 49 onwards). Since injury could occur beyond the 1 km standard mitigation zone (up to a maximum range of ~14,540 m), an ADD will also be deployed and activated to deter animals from the potential injury zone. The ADD selected will be suitable for the target species (McGarry *et al*., 2020) and will be placed in the water in close proximity to the UXO. ADD activation will commence at the start of the search period for a specified period (Table 1.8). If marine mammals are observed or acoustically detected within the potential injury range, noting the limitations of visually or acoustically detecting marine mammals at large ranges, they will be tracked until they move out of range. Detonation will not occur until the animal has not been detected again for 20 minutes.

48. A range of UXO munitions sizes have been considered for the purpose of determining effective secondary mitigation measures, up to a maximum scenario of a UXO size of 698 kg NEQ. This approach follows a similar strategy as per the Seagreen EPS Risk Assessment and MMMP (Seagreen Wind Energy Ltd, 2021). The assumption is that marine mammals swim away from the ADD in a straight line at speeds agreed in consultation with NatureScot for the Array (volume 3, appendix 10.3). These swim speeds are summarised in Table 1.4. The duration of the activation of the ADD prior to UXO detonation will determine whether animals can move out of the potential injury zone. The potential range of displacement based on these swimming speeds for varying UXO sizes is summarised in Table 1.8.

Table 1.8 Recommended ADD Duration for High Order UXO Clearance and Sizes and Associated Displacement Distance

UXO size	Minimum ADD Duration Prior to Detonation (Minutes)	Displacement Distance (m)				
		Harbour Porpoise	Bottlenose Dolphin	White-beaked Dolphin	Minke Whale	Grey Seal
Up to 227 kg NEQ (realistic maximum case)	112 min of ADD	10,080	10,214	10,214	15,456	12,096
Up to 698 kg NEQ (maximum UXO size)	162 min of ADD	14,580	14,774	14,774	22,356	17,496
Maximum PTS range (m)		**14,540**	**840**	**840**	**2,575**	**2,850**

49. The length of the pre-detonation search will depend on the size of UXO to be cleared (Table 1.8). For all species, except harbour porpoise, duration of ADD for 30 minutes (a designed in measure) would be sufficient to deter marine mammals from the potential injury zone. With the inclusion of 20 minute of soft start, in addition to 30 minutes of ADD, all species except for harbour porpoise would be deterred beyond the maximum injury zone. For high order UXO clearance, injury ranges are larger.

50. Assuming the ADD is activated for an indicative 60 minutes, the displacement distance for harbour porpoise would be 5,400 m, meaning there is a need to deter harbour porpoise from larger ranges that cannot be achieved using an ADD for 60 minutes duration alone (i.e. the injury zone exceeds 5,400 m).

51. Therefore, for high order UXO, to reduce the risk of PTS, there is a need to deter animals from larger ranges than cannot be achieved using an ADD alone. Therefore, following an ADD activation period of 60 minutes, a 'soft start' will be undertaken, using a sequence of small explosive charges, detonated at five minutes intervals, over a total of maximum 20 minutes. It is expected that 80 minutes of combined ADD/soft start procedure (60 minutes of ADD and 20 minutes of soft start) will displace harbour porpoise to ranges of 7,200 m. Whilst this secondary mitigation is considered to be sufficient to deter most animals (noting that use of 30 minutes of ADD alone deterred all other species from the injury zone), there may be a residual effect for harbour porpoise for this largest UXO size, as the maximum predicted PTS impact range for this species was 10,080 for the 227 kg NEQ and 14,580 m for 698 kg NEQ. Therefore, additional secondary mitigation may be required and proposed as part of the final MMMP (see paragraph 53).

52. Following detonation, the marine mammal observers and PAM operator will undertake a post-detonation search of the mitigation zone for at least 15 minutes after the final detonation. The purpose of this search is to look for evidence of injury to marine life, including fish kills. Any other unusual observation will also be noted.

53. Prior to the commencement of UXO clearance works, a more detailed update to this outline MMMP will be produced as a part of the EPS licence supporting information. Additionally, tailored secondary mitigation measures will be further developed based on further information on UXO number, sizes and depth of burial. The final secondary mitigation will be agreed with statutory stakeholders as a part of a UXO specific MMMP.

1.6.3 GEOPHYSICAL SURVEYS

54. Standard JNCC (2017) guidance will be adhered to in order to mitigate any injurious effects to marine mammals. This will involve the use of marine mammal observers and PAM within a standard 500 m mitigation zone, as well as soft-starts where the power is built up gradually from a low-energy. The duration of the soft-start will be survey-specific. As the maximum predicted ranges for PTS are lower than 500 m across all species and geophysical survey techniques (Table 1.7), the standard 500 m mitigation zone will be sufficient to mitigate against injury (in terms of PTS) for all species.

55. Marine mammal observers and PAM will be used for a pre-shooting search of at least 30 minutes prior to commencement of geophysical surveys. The pre-shooting search is a period of visual and acoustic monitoring of the 500 m mitigation zone for the presence of marine mammals.

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

57. The JNCC (2017) guidance will be adhered to if marine mammals are detected within the mitigation zone. Firstly, if marine mammals are detected in the mitigation zone during the 30 minute pre-shooting search, the soft-start to 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 mitigation zone. 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 mitigation zone. Secondly, if seal(s) are congregating around a fixed platform within the survey area, the soft start should commence at least 500 m from the platform. If marine mammals are detected within the mitigation zone whilst the airguns are firing (whether during the soft start or when at full power), there is no requirement to stop firing.

58. Overall, the implementation of designed in and secondary mitigation measures detailed above ensure the potential risk of injury from geophysical surveys is minimised.

59. If multi-beam surveys (such as MBES) are conducted in shallow waters (<200 m), the secondary mitigation (in form of pre-shooting search and soft-starts) will not be required (based on the JNCC guidance; JNCC, 2017).

1.7. ROLES AND RESPONSIBILITES

60. As per the JNCC guidance (2010a, 2010b, 2017), persons involved in implementing, and ensuring compliance with this outline MMMP include:

- the Applicant's Environmental Manager;
- independent Environmental Clerk of Work (ECoW)
- MMO[2];
- PAM Operator;
- ADD Operator; and
- piling, Explosive Ordinance Disposal (EOD) or geophysical survey supervisor.

61. They 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.

1.7.1 THE APPLICANT'S ENVIRONMENTAL MANAGER

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

1.7.2 INDEPENDENT ENVIRONMENTAL CLERK OF WORK

63. The independent ECoW will be responsible for completing inductions and toolbox talks to onsite construction teams (including piling and UXO detonation) on requirements of the outline MMMP and monitoring that all piling and UXO detonation activities are being completed in accordance with the outline 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 outline MMMP and/or consent conditions and reporting all non-compliances to MD-LOT.

1.7.3 MARINE MAMMAL OBSERVERS

64. There will be two dedicated marine mammal observers responsible for monitoring the mitigation zones and conducting searches prior to piling, UXO detonation and/or soft start procedures, and geophysical surveys. They will report to the ECoW and will be responsible for conducting the 15-minute post-detonation search as part of the UXO clearance protocol. They will be appropriately trained: have completed the JNCC registered marine mammal observer course and have sufficient field experience (at least one year of marine mammal observers experience on offshore projects).

65. They will be positioned on a suitable platform on a vessel that allows full 360° coverage of the mitigation zone and an observer eye height of at least 5 m. 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.

1.7.4 PAM OPERATOR

66. There will be one dedicated PAM Operator who will be responsible for acoustically tracking vocalising marine mammals using a hydrophone, via the computer software 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).

67. They will operate from the same vessel as the marine mammal observers and will collaborate with the marine mammal observers to compile all the data on mitigation activities and observations. They will also be responsible for using PAMGuard to confirm that the ADD is functioning correctly and communicating with the ADD operator if it is not.

1.7.5 ADD OPERATOR

68. There will be one ADD Operator responsible for deploying, maintaining, and operating the ADDs and any spares, with the requirements outlined in this outline MMMP. They will report to the ECoW and will be required to communicate clearly with marine mammal observers, 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.

69. The ADD Operator will also be responsible for providing final report(s) on ADD usage during the UXO clearance excursions.

1.7.6 EOD SUPERVISOR

70. An EOD Supervisor will be required during UXO clearance activities to ensure that the requirements of the outline 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, marine mammal observers, PAM Operator, ADD Operator and EOD contractors.

1.8. REPORTING

71. The ECoW will be responsible for monitoring piling, UXO clearance and geophysical surveys and implementation of the outline MMMP and will keep a detailed record of operations, mitigation procedures and any marine mammal sightings. These records will be prepared and submitted in compliance with consent and/or license conditions to MD-LOT and will include completing and submitting Marine Mammal Recording Forms provided by the JNCC.

1.8.1 PILING

72. Reporting will include a record of the following:

- date and location of piling operations;
- a record of all occasions when piling occurred, including details of the duration of the pre-piling search and soft-start procedures, and any occasions when piling activity was stopped or delayed due to the presence of marine mammals;
- presence, location, and activity of vessels during piling procedures;
- the mitigation procedures followed for each piling event, including details of marine mammal observer activities, PAM operation, ADD duration and size and timing of soft-start charges where required;
- details of PAM equipment and ADDs used and any relevant observations on their efficacy;
- all marine mammal sightings and mitigation taken and completed JNCC marine mammal recording forms;
- detailed descriptions of any technical problems encountered and what, if any, actions were taken;
- any problems encountered and instances of non-compliances with the JNCC guidelines (2010a), outline MMMP, and variations from agreed procedures; and
- protocols followed and put forward any recommendations based on the project and any marine mammal sightings/behaviour encountered during the piling operations which could benefit future projects.

1.8.2 UXO CLEARANCE

73. Reporting will include a record of the following:

- identification of all confirmed UXO, including estimated size, type, location and depth;
- approach taken for each UXO, including dates, times, disposal method attempted (based on size and type, and number of donor charge(s) used);
- details of any UXOs relocated or if any UXOs larger than 698 kg are identified;
- presence, location, and activity of vessels during UXO clearance;
- outcome of each UXO clearance, including evidence of high-order detonation, clearing charges required, and method of debris and residue recovery;
- the mitigation procedures followed for each UXO clearance, including details of marine mammal observers activities, PAM operation, ADD duration and size and timing of soft-start charges where required;
- details of PAM equipment and ADDs used and any relevant observations on their efficacy;
- all marine mammal sightings and mitigation taken and completed JNCC marine mammal recording forms;
- detailed descriptions of any technical problems encountered and what, if any, actions were taken;
- any problems encountered and instances of non-compliance with the JNCC guidelines (2010b), outline MMMP, and variations from agreed procedures; and
- protocols followed and put forward any recommendations based on the project and any marine mammal sightings/behaviour encountered during the UXO operations which could benefit future projects.

1.8.3 GEOPHYSICAL SURVEYING

74. Reporting will include a record of the following:

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

- presence, location, and activity of vessels during geophysical surveying;
- a summary of the marine mammal observers and PAM activities, including specifics of the conducted surveys and any relevant observations on the efficacy of PAM equipment;
- all marine mammal sightings and mitigation taken and completed JNCC marine mammal recording forms;
- detailed descriptions of any technical problems encountered and what, if any, actions were taken;
- any problems encountered and instances of non-compliances with the JNCC guidelines (2017), outline MMMP, and variations from agreed procedures; and
- protocols followed and put forward any recommendations based on the project and any marine mammal sightings/behaviour encountered during the geophysical surveying operations which could benefit future projects.

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