NORTH FALLS

Offshore Wind Farm

REPORT TO INFORM APPROPRIATE ASSESSMENT

Appendix 3.1 Unexploded Ordnance Clearance Information and Assessment

Document Reference:	7.1.3.1
Volume:	7
APFP Regulation:	5(2)(g)
Date:	July 2024
Revision:	0

Project Reference: EN010119

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Project	North Falls Offshore Wind Farm
Document Title	Report Inform Appropriate Assessment Appendix 3.1 Unexploded Ordnance Clearance Information and Assessment
Document Reference	7.1.3.1
APFP Regulation	5(2)(g)
Supplier	Royal HaskoningDHV
Supplier Document ID	PB9244-RHD-ZZ-OF-RP-YE-0289

Revision	Date	Status/Reason for Issue	Originator	Checked	Approved
0	July 2024	Submission	RHDHV	NFOW	NFOW

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Glossary of Acronyms

ADD	Acoustic Deterrent Device
DCO	Development Consent Order
EDR	Effective Deterrent Range
EQT	Effective Quiet Threshold
ES	Environmental Statement
HRA	Habitat Regulation Assessment
ML	Marine Licence
MMMP	Marine Mammal Mitigation Plan
MMO	Marine Management Organisation
MMOb	Marine Mammal Observer
MTD	Marine Technical Directorate
MU	Management Unit
NEQ	Net Explosive Quantity
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SEL	Sound Exposure Level
SIP	Site Integrity Plan
SNCB	Statutory Nature Conservation Body
SNS	Southern North Sea
SPL_{peak}	Sound Pressure Level
TTS	Temporary Threshold Shift
TW & NNC	The Wash and North Norfolk Coast
UXO	Unexploded Ordnance

Glossary of Terminology

Array area	The offshore wind farm area, within which the wind turbine generators, array cables, platform interconnector cable, offshore substation platform(s) and/or offshore converter platform will be located.
Offshore cable corridor	The corridor of seabed from array area to the landfall within which the offshore export cables will be located.
Offshore project area	The overall area of the array area and the offshore cable corridor.
Platform interconnector cable	Cable connecting the offshore substation platforms (OSP); or the OSP and offshore converter platform (OCP).
The Applicant	North Falls Offshore Wind Farm Limited (NFOW).
The Project Or 'North Falls'	North Falls Offshore Wind Farm, including all onshore and offshore infrastructure.

1 Introduction

1. This appendix provides an assessment of potential auditory injury and disturbance effects on marine mammals during Unexploded Ordnance (UXO) clearance for the North Falls offshore project area. This assessment is provided with the Report to Inform Appropriate Assessment (RIAA) for information purposes only. A separate Marine Licence (ML) application for UXO clearance will be submitted post-consent, once detailed information on the locations and extent of UXO required to be cleared is known.

2 Worst case scenario

2. Table 2.1 sets out the realistic worst-case parameters for the marine mammal UXO assessment.

Table 2.1 Realistic worst-case parameters for marine mammal UXO assessment

Parameters	Notes and Rationale
Types and Sizes of UXO: Various possible types and sizes of UXO, ranging from 0.5kg to 750kg.	Indicative only. A detailed UXO survey would be completed prior to construction. The exact type, size and number of possible detonations and duration of UXO clearance operations is therefore not known at this stage.
Number of UXO requiring clearance: Estimated 40 (25 in the array area and 15 in the offshore cable corridor)	
Clearance techniques: Low-order clearance would be the first and preferred method for UXO that require clearance. As a worst-case, assessments are based on high-order clearance.	High-order clearance would only be undertaken in the event that low-order clearance is not possible, or failed to clear the device completely. This is therefore unlikely to be required, however, it is assessed as the worst-case.

3 North Falls mitigation and monitoring measures

3. As part of the separate licencing process, the Applicant would commit to a Marine Mammal Mitigation Plan (MMMP) and underwater noise modelling for UXO Clearance, as outlined in Table 3.1. The Applicant would also commit to a Site Integrity Plan (SIP) for the Southern North Sea (SNS) Special Area of Conservation (SAC) should there be a risk of exceeding disturbance thresholds for the SAC (discussed further in Table 3.1 below).

Table 3.1 UXO clearance mitigation and monitoring measures

Mitigation and Monitoring Measure	Additional Information
Marine Mammal Mitigation Plan (MMMP) for UXO Clearance	A detailed MMMP will be prepared for UXO clearance during the post-consent phase, during the ML application process. The MMMP for UXO clearance will ensure there are adequate mitigation measures to minimise the risk of any physical injury or permanent auditory damage to marine mammals as a result of UXO clearance. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation measures, based upon best available information and methodologies at that time. The MMMP for UXO clearance will be prepared in consultation with the Marine Management Organisation (MMO) and relevant Statutory Nature Conservation Bodies (SNCBs). The MMMP for UXO clearance will include details of all the required mitigation measures to minimise the potential risk of permanent threshold shift (PTS) as a result of underwater noise during UXO clearance, for example, this would consider the options, suitability and effectiveness of mitigation measures such as, but not limited to: • Low-order clearance techniques, such as deflagration; • The use of bubble curtains if any high-order detonation is required (taking into consideration the environmental limitations); • All UXO clearance to take place in daylight and in favourable conditions with good visibility (sea state 3 or less); • Establishment of a monitoring area with minimum of 1km radius; • The observation of the monitoring area will be by dedicated and Joint Nature Conservation Committee (JNCC) trained marine mammal observers (MMObs) during daylight hours and suitable visibility and sea state conditions; • The observation of the monitoring area using Passive Acoustic Monitoring (PAM) as an additional monitoring tool; • The activation of Acoustic Deterrent Device (ADDs); • The controlled explosions of the UXO will be undertaken by specialist contractors, using the minimum amount of explosive required in order to achieve safe disposal of the UXO; and • Other UXO clearance techniques, such as avoidance of UXO; or relocation of UXO. If more than one high-order detonation is required, other measures such as multiple detonations, if UXO are located in close proximity, will also be considered in consultation with the MMO and SNCBs. In the event that UXOs are not able to be avoided or removed for onshore disposal, the preferred method for UXO clearance would be a low-order clearance method. However, if high-order detonation is required the following measures are also proposed: • Use of a bubble curtain (if required, and taking into account environmental constraints). UXO is not included in the development consent order (DCO) application, as currently not enough detailed information is available. Therefore, UXO clearance will be in a separate ML post consent.
Site Integrity Plan (SIP) for the Southern North Sea Special Area of Conservation (SAC)	In addition to the MMMP for UXO clearance, a SIP for the Southern North Sea SAC will be developed (if required). The SIP will set out the approach to deliver any mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the Southern North Sea SAC Conservation Objectives. The SIP is an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the Southern North Sea SAC. In the event that UXOs are not able to be avoided or removed for onshore disposal, the preferred method for UXO clearance would be a low-order

Mitigation and Monitoring Measure	Additional Information
	clearance method. However, if high-order detonation is required the following measures are likely to be proposed in order to manage noise within the SAC: • Use of a bubble curtain (if required, and taking into account environmental constraints). • Only one high-order detonation would be detonated per day during UXO clearance operations, during the winter period (October to March). • There would be no UXO high-order detonations on the same day as piling during the winter period (October to March). The SIP will be developed in the pre-construction period, as part of the separate Marine Licencing process (if deemed to be required) and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and the MMO.
Underwater noise monitoring for UXO clearances	Underwater noise monitoring will be undertaken for all UXO clearances following the *Protocol for In-Situ Underwater Measurement of Explosive Ordnance Disposal for UXO* (National Physical Laboratory, 2020a).

4 Information to Support Habitat Regulation Assessment (HRA) for UXO clearance

4. The approach to a Habitat Regulation Assessment (HRA) for marine mammals is presented in Section 3 of the RIAA (document reference 7.1.3) outlining the definitions of adverse effects on integrity. Site overviews for the following screened-in UK and European SACs are also detailed in the RIAA:

   - Southern North Sea (SNS) SAC for harbour porpoise;
   - The Humber Estuary SAC for grey seal;
   - The Wash and North Norfolk Coast (TW & NNC) SAC for harbour seal; and
   - 27 European sites along the French, Belgian, Dutch and German coast for harbour porpoise, grey seal and/or harbour seal.

5. The approach to define the potential for adverse effect on the integrity of the site is based on the approach set out within Section 3.3.1 of the RIAA Part 3 (document reference 7.1.3), and is therefore as follows:

   - For temporary effects, there would be potential for an adverse effect on the integrity of the site, if there is an effect to 5% or more of the population; and
   - For permanent effects, there would be potential for an adverse effect on the integrity of the site, if there is an effect to 1% of more of the population.

4.1 Potential effects to marine mammals from UXO clearance

6. It is important to note, the assessments for UXO clearance are for information only and are not secured as part of the DCO application. A separate ML application will be submitted when a detailed UXO survey has been completed prior to construction, and a detailed assessment based on that latest available information (including potential UXO locations, size, type, and number) has been undertaken.

7. Prior to construction, there is the potential for UXO clearance to be required. While any identified UXO will either be avoided or removed and disposed of onshore in a designated place, there is the potential that underwater detonation could be required where it is necessary and unsafe to remove the UXO.

8. A detailed UXO survey will be completed prior to construction. Therefore, the number of possible UXO that may be required to clear, along with the duration of UXO clearance operations is currently unknown.

9. For the assessment, a conservative estimate has been made, based on the best available information from other offshore wind farm UXO clearance operations nearby, and other published information. It is not currently known the size or type of the UXO that could be present, therefore a range of sizes has been assessed, with the maximum charge weight of up to 750kg Net Explosive Quantity (NEQ).

10. When an item of UXO detonates on the seabed underwater, several effects are generated, most of which are localised at the point of detonation, such as crater formation and movement of sediment and dispersal of nutrients and contaminants. After detonation, there is the rapid expansion of gaseous products known as the “bubble pulse”. Once it reaches the surface, the energy of the bubble is dissipated in a plume of water and the detonation shock front rapidly attenuates at the water/air boundary. Fragmentation (that is shrapnel from the weapon casing and surrounding seabed materials) is also ejected but does not pose a significant hazard beyond 10m from source.

11. The potential effects of underwater explosions on marine mammals include: (i) physical injury from direct or indirect blast wave effect of the high amplitude shock waves and sound wave produced by underwater detonation, which could result in immediate or eventual mortality; (ii) auditory impairment (from exposure to the acoustic wave), resulting in a temporary or permanent loss in hearing sensitivity such as temporary threshold shift (TTS) or PTS; or (iii) behavioural change, such as disturbance to feeding, mating, breeding, and resting (Richardson *et al.,* 1995; Ketten, 2004; von Benda-Beckmann *et al.,* 2015).

12. The severity of the consequences of UXO detonation will depend on many variables, but principally, on the charge weight and its proximity to the receptor. After detonation, the shock wave will expand spherically outwards and will propagate outwards (i.e. line of sight), unless the wave is reflected, channelled or meets an intervening obstruction.

13. There are limited acoustic measurements for underwater explosions, and there can be large differences in the noise levels, depending on the charge size, as well as water depth, bathymetry and seabed sediments at the site, which can also influence noise propagation. The water depth in which the explosion occurs has a significant influence on the effect range for a given charge mass (von Benda-Beckmann *et al.,* 2015).

14. It is important to note that assessments are based on the worst-case for high-order UXO detonations with no mitigation, which is highly unlikely, as the preferred and first option for any UXO requiring detonation would be a low-order clearance method.

4.2 Underwater noise modelling for UXO clearance

15. A number of UXOs with a range of charge weights (or quantity of contained explosive) could be located within the offshore project area. There is the potential for there to be a variety of explosive types, which will have been subject to degradation and burying over time. Two otherwise identical explosive devices are therefore likely to produce different blasts if one has been subject to different environmental factors.

16. The Galloper Wind Farm UXO clearance report includes detonation of the UXO devices (and sizes) as shown in Table 4.1.

17. A selection of explosive sizes has been considered in the estimation of the underwater noise levels produced by detonation of UXO (Table 4.1). The assessment assumes the maximum explosive charge (see the ES Appendix 12.3, Volume III).

Table 4.1 Selection of UXO potentially present at North Falls (data on UXO from Galloper Wind Farm is taken from Innogy Renewables UK Limited, 2019)

UXO devices potentially present (based on those found within Galloper Wind Farm)	UXO sizes potentially present (based on those found within Galloper Wind Farm)	NEQ for UXO devices included within the following assessment
– German E-Series sub-marine land buoyant mine – German LMB ground mine – Air delivered ground mine or explosive bomb – British buoyant mine – Allied (high) explosive device – Naval Projectiles – Torpedo bomb – Mortar Mk10 anti-submarine projectile or squid device	– 50kg – 250lb (113kg) – 500lb (227kg) – 1,000lb (454kg)	– 25kg – 55kg – 120kg – 240kg – 525kg – 750kg

4.2.1 Background to underwater noise

18. The noise produced by the detonation of explosives is affected by a number of different elements (e.g. its design, composition, age, position, orientation, whether it is covered by sediment) which are unknown and cannot be directly considered in an assessment. This leads to a high degree of uncertainty in the estimation of the source noise level (i.e. the noise level at the position of the UXO). A worst-case estimation has therefore been used for calculations, assuming that the UXO to be detonated is not buried, degraded or subject to any other significant attenuation. The consequence of this is that the noise levels produced, particularly by the larger explosives under consideration, are likely to be over-estimated as they are likely to be covered by sediment and degraded.

19. The assessment also does not take into account the variation in the noise level at different depths. Where animals are swimming near the surface, the acoustics at the surface cause the noise level, and hence the exposure, to be lower at this position compared to deeper waters. The risk to animals near the surface may therefore be lower than indicated by the range estimate and therefore this can be considered conservative in respect of impact at different depths.

20. The potential impact has been assessed based on the latest Southall *et al.* (2019) thresholds and criteria for marine mammals that could be present in the area. The thresholds indicate the point at which there is an increase in risk of permanent hearing damage in an underwater receptor (although not all individuals within the maximum PTS range will have permanent hearing damage; this is assumed as a worst-case scenario).

21. The Sound Exposure Level (SEL) criteria are weighted, which takes into account the sound level based on the sensitivity of the receiver, for example, harbour porpoise *Phocoena phocoena* are less sensitive to low frequency sound than minke whales *Balaenoptera acutorostrata*. Southall *et al.* (2019) also includes criteria based on peak Sound Pressure Level (SPL_{peak}), which are unweighted and do not take species hearing sensitivity into account.

22. Both SPL_{peak} and SEL values based on the impulsive and non-impulsive criteria are included in the assessments. However, it is important to note that they are different criteria and as such they should not be compared directly. All decibel SPL values are referenced to 1 µPa and all SEL values are referenced to 1 μPa^2s.

23. Peak noise levels are difficult to predict accurately in a shallow water environment (von Benda Beckmann *et al.,* 2015) and would tend to be significantly over-estimated by the modelling over increased distances from the source. With increased distance from the source, impulsive noise, such as UXO detonation, noise becomes more of a non-impulsive noise, unfortunately it is currently difficult to determine the distance at which an impulsive noise becomes more like a non-impulsive noise. Therefore, modelling was conducted using both the impulsive and non-impulsive criteria for PTS weighted SEL to give an indication of the difference between maximum potential impact ranges (see Appendix 12.3, Volume III).

24. Impulsive noise sources are described as having a rapid rise time, short duration and high peak pressure. A study into the distance at which underwater noise sources (from offshore wind farm piling and seismic surveys) 'transformed' from an impulsive to a non-impulsive noise revealed that, at a distance of between 2 and 3km the noise sources no longer contained the characteristics (in particular a high enough peak pressure) to be classed as an impulsive noise (Hastie *et al.,* 2019). However, this study was completed in a shallow water environment, with a relatively flat seabed, and the actual range at which a sound source transforms into a non-impulsive noise is likely to be dependent on a number of environmental variables and other sound source characteristics (Hastie *et al.,* 2019).

25. The work by Hastie *et al.* (2019) is preliminary work, and Martin *et al.* (2020) suggest that the change in noise characteristics from impulsive to non-impulsive does not make a difference to assessment of injury because sounds retain impulsive character when SPLs are above effective quiet threshold (EQT). However, as outlined in the Hornsea Project Four Environmental Statement Chapter 4 (Orsted, 2021), some of the results presented by Martin *et al.* (2020) indicate that some of the piling sound loses its impulsiveness with increasing distance from the piling site, therefore the sound loses its harmful impulsive characteristics with increased distance.

4.2.2 UXO clearance techniques

26. All assessments have been based on the worst-case scenario and maximum predicted effect ranges for impulsive thresholds.

27. Low-order clearance techniques, where the ordnance is disposed of or rendered safe without a high-order detonation, is the preferred option for UXO clearance. Examples of low-order clearance techniques include (NPL, 2020b):

- Freezing the munition to render it inactive;
- Water abrasive suspension cutting in order to physically disrupt the munition;
- Disposal in a Static Detonation Chamber;
- Photolytic destruction of the munition; and
- Low-order deflagration.

28. Deflagration is a technique whereby the explosive within the UXO is rapidly burned at subsonic speeds using plasma from a small-shaped charge that generates insufficient shock to detonate the UXO (Merchant and Robinson, 2020; NPL, 2020b). The explosive material inside the UXO reacts with a rapid burning rather than a chain reaction that would lead to a full explosion (NPL, 2020b).

29. Substantial noise reduction for deflagration over high-order (SPL_{peak} and SEL are more than 20 dB lower) and acoustic output for deflagration depends only on the size of the shaped charge (rather than the size of the UXO) (NPL, 2020b; Robinson *et al.,* 2020).

30. The technique of low-order clearance appears to present a viable option to avoid high-order explosive detonation. Low-order clearance techniques, such as deflagration, are relatively new to civilian applications but have been used by the UK military since 2005 (Merchant and Robinson, 2020). However, a number of UK offshore wind farms have successfully implemented low-order clearance to date.

31. The Moray West Offshore Wind Farm recently undertook a large scale UXO clearance campaign that utilised only low-order deflagration. This method proved successful for all 82 UXO that required clearing, including the largest device with a NEQ of 700kg (Ocean Winds, 2024).

32. In the unlikely event that low order clearance was unsuccessful or deemed unsuitable for a specific UXO (e.g., due to its condition), high-order clearance may be undertaken. Therefore, as a worst-case, high-order detonations have been considered, alongside low-order clearance.

4.2.3 Underwater noise modelling methodology

33. The range of equivalent charge weights for the potential UXO devices that could be present within the North Falls boundaries have been estimated as 25kg, 55kg, 120kg, 240kg, 525kg and 750kg for high-order detonation.

34. In addition, low-order clearance (such as deflagration) has been assessed, which assumes that the donor or shaped charge (donor charge weight of 0.5kg) detonates fully but without the follow-up high-order detonation of the UXO.

35. Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014), which follows Arons (1954) and Marine Technical Directorate (MTD) (1996) (see Appendix 12.3, Volume III).

36. Table 4.2 provides the source level used for the underwater noise modelling (further details on how these were calculated is provided in Appendix 12.3, Volume III).

Table 4.2 Source levels (unweighted SPL_{peak} and SEL_{ss}) used for UXO modelling

Charge weight (NEQ)	0.5kg	25kg + donor charge	55kg + donor charge	120kg + donor charge	240kg + donor charge	525kg + donor charge	750kg + donor charge
SPL_{peak} source level (dB re 1 µPa @ 1m)	272.1	284.9	287.5	290.0	292.3	294.8	296.0
SEL_{ss} source level (dB re 1 μPa^2s @ 1m)	217.1	228.0	230.1	232.3	234.2	236.4	237.3

37. See the ES Appendix 12.3 (Volume III) for more detail on the underwater noise modelling methodologies.

4.3 Southern North Sea SAC

38. The SNS SAC covers an area of 36,951km^2, with both winter and summer habitats of importance to harbour porpoise (JNCC, 2017). Approximately 27,028km^2 of the site is important in the summer period (183 days from April to September inclusive) and 12,696km^2 of the site is important in the winter period (182 days from October to March inclusive) (JNCC *et al.*, 2020). The majority of the site is less than 40m in depth, reaching up to 75m in the northernmost areas.

39. The North Falls array area is fully within the winter area of the SNS SAC, and the offshore cable corridor is partly within the winter area of the SAC.

40. For harbour porpoise, the reference population is 338,918 (NS MU population; see Section 3.4.1 in the RIAA (document reference 7.1.3)) and the density estimates for the SNS SAC are the worst case estimates gained from the site specific surveys which was the average winter estimate of 3.217/km^2 see Table 3.6 in the RIAA (document reference 7.1.3)).

4.3.1 Impact 1: Auditory injury due to underwater noise associated with UXO clearance

41. See Table 4.3 for details on the effect ranges in which there is a potential for permanent auditory injury.

Table 4.3 Potential maximum impact ranges (and areas) of PTS for harbour porpoise during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km^2))		
	PTS SPL_{peak} Unweighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Non-impulsive criteria)
Harbour porpoise (Very High Frequency (VHF) cetacean)			
Threshold level	**202 dB re 1 µPa**	**155 dB re 1 µPa^{2}s**	**173 dB re 1 µPa^{2}s**
0.5kg (low-order clearance)	**1.2km (4.5km^2)**	0.11km (0.04km^2)	<0.05km (0.008km^2)
25kg + donor charge	4.6km (66.5km^2)	0.57km (1.02km^2)	<0.05km (0.008km^2)
55kg + donor charge	6.0km (113.1km^2)	0.74km (1.7km^2)	<0.05km (0.008km^2)
120kg + donor charge	7.8km (191.1km^2)	0.95km (2.8km^2)	0.07km (0.02km^2)
240kg + donor charge	9.8km (301.7km^2)	1.1km (3.8km^2)	0.10km (0.03km^2)
525kg + donor charge	12km (452.4km^2)	1.4km (6.2km^2)	0.13km (0.05km^2)
750kg + donor charge	**14km (615.8km^2)**	1.5km (7.07km^2)	0.16km (0.08km^2)

42. The assessment concludes that the potential for PTS from a high-order UXO detonation (up to 750kg NEQ) and low-order clearance (0.5kg) would affect 0.58% and 0.004% of the harbour porpoise SNS SAC population respectively (Table 4.4).

Table 4.4 Assessment of the potential for PTS during high (750kg + donor charge) and low (0.5kg) order UXO clearance activities

Species	Criteria	Maximum effect range (and area)	Maximum number of individuals	% of SAC population
Harbour porpoise	PTS SPL_{peak} (unweighted, impulsive)	High-order detonation (750kg (NEQ) + donor charge) 14km (615.8km^2)	1,981 (based on the worst-case HiDef survey density for the winter period of 3.217/km^2)	0.58% NS MU
		Low-order clearance (0.5kg (NEQ)) 1.2km (4.5km^2)	15 (based on the worst-case HiDef survey density for the winter period of 3.217/km^2)	0.004% NS MU

Summary

43. The potential for PTS from UXO clearance activities would effect less than 1% of the harbour porpoise NS MU population. Therefore, there would be no adverse effect of PTS on harbour porpoise from UXO clearance on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise (outlined in the Section 3.4.2 of the RIAA (document reference 7.1.3)).

4.3.2 Impact 2: Disturbance due to underwater noise associated with UXO clearance

4.3.2.1 Disturbance due to UXO clearance underwater noise

Assessment against the North Sea MU population

44. The potential for disturbance, based on a 26km EDR during a high-order UXO clearance (Table 4.5), or for a 5km disturbance range during low-order UXO clearance (Table 4.6) would temporarily impact less than 5% of the harbour porpoise SNS SAC population.

Table 4.5 Estimated number of harbour porpoise that could potentially be disturbed during UXO clearance based on 26km EDR for high-order detonation with no mitigation

Species	Maximum effect area	Maximum number of individuals	% of reference population
Harbour porpoise	2,123.7km^2	6,832 (based on the worst-case HiDef survey density for the winter period of 3.217/km^2)	2.02% NS MU

Table 4.6 Estimated number of harbour porpoise that could potentially be disturbed during low-order UXO clearance based on 5km disturbance range

Species	Maximum effect area	Maximum number of individuals	% of reference population
Harbour porpoise	78.54km^2	253 (based on the worst-case HiDef survey density for the winter period of 3.217/km^2)	0.07% NS MU

45. As less than 5% of the harbour porpoise NS MU population would temporarily be at risk of potential to disturbance, there would therefore be no adverse effect from disturbance on harbour porpoise from UXO clearance on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise (the conservation objectives for the SNS SAC are outlined in Section 3.4.2. of the RIAA (document reference 7.1.3)).

Spatial assessment

46. If one high-order UXO detonation was undertaken per day, there would be a maximum overlap of 2,055.5km^2 within the SNS SAC winter area, or approximately 16.19% of the winter area (Table 4.7).

47. For one low-order detonation, the maximum overlap area of disturbance would be 78.54km^2 which would be approximately 0.62% of the winter area (Table 4.7).

Table 4.7 Estimated overlaps with the SNS SAC winter area from UXO clearance at North Falls

EDR	Maximum area of overlap with SNS SAC winter area (% of SNS SAC winter area)	Minimum area of overlap with SNS SAC winter area (% of SNS SAC winter area)	Potential adverse effect on site integrity
26km for high-order UXO clearance	2,055.5km^2 (16.19%)	1,789.2km^2 (14.09%)	No Temporary effect. Displacement of harbour porpoise would not exceed 20% of the seasonal component of the SNS SAC area on any given day during UXO clearance at North Falls based on a single clearance per day.
5km for low-order UXO clearance	78.54km^2 (0.62%)	78.54km^2 (0.62%)	

48. The assessment indicates that for both high and low-order UXO clearance, less than 20% of the winter area of the SNS SAC would be affected.

49. Therefore there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise from UXO clearance at North Falls.

Seasonal average assessment

50. The seasonal averages have been calculated by multiplying the average area on any one day by the proportion of days within the season on which UXO clearance could occur. Based on the worst case scenario, as presented in section 2, a total 40 UXO clearances are estimated, and it is assumed there will be one UXO clearance per day; therefore, a total of 40 days (Table 4.8). It is assumed the majority of the detonations will be low order clearances, therefore 90% of the days have been assessed as potentially being a low order clearance.

Table 4.8 Estimated seasonal averages with the SNS SAC summer and winter areas from UXO clearance at North Falls

UXO clearance type	Average overlap with seasonal area	Number of UXO clearance days within North Falls	In-combination assessment scenario
High-order clearance	1,922.4km^2 (15.14%)	4	0.33%
Low-order clearance	78.54km^2 (0.62%)	36	0.12%

51. The assessment indicates that for both high and low-order UXO clearance, less than 10% of the winter area of the SNS SAC would be affected.

52. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise from UXO clearance at North Falls.

4.3.2.2 Disturbance from ADD activation

Assessment against the North Sea MU population

53. For high-order clearance, an ADD would be activated for a maximum of approximately 80 minutes, during which harbour porpoise would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000).

54. For low-order clearance, ADD would be activated for approximately 14 minutes, during which harbour porpoise would move at least 1.26km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000).

55. These maximum deterrence ranges have been assessed as a disturbance range for harbour porpoise. The area of disturbance is based on these potential disturbance ranges as a radius of a circular area. It should be noted that this is not an additive disturbance effect, as the disturbance from any ADD activation would be wholly within the area of disturbance from the UXO clearance itself.

56. As seen in Table 4.9, less than 5% of the harbour porpoise NS MU population would temporarily be at risk of potential to disturbance. Therefore, there would be no adverse effect from disturbance on harbour porpoise from ADD activation during UXO clearance on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise (outlined in Section 3.4.2. of the RIAA (document reference 7.1.3)).

Table 4.9 Estimated number of harbour porpoise that could potentially be disturbed during ADD activation for UXO clearance

Species	Low-order clearance [up to 14 minutes]		High-order detonation [up to a maximum of 80 minutes]	
	Number of individuals potentially disturbed	% of SAC population	Number of individuals potentially disturbed	% of SAC population
Harbour porpoise	17 (based on the worst-case HiDef survey density for the winter period of 3.217/km^2)	0.005% NS MU	524 (based on the worst-case HiDef survey density for the winter period of 3.217/km^2)	0.15% of NS MU

4.3.3 Impact 3: Changes to prey availability as a result of underwater noise from UXO clearance activities

57. The diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.,* 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes in prey resources.

58. Chapter 11 Fish and Shellfish Ecology assessed the potential impact of underwater noise and vibration as a result of UXO clearance activities to fish species. Physical injury/trauma would be expected in close proximity to the detonation (tens to hundreds of meters, depending on charge) with TTS and behavioural impacts potentially occurring at greater distances. In all cases, however, high risks are only anticipated at short distances. Taking this into consideration and the short term and intermittent nature of this activity (limited to instances when detonation of UXO is required), the magnitude of the impact is considered to be negligible for fish species.

59. Therefore, the magnitude of effect for changes to prey resources as a result of UXO clearance activity, has been assessed as negligible for all marine mammal species.

60. The predicted impact would be insignificant given the short-term and temporary nature of UXO clearances. The effects of changes to prey would have no adverse effects on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise for North Falls.

4.4 The Humber Estuary SAC

61. The Humber Estuary SAC is located at a distance of 230km from the closest point at North Falls. Therefore, there is no potential for direct effects on the SAC itself as a result of UXO clearance activities at North Falls. However, due to the foraging range of grey seals (448km) (Carter *et al*., 2022), there is the potential for effects on foraging seals from the Humber Estuary SAC in the vicinity of North Falls.

62. The grey seal density estimate for North Falls has been calculated from the latest seal at sea maps produced by (Carter *et al.,* 2022), based on the 5km x 5km grids that overlap with each area (see the ES Appendix 12.2, Volume III), and using the density data for the Humber Estuary SAC. This effectively apportions the potential for effect to only those seals that are associated with the SAC itself.

63. For grey seal, the reference population is 15,495 (SAC population; see Table 3-51 in the RIAA (document reference 7.1.3)) and the mean at sea relative density estimates for the Humber Estuary SAC are:

- 0.005 grey seal/km^2 for the array area; and
- 0.013 grey seal/km^2 for the cable corridor.

4.4.1 Impact 1: Auditory injury due to underwater noise associated with UXO clearance

4.4.1.1 PTS from UXO clearance

64. See Table 4.10 for details on the effect ranges in which there is a potential for permanent auditory injury.

Table 4.10 Potential maximum impact ranges (and areas) of PTS for grey seal during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km^2))		
	PTS SPL_{peak} Unweighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Non-impulsive criteria)
Grey seal (Phocid Carnivores in Water (PCW))			
Threshold level	**218 dB re 1 µPa**	**185 dB re 1 μPa^2s**	**201 dB re 1 μPa^2s**
0.5kg (low-order clearance)	0.24km (0.18km^2)	0.06km (0.01km^2)	<0.05km (0.008km^2)
25kg + donor charge	0.91km (2.60km^2)	0.39km (0.48km^2)	<0.05km (0.008km^2)
55kg + donor charge	1.1km (3.80km^2)	0.57km (1.02km^2)	<0.05km (0.008km^2)
120kg + donor charge	1.5km (7.1km^2)	0.83km (2.2km^2)	<0.05km (0.008km^2)
240kg + donor charge	1.9km (11.3km^2)	1.1km (3.8km^2)	0.07km (0.02km^2)
525kg + donor charge	2.5km (19.6km^2)	1.6km (8.0km^2)	0.10km (0.03km^2)
750kg + donor charge	2.8km (24.6km^2)	2.0km (12.6km^2)	0.12km (0.05km^2)

65. An assessment of the maximum number of individuals that could be at risk of PTS, for a high-order UXO detonation (up to 750kg NEQ), and low-order clearance (0.5kg) for grey seal associated with the Humber Estuary SAC is presented in Table 4.11.

Table 4.11 Assessment of the potential for PTS during high (750kg + donor charge) and low (0.5kg) order UXO clearance activities

Species	Criteria	Maximum effect range (and area)	Maximum number of individuals	% of SAC population
Grey seal	PTS SPL_{peak} (unweighted, impulsive)	High-order detonation (750kg (NEQ) + donor charge) 2.8km (24.6km^2)	0.3 (based on the SAC specific offshore cable corridor density of 0.013/km^2)	0.002% of Humber Estuary SAC population
			0.1 (based on the SAC specific array area density) of 0.005/km^2)	0.0008% of Humber Estuary SAC population
		Low-order clearance (0.5kg (NEQ)) 0.24km (0.18km^2)	0.002 (based on the SAC specific offshore cable corridor density of 0.013/km^2)	0.00002% of Humber Estuary SAC population
			0.0009 (based on the SAC specific array area density) of 0.005/km^2)	0.000006% of Humber Estuary SAC population

Summary

66. The potential for PTS from a high-order UXO detonation (up to 750kg NEQ), and low-order clearance (0.5kg) would effect less than 1% of the grey seal Humber Estuary SAC population.

67. Therefore, there would be no adverse effect of PTS from UXO clearance activities on the integrity of the Humber Estuary SAC for grey seal in relation to the conservation objectives outlined in Section 3.5.2 of the RIAA (document reference 7.1.3).

4.4.1.2 Impact 2: Disturbance due to underwater noise associated with UXO clearance

4.4.1.3 Disturbance from UXO clearance

68. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals. However, a fleeing response is assumed to occur at the same noise levels as TTS for high-order UXO detonation. The use of the TTS threshold is appropriate for UXO disturbance, as the noise from the UXO explosion is only fleetingly in the environment.

69. There would be only one high-order UXO detonation at a time during UXO clearance operation, i.e., there would be no simultaneous high-order UXO detonations. Although, more than one UXO clearance (low order) could occur in a 24-hour period.

70. Based on the worst-case modelled TTS ranges (Table 4.12), the estimated number of grey seal and percentage of the Humber Estuary SAC that could be disturbed as a result of UXO clearance activities at North Falls is presented in Table 4.13.

Table 4.12 Potential maximum impact ranges (and areas) of TTS for grey seal during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km^2))		
	TTS SPL_{peak} Unweighted (Impulsive criteria)	TTS SEL_{ss} Weighted (Impulsive criteria)	TTS SEL_{ss} Weighted (Non-impulsive criteria)
Grey seal (PCW)			
Threshold level	**212 dB re 1 µPa**	**170 dB re 1 μPa^2s**	**181 dB re 1 μPa^2s**
0.5kg (low-order clearance)	0.45km (0.64km^2)	**0.8km (2.01km^2)**	0.11km (0.04km^2)
25kg + donor charge	1.6km (8.04km^2)	5.2km (84.95 km^2)	0.79km (2.0km^2)
55kg + donor charge	2.1km (13.85km^2)	7.5km (176.72km^2)	1.1km (3.8km^2)
120kg + donor charge	2.8km (24.63km^2)	10km (314.16km^2)	1.6km (8.0km^2)
240kg + donor charge	3.5km (38.49km^2)	14km (615.75km^2)	2.3km (16.6km^2)
525kg + donor charge	4.6km (66.48km^2)	19km (1,134.12km^2)	3.3km (34.2km^2)
750kg + donor charge	5.1km (81.7km^2)	**22km (1,520.53km^2)**	4km (50.3km^2)

Table 4.13 Estimated number of seals that could potentially be disturbed during low-order UXO clearance based on modelled TTS ranges

Species	Maximum effect area	Maximum number of individuals	% of SAC population
Grey seal	High-order detonation (750kg (NEQ) + donor charge) 22km (1,520.5km^2)	20 (based on the SAC specific offshore cable corridor density of 0.013/km^2)	0.13% of Humber Estuary SAC population
		8 (based on the SAC specific array area density) of 0.005/km^2)	0.05% of Humber Estuary SAC population
	Low-order clearance (0.5kg (NEQ)) 0.8km (2.01km^2)	0.03 (based on the SAC specific offshore cable corridor density of 0.013/km^2)	0.0002% of Humber Estuary SAC population
		0.01 (based on the SAC specific array area density) of 0.005/km^2)	0.00006% of Humber Estuary SAC population

4.4.1.4 Disturbance from ADD activation

71. The MMMP for UXO clearance will include ADD activation prior to all UXO clearance, where the duration of ADD activation will be determined for the final MMMP for UXO clearance. As such, assessments provided below are for information purposes only.

72. The ADD would only be activated for the minimum time required to ensure effective mitigation. The disturbance as a result of ADD activation is within the maximum effect range assessed for TTS / disturbance from UXO clearance and is therefore not an additive effect to the overall area of potential disturbance.

73. For low-order clearance, the ADD would be activated for 14 minutes, during which grey seal would move at least 1.26km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000). For high-order clearance, an ADD would be activated for a maximum of 80 minutes, during which grey seal would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000).

74. These maximum deterrence ranges have been assessed as a disturbance range for each species. The area of disturbance is based on these potential disturbance ranges as a radius of a circular area.

75. An assessment for the maximum number of individuals that could be potentially disturbed from the effect of ADD activation prior to UXO clearance is presented in Table 4.14.

Table 4.14 Estimated number of seals that could potentially be disturbed during ADD activation for UXO clearance

Species	Low-order clearance [up to 14 minutes]		High-order detonation [up to a maximum of 80 minutes]	
	Number of individuals potentially disturbed	% of SAC population	Number of individuals potentially disturbed	% of SAC population
Grey seal	0.06 (based on the SAC specific offshore cable corridor density of 0.013/km^2)	0.0004% of Humber Estuary SAC population	3 (based on the SAC specific offshore cable corridor density of 0.013/km^2)	0.02% of Humber Estuary SAC population
	0.03 (based on the SAC specific array area density) of 0.005/km^2)	0.0002% of Humber Estuary SAC population	0.8 (based on the SAC specific array area density) of 0.005/km^2)	0.005% of Humber Estuary SAC population

Summary

76. The potential for temporary disturbance would impact less than 5% of the grey seal Humber Estuary SAC population.

77. Therefore, there would be no adverse effect of disturbance from UXO clearance activities on the integrity of the Humber Estuary SAC for grey seal in relation to the conservation objectives outlined in Section 3.5.2 of the RIAA (document reference 7.1.3).

4.4.2 Impact 3: Changes to prey availability as a result of underwater noise from UXO clearance activities

78. Grey seal feed on a variety of prey species, and are considered to be opportunistic feeders, feeding on wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges (see Appendix 12.2, Volume III).

79. ES Chapter 11 Fish and Shellfish Ecology (Volume I) provides an assessment of the impact pathways of underwater noise and vibration as a result of UXO clearance activities on the relevant fish and shellfish species. The assessment found in all cases that high risks are only anticipated at short distances. Taking this into consideration as well as the short term and intermittent nature of this activity (limited to instances when detonation of UXO is required) the pathways of effect is considered to be negligible in EIA terms for fish species.

80. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment on changes in prey availability associated with UXO clearances at North Falls would be localised and short in duration and would therefore be unlikely to affect grey seals associated with the Humber Estuary SAC.

81. Taking into account the separation distance of North Falls from the Humber Estuary SAC, with no potential for any direct effect on the SAC itself, there would be no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives (outlined in Section 3.5.2 of the RIAA (document reference 7.1.3)) as a result of any changes to prey availability during construction for North Falls.

4.5 The Wash and North Norfolk Coast SAC

82. TW & NNC SAC is located 150km from the closest point of North Falls. Therefore, there is no potential for direct effects on the SAC as a result of UXO clearance activities. However, due to the foraging range of harbour seals (of up to 273km) (Carter *et al*., 2022), there is the potential for effects on foraging seals associated with TW & NNC SAC.

83. The harbour seal density estimate for North Falls has been calculated from the latest seal at sea maps produced by (Carter *et al.,* 2022), based on the 5km x 5km grids that overlap with each area (see the ES Appendix 12.2, Volume III), and using the density data for TW & NNC SAC. This effectively apportioned the potential for effect to only those seals that are associated with the SAC itself.

84. For harbour seal, the reference population is 3,956 (SAC population, see Table 3-76 in HRA RIAA (document reference 7.1.3)) and the mean at sea relative density estimates for the TW & NNC SAC are:

- 0.000010 harbour seal/km^2 for the array area; and
- 0.0011 harbour seal/km^2 for the cable corridor.

4.5.1 Impact 1: Auditory injury due to underwater noise associated with UXO clearance

4.5.1.1 PTS from UXO clearance

85. See Table 4.15 for details on the effect ranges in which there is a potential for permanent auditory injury.

Table 4.15 Potential maximum impact ranges (and areas) of PTS for harbour seal during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km^2))		
	PTS SPL_{peak} Unweighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Non-impulsive criteria)
Harbour seal (Phocid Carnivores in Water (PCW))			
Threshold level	**218 dB re 1 µPa**	**185 dB re 1 µPa^{2}s**	**201 dB re 1 µPa^{2}s**
0.5kg (low-order clearance)	**0.24km (0.18km^2)**	0.06km (0.01km^2)	<0.05km (0.008km^2)
25kg + donor charge	0.91km (2.60km^2)	0.39km (0.48km^2)	<0.05km (0.008km^2)
55kg + donor charge	1.1km (3.80km^2)	0.57km (1.02km^2)	<0.05km (0.008km^2)
120kg + donor charge	1.5km (7.1km^2)	0.83km (2.2km^2)	<0.05km (0.008km^2)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km^2))		
	PTS SPL_{peak} Unweighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Impulsive criteria)	PTS SEL_{ss} Weighted (Non-impulsive criteria)
240kg + donor charge	1.9km (11.3km^2)	1.1km (3.8km^2)	0.07km (0.02km^2)
525kg + donor charge	2.5km (19.6km^2)	1.6km (8.0km^2)	0.10km (0.03km^2)
750kg + donor charge	**2.8km (24.6km^2)**	2.0km (12.6km^2)	0.12km (0.05km^2)

86. An assessment of the maximum number of individuals that could be at risk of PTS, for a high-order UXO detonation (up to 750kg NEQ), and low-order clearance (0.5kg), for harbour seal associated with TW & NNC SAC is presented in Table 4.16.

Table 4.16 Assessment of the potential for PTS during high (750kg + donor charge) and low (0.5kg) order UXO clearance activities

Species	Criteria	Maximum effect range (and area)	Maximum number of individuals	% of SAC population
Harbour seal	PTS SPL_{peak} (unweighted, impulsive)	High-order detonation (750kg (NEQ) + donor charge) 2.8km (24.6km^2)	0.03 (based on the SAC specific offshore cable corridor density of 0.0011/km^2)	0.0007% of TW & NNC SAC population
			0.0003 (based on the SAC specific array area density of 0.000010/km^2)	0.000006% of TW & NNC SAC population
		Low-order clearance (0.5kg (NEQ)) 0.24km (0.18km^2)	0.0002 (based on the SAC specific offshore cable corridor density of 0.0011/km^2)	0.000005% of TW & NNC SAC population
			0.000002 (based on the SAC specific array area density of 0.000010/km^2)	<0.0000001% of TW & NNC SAC population

Summary

87. The potential for PTS from a high-order UXO detonation (up to 750kg NEQ), and low-order clearance (0.5kg) would affect less than 1% of the harbour seal TW & NNC SAC population.

88. Therefore, there would be no adverse effect of PTS from UXO clearance activities on the integrity of TW & NNC SAC for harbour seal in relation to the conservation objectives outlined in 3.6.2 of the RIAA (document reference 7.1.3).

4.6 Impact 2: Disturbance due to underwater noise associated with UXO clearance

4.6.1 Disturbance from UXO clearance

89. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals. However, a fleeing response is assumed to occur at the same noise levels as TTS for high-order UXO detonation. The use of the TTS threshold is appropriate for UXO disturbance, because the noise from the UXO explosion is only fleetingly in the environment.

90. Based on the worst-case modelled TTS ranges (Table 4.17), the estimated number of harbour seal and percentage of TW & NNC SAC reference population that could be disturbed as a result of UXO clearance activities at North Falls is presented in Table 4.18.

Table 4.17 Potential maximum impact ranges (and areas) of TTS for harbour seal during UXO clearance (the maximum potential impact range and area for each species used in assessments are shown in bold)

Potential maximum charge weight (NEQ)	Maximum predicted impact range (km) (and area (km^2))		
	TTS SPL_{peak} Unweighted (Impulsive criteria)	TTS SEL_{ss} Weighted (Impulsive criteria)	TTS SEL_{ss} Weighted (Non-impulsive criteria)
Harbour seal (PCW)			
Threshold level	**212 dB re 1 µPa**	**170 dB re 1 μPa^2s**	**181 dB re 1 μPa^2s**
0.5kg (low-order clearance)	0.45km (0.64km^2)	**0.8km (2.01km^2)**	0.11km (0.04km^2)
25kg + donor charge	1.6km (8.04km^2)	5.2km (84.95 km^2)	0.79km (2.0km^2)
55kg + donor charge	2.1km (13.85km^2)	7.5km (176.72km^2)	1.1km (3.8km^2)
120kg + donor charge	2.8km (24.63km^2)	10km (314.16km^2)	1.6km (8.0km^2)
240kg + donor charge	3.5km (38.49km^2)	14km (615.75km^2)	2.3km (16.6km^2)
525kg + donor charge	4.6km (66.48km^2)	19km (1,134.12km^2)	3.3km (34.2km^2)
750kg + donor charge	5.1km (81.7km^2)	**22km (1,520.53km^2)**	4km (50.3km^2)

Table 4.18 Estimated number of seals that could potentially be disturbed during low-order UXO clearance based on modelled TTS ranges

Species	Maximum effect area	Maximum number of individuals	% of SAC population
Harbour seal	High-order detonation (750kg (NEQ) + donor charge) 22km (1,520.5km^2)	2 (based on the SAC specific offshore cable corridor density of 0.0011/km^2)	0.05% of TW & NNC SAC population
		0.02 (based on the SAC specific array area density of 0.000010/km^2)	0.0004% of TW & NNC SAC population
	Low-order clearance (0.5kg (NEQ)) 0.8km (2.01km^2)	0.002 (based on the SAC specific offshore cable corridor density of 0.0011/km^2)	0.00006% of TW & NNC SAC population

Species	Maximum effect area	Maximum number of individuals	% of SAC population
		0.00002 (based on the SAC specific array area density of 0.000010/km^2)	0.0000005% of TW & NNC SAC population

4.6.2 Disturbance from ADD activation

91. For low-order clearance, ADD would be activated for approximately 14 minutes, during which harbour seal would move at least 1.26km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000). For high-order clearance, an ADD would be activated for a maximum of approximately 80 minutes, during which harbour seal would move at least 7.2km away, based on precautionary swimming speed of 1.5m/s (Otani *et al.,* 2000).

92. As assessment for the maximum number of individuals that could be potentially disturbed from the effect of ADD activation prior to UXO clearance is presented in Table 4.19.

Table 4.19 Estimated number of seals that could potentially be disturbed during ADD activation for UXO clearance

Species	Low-order clearance [up to 14 minutes]		High-order detonation [up to a maximum of 80 minutes]	
	Number of individuals potentially disturbed	% of SAC population	Number of individuals potentially disturbed	% of SAC population
Harbour seal	0.006 (based on the SAC specific offshore cable corridor density of 0.0011/km^2)	0.0001% of TW & NNC SAC population	0.2 (based on the SAC specific offshore cable corridor density of 0.0011/km^2)	0.005% of TW & NNC SAC population
	0.00005 (based on the SAC specific array area density of 0.000010/km^2)	0.000001% of TW & NNC SAC population	0.002 (based on the SAC specific array area density of 0.000010/km^2)	0.00004% of TW & NNC SAC population

Summary

93. The potential for temporary disturbance would impact less than 5% of the harbour seal TW & NNC SAC population.

94. Therefore, there would be no adverse effect of disturbance from UXO clearance activities on the integrity of TW & NNC SAC for harbour seal in relation to the conservation objectives outlined in 3.6.2 of the RIAA (document reference 7.1.3).

4.6.3 Impact 3: Changes to prey availability as a result of underwater noise from UXO clearance activities

95. Harbour seal feed on a variety of prey species, and are considered to be opportunistic feeders, feeding on wide range of prey species and they are able to forage in other areas and have relatively large foraging ranges (see Appendix 12.2, Volume III).

96. ES Chapter 11 Fish and Shellfish Ecology (Volume I) provides an assessment of the impact pathways of underwater noise and vibration as a result of UXO clearance activities on the relevant fish and shellfish species. The assessment found in all cases that high risks are only anticipated at short distances. Taking this into consideration as well as the short term and intermittent nature of this activity (limited to instances when detonation of UXO is required) the pathways of effect is considered to be negligible for fish species in EIA terms.

97. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment on changes in prey availability associated with UXO clearances at North Falls would be localised and short in duration and would therefore be unlikely to affect harbour seals in TW & NNC SAC.

98. Taking into account the separation distance of North Falls from TW & NNC SAC, and that there is no potential for any direct effect on these, there would be no adverse effect on the integrity of TW & NNC SAC in relation to the conservation objectives (outlined in 3.6.2 of the RIAA (document reference 7.1.3)) as a result of any changes to prey availability during construction for North Falls.

4.7 European Sites

99. Of the 25 European sites that were screened-in, the closest site, Vlaamse Banken SAC, would be at greatest risk of effect at 34km to the closest point to the North Falls array area. All other sites, with greater distances to North Falls, along the European coastline, were assumed to experience the same or less of the effects as assessed for Vlaamse Banken SAC.

100. In summary, taken from Section 3.7.2.3 in the RIAA (document reference 7.1.3), there were no adverse effects on the integrity of the Vlaamse Banken SAC in relation to the conservation objectives for harbour porpoise, grey seal and harbour seal from piling and other construction or maintenance activities at North Falls. It can be assumed that UXO clearance, would not cause any further effects on site integrity.

101. Furthermore, it was assumed that greater connectivity is expected for the sites within the UK, and therefore the greater potential for effect would be present (and assessed) for the UK sites.

5 References

Arons, A.B., 1954. Underwater explosion shock wave parameters at large distances from the charge. *The journal of the acoustical society of america*, *26*(3), pp.343-346.

Carter, M.I., Boehme, L., Cronin, M.A., Duck, C.D., Grecian, W.J., Hastie, G.D., Jessopp, M., Matthiopoulos, J., McConnell, B.J., Miller, D.L. and Morris, C.D., 2022. Sympatric seals, satellite tracking and protected areas: habitat-based distribution estimates for conservation and management. Frontiers in Marine Science, 9, p.875869.

Hastie, G., Merchant, N.D., Götz, T., Russell, D.J., Thompson, P. and Janik, V.M., 2019. Effects of impulsive noise on marine mammals: investigating range-dependent risk. *Ecological Applications*, *29*(5), p.e01906.

Innogy Renewables UK Limited, 2019. Galloper Wind Farm UXO Disposal for Operational Phase: Information to Support Habitats Regulations Assessment. Available from: https://marinelicensing.marinemanagement.org.uk/mmofox5/download/parcel/k8j4hh6fvi7uuavamknngkiiq00o38r0ovqtr08ip4ermj5n6ggt63akliqmmk2chtojoc8bmvni6ijup3jn775drjuhevnie178/6d6e9dc5ff7b8e32e27324d1a2c4ec83/Galloper+UXO+operation_HRA+assessment.pdf?

JNCC, 2017. JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines). Available at: JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines) | JNCC Resource Hub

JNCC, Natural England and Department of Agriculture, Environment and Rural Affairs, 2020. Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland).

Kastelein, R.A., Hardeman, J. and Boer, H., 1997. Food consumption and body weight of harbour porpoises (Phocoena phocoena). *The biology of the harbour porpoise*, pp.217-233.

Ketten, D.R., 2004. Marine mammal auditory systems: a summary of audiometric and anatomical data and implications for underwater acoustic impacts. *Polarforschung*, *72*(2/3), pp.79-92.

Marine Technical Directorate Ltd (MTD), 1996. Guidelines for the safe use of explosives under water. MTD Publication 96/101. ISBN 1 870553 23 3.

Martin, S.B., Lucke, K. and Barclay, D.R., 2020. Techniques for distinguishing between impulsive and non-impulsive sound in the context of regulating sound exposure for marine mammals. *The Journal of the Acoustical Society of America*, *147*(4), pp.2159-2176.

Merchant, N.D. and Robinson, S.P., 2019, November. Abatement of underwater noise pollution from pile-driving and explosions in UK waters. In Report of the UKAN workshop held on Tuesday (Vol. 12).

National Physical Laboratory, 2020b. Final report: characterisation of acoustic fields generated by UXO removal - Phase 2. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/893773/NPL_2020_-_Characterisation_of_Acoustic_Fields_Generated_by_UXO_Removal.pdf

National Physical Laboratory, 2020a. Protocol for in-situ underwater measurement of explosive ordnance disposal for UXO, Version 2.

Ocean Winds. (2024). Low order deflagration of unexploded ordnance reduces underwater noise impacts from offshore wind farm construction. Available from: https://oceanwinds.com/wp-content/uploads/2024/05/OW-UXO-BusinessCase.pdf

Orsted, 2021. Hornsea Project Four: Environmental Statement (ES) Chapter 4: Marine Mammals. PINS Document Reference: A2.4. APFP Regulation: 5(2)(a).

Otani, S., Naito, Y., Kato, A. and Kawamura, A., 2000. Diving behavior and swimming speed of a free-ranging harbor porpoise, Phocoena phocoena. *Marine Mammal Science*, *16*(4), pp.811-814.

Richardson, W. J., C. R. Greene, Jr., C. I. Malme and D. H. Thomson., 1995. Marine mammals and noise. Academic Press, San Diego, CA.

Robinson, S.P., Wang, L., Cheong, S.H., Lepper, P.A., Marubini, F. and Hartley, J.P., 2020. Underwater acoustic characterisation of unexploded ordnance disposal using deflagration. *Marine pollution bulletin*, *160*, p.111646.

Soloway, A.G. and Dahl, P.H., 2014. Peak sound pressure and sound exposure level from underwater explosions in shallow water. *The Journal of the Acoustical Society of America*, *136*(3), pp.EL218-EL223.

Southall, B.L., Bowles, A.E., Ellison, W.T., Finneran, J.J., Gentry, R.L., Greene Jr., C.R., Kastak, D., Ketten, D.R., Miller, J.H., Nachtigall, P.E., Richardson, W.J., Thomas, J.A., and Tyack, P.L., 2007. Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations. Aquatic Mammals, 33 (4), pp. 411-509.

Southall, B.L., Finneran, J.J., Reichmuth, C., Nachtigall, P.E., Ketten, D.R., Bowles, A.E., Ellison, W.T., Nowacek, D.P. and Tyack, P.L., 2019. Marine mammal noise exposure criteria: Updated scientific recommendations for residual hearing effects. *Aquatic Mammals*, *45*(2), pp.125-232.

Southall, B.L., Nowacek, D.P., Bowles, A.E., Senigaglia, V., Bejder, L. and Tyack, P.L., 2021. Marine Mammal Noise Exposure Criteria: Assessing the Severity of Marine Mammal Behavioral Responses to Human Noise. Aquatic Mammals, 47(5), pp.421-464.

von Benda-Beckmann, A.M., Aarts, G., Sertlek, H.Ö., Lucke, K., Verboom, W.C., Kastelein, R.A., Ketten, D.R., van Bemmelen, R., Lam, F.P.A., Kirkwood, R.J. and Ainslie, M.A., 2015. Assessing the impact of underwater clearance of unexploded ordnance on harbour porpoises (Phocoena phocoena) in the Southern North Sea. *Aquatic Mammals*, *41*(4), p.503.

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