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Environmental Impact Assessment Report  
Volume 1, Chapter 11: Marine Mammals

# MarramWind Offshore Wind Farm

December 2025

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# 11. Marine Mammals

## 11.1 Introduction

11.1.1.1 This marine mammals Chapter of the Environmental Impact Assessment (EIA) Report presents the results of the assessment of the likely significant effects on marine mammal receptors that may arise from the construction, operation and maintenance (O&M) and decommissioning of the offshore Project seaward of Mean High Water Springs (MHWS). It should be read in conjunction with the project description provided in **Chapter 4: Project Description** and the relevant parts of the following chapters and appendices:

- **Chapter 6: Marine Geology, Oceanography and Physical Processes:** Changes to marine geology, oceanography and physical processes have the potential to affect marine mammal receptors and their prey and habitats. The information from the marine geology, oceanography and physical processes chapter will be used to inform this Chapter.
- **Chapter 7: Marine Water and Sediment Quality:** Changes to marine water and sediment quality have the potential to affect marine mammal receptors and their prey species through accidental pollution, increased concentrations of suspended solids and the leaching of toxins. The information from the marine water and sediment quality chapter will be used to inform this Chapter.
- **Chapter 8: Underwater Noise:** Changes to underwater noise have the potential to affect marine mammal receptors and their prey species. The information from the underwater noise chapter will be used to inform this Chapter.
- **Chapter 9: Electromagnetic Fields:** Electromagnetic fields (EMF) have the potential to affect marine mammal receptors. The information from the EMF chapter will be used to inform this Chapter.
- **Chapter 10: Benthic, Epibenthic and Intertidal Ecology:** Changes to benthic, epibenthic and intertidal ecology have the potential to affect marine mammal receptors by affecting their prey species and habitats. The information from the benthic, epibenthic and intertidal ecology chapter will be used to inform this Chapter.
- **Chapter 13: Fish Ecology:** Changes to fish ecology have the potential to affect marine mammal receptors by affecting their prey species and habitats. The information from the fish ecology chapter will be used to inform this Chapter.
- **Chapter 14: Commercial Fisheries:** Commercial fisheries have the potential to indirectly affect marine mammal receptors by affecting their prey species, such as whiting, cod, sandeel and salmon. The information from the commercial fisheries chapter will be used to inform this Chapter.
- **Chapter 15: Shipping and Navigation:** Maritime traffic has the potential to affect marine mammal receptors. The information from the shipping and navigation chapter will be used to inform this Chapter.
- **Chapter 28: Climate Resilience:** Changes to climate (for example, water temperature) have the potential to affect marine mammal receptors, their prey species and habitats. The information from the climate resilience chapter will be used to inform this Chapter.

11.1.1.2 This Chapter describes:

- the legislation, planning policy, guidance and other documentation that has informed the assessment (**Section 11.2: Relevant legislative and policy context**);
- the outcome of consultation and engagement that has been undertaken to date, including how matters relating to marine mammals have been addressed (**Section 11.3: Consultation and engagement**);
- the scope of the assessment for marine mammals (**Section 11.4: Scope of the assessment**);
- the data sources and methods used for gathering baseline data including surveys where appropriate (**Section 11.5: Methodology for baseline data gathering**);
- the overall environmental baseline (**Section 11.6: Baseline conditions**);
- the basis for EIA Report (**Section 11.7: Basis for EIA Report**);
- methodology for EIA Report (**Section 11.8: Methodology for EIA Report**);
- the assessment of marine mammal effects (**Section 11.9 Assessment of effects: Construction stage**., **Section 11.10: Assessment of effects: Operation and maintenance stage**, and **Section 11.11: Assessment of effects: Decommissioning stage**);
- summary of effects (**Section 11.12: Summary of effects**);
- consideration of transboundary effects (**Section 11.13: Transboundary effects**);
- consideration of inter-related effects and cumulative effects (**Section 11.14: Inter-related effects** and **Section 11.15: Assessment of cumulative effects**);
- a summary of residual effects for marine mammals (**Section 11.16: Summary of residual likely significant effects**);
- a reference list is provided (**Section 11.17: References**); and
- a glossary of terms and abbreviations is provided (**Section 11.18: Glossary of terms and abbreviations**).

11.1.1.3 This Chapter is also supported by the following:

- **Volume 3, Appendix 8.1: Underwater Noise Modelling**;
- **Volume 3, Appendix 11.1: Marine Mammal Baseline Technical Report**;
- **Volume 3, Appendix 11.2: Population Distribution Modelling**;
- **Volume 4: Outline Environmental Management Plan**;
- **Volume 4: Outline Piling Strategy**;
- **Volume 4: Outline Project Environmental Monitoring Programme**;
- **Volume 4: Outline Marine Mammal Mitigation Protocol**; and
- **Volume 4: Outline Vessel Management and Safety Plan**.

## 11.2 Relevant legislative and policy context and technical guidance

### 11.2.1 Legislative and policy context

- 11.2.1.1 This Section identifies the relevant legislation and policy context that has informed the scope of the marine mammal assessment. Further information on policies relevant to the EIA and their status is set out in **Chapter 2: Legislative and Policy Context**, which provides an overview of the relevant legislative and policy context for the Project. **Chapter 2: Legislative and Policy Context** is supported by **Volume 3, Appendix 2.1: Planning Policy Framework**, which provides a detailed summary of international, national, marine and local planning policies of relevance to the EIA. Individual policies of specific relevance to this assessment and associated appendices have been taken into account.
- 11.2.1.2 This summary provides a foundation for understanding the specific requirements that this Chapter must address in terms of assessing and mitigating impacts on receptors and relevant environmental issues.
- 11.2.1.3 The legislation and international agreements relevant to marine mammals include:
- Convention on Biological Diversity Post-2020 Global Biodiversity Framework, 2022;
  - Convention on Biological Diversity and the Aichi Biodiversity Targets 2020;
  - The European Biodiversity Strategy to 2030 (European Commission, 2020);
  - Marine Environment (Amendment) (EU Exit) Regulations 2018;
  - Protection of Seals (Designated Seal Haul-out sites) (Scotland) Order 2014;
  - Wildlife and Natural Environment (Scotland) Act 2011;
  - Marine (Scotland) Act 2010;
  - Marine Strategy Regulations 2010;
  - Marine and Coastal Access Act 2009;
  - Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas, 2008 (ASCOBANS);
  - Directive 2008/56/EC (Marine Strategy Framework Directive);
  - The Planning Act (2008);
  - Nature Conservation (Scotland) Act 2004;
  - the Habitats Regulations (collective term for The Conservation (Natural Habitats, &c.) Regulations 1994, The Conservation of Habitats and Species Regulations 2017, and The Conservation of Offshore Marine Habitats and Species Regulations 2017);
  - Council Directive (92/43/EEC) on the Conservation of Natural Habitats and of Wild Fauna and Flora (The Habitats Directive);
  - Oslo and Paris Convention for the Protection of the Marine Environment (OSPAR Convention) 1992;
  - Electricity Act 1989;
  - the Wildlife and Countryside Act 1981 (as amended);

- Convention on the Conservation of European Wildlife and Natural Habitats (The Bern Convention) 1979;
- Convention on the Conservation of Migratory Species of Wild Animals (The Bonn Convention) 1979;
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973; and
- Conservation of Seals Act 1970.

11.2.1.4 The policies relevant to marine mammals include:

- the UK Biodiversity Framework. Joint Nature Conservation Committee (JNCC) behalf of Four Countries' Biodiversity Group (4CBG; JNCC, 2024);
- Scottish Biodiversity Strategy to 2045 – Tackling the Nature Emergency in Scotland (The Environment and Forestry Directorate, 2023);
- Sectoral Marine Plan for Offshore Wind Energy 2020 (Scottish Government, 2020);
- Scotland's National Marine Plan (Scottish Government, 2015);
- United Kingdom (UK) Marine Policy Statement (HM Government, 2011); and
- Scottish Planning Policy 2014 (Scottish Government, 2014);

## 11.2.2 Relevant technical guidance

11.2.2.1 Other information and technical guidance relevant to the assessment undertaken for marine mammals include:

- JNCC guidelines on minimising the risk of injury to marine mammals from unexploded ordnance (UXO) clearance in the marine environment (JNCC, 2025);
- JNCC, Natural England and Centre for Environment, Fisheries and Aquaculture (Cefas) position on the use of quieter piling methods and noise abatement systems when installing offshore wind turbine foundations (JNCC *et al.*, 2025);
- Marine licensing – unexploded clearance: application guidance (Marine Directorate, 2025);
- UK Government Policy paper: marine environment: UXO clearance joint position statement (UK Government, 2025);
- JNCC guidance for the use of Passive Acoustic Monitoring (PAM) in UK waters for minimising the risk of injury to marine mammals from offshore activities (JNCC, 2023);
- Evidence base for application of Acoustic Deterrent Devices (ADDs) as marine mammal mitigation (Version 4: October 2022) (McGarry *et al.*, 2022);
- European Union guidance on wind energy developments on Natura 2000 legislation (European Commission, 2021);
- The protection of marine European Protected Species (EPS) from injury and disturbance: guidance for inshore waters (July 2020 Version; Marine Scotland, 2020);
- Marine mammal permanent threshold shift (PTS) onset noise exposure criteria (Southall *et al.*, 2019);
- JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys (seismic survey guidelines; JNCC, 2017);

- Scottish marine wildlife watching code (Scottish Natural Heritage (SNH), 2017);
- Description of Scottish Priority Marine Features, commissioned report (Tyler-Walters *et al.*, 2016);
- Guidance on the offence of harassment at seal haul-out sites (Marine Scotland, 2014);
- Guidance on mitigation protocols to minimise the risk of injury to marine mammals from piling noise (JNCC, 2010);
- Institute of Ecology and Environmental Management (IEEM) guidelines for marine and coastal ecological impact assessment in Britain and Ireland (IEEM, 2010); and
- Oslo-Paris Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) guidance on environmental considerations for offshore wind farm development (OSPAR, 2008).

## 11.3 Consultation and engagement

### 11.3.1 Overview

- 11.3.1.1 This Section describes the consultation and stakeholder engagement undertaken on the Project in relation to marine mammals. This includes early engagement, the outcome of and response to the Scoping Opinions (Scottish Government, 2023; Aberdeenshire Council, 2023) in relation to the marine mammal assessment, non-statutory consultation, and the findings of the Project's Statutory Consultation. An overview of engagement undertaken for the Project as a whole can be found in Section 5.5 of **Chapter 5: Approach to the EIA**.

### 11.3.2 Key issues

- 11.3.2.1 A summary of the key issues raised during statutory and non-statutory consultation, specific to marine mammals, is outlined below in **Table 11.1**, together with how these issues have been considered in the production of this EIA Report.

**Table 11.1 Stakeholder issues responses – marine mammals**

Stakeholder	Stakeholder issue ID	Date, document, forum	Stakeholder comment	How is this addressed in the EIA Report
Marine Directorate Licensing Operations Team (MD-LOT) and NatureScot	6	14 April 2022 EPS Risk Assessment – Geophysical Surveys.	NatureScot advised that the geophysical surveys of the export cable corridor (ECC) should follow JNCC guidance with one amendment including extending the mitigation zone to 600 metres (m) rather than the advised 500m following potential impact ranges of equipment. NatureScot advised that an EPS licence was not required for this activity.	Mitigation zones are determined by the modelled impact ranges for activities and the recommended zones within JNCC guidance, using whichever is greater. This approach is taken in <b>Volume 4: Outline Marine Mammal Mitigation Protocol</b> .
MD-LOT and NatureScot	315, 479, 480	12 May 2023 MD-LOT Scoping Opinion (Scottish Government, 2023).	The study area including the Offshore Agreement Area (OAA), cable corridor and a buffer zone of 60 kilometres (km) was questioned as to how it was determined or what it will be used for. NatureScot recommend using the relevant MU <sup>1</sup> for the wider context, and the relevant SCANS block(s) <sup>2</sup> for regional context, as well as determining the most relevant impact area for specific pathways, for example underwater noise.	The study area consists of the species management units rather than a buffer zone approach due to the highly mobile nature of marine mammals.
MD-LOT and NatureScot	317, 486, 487	12 May 2023 MD-LOT Scoping Opinion (Scottish Government, 2023).	The Scottish Ministers advised in line with the NatureScot representation that the impacts to be scoped in/out of the assessment concerning marine mammal interests are acceptable. However, it should be made clear whether geophysical surveys will be assessed separately from the EIA process as these are not included in the list of activities. Additionally, the Scottish Ministers highlight the NatureScot representation regarding the inclusion of noise from all sources. The Developer must ensure this is implemented in the EIA Report.	The impacts assessed in the EIA Report reflect those scoped in or out in the EIA Scoping Report. The impact of all Project noise sources, including geophysical surveys, is fully assessed in the EIA Report.

<sup>1</sup> MU refers to species-specific management units as defined by the Inter Agency Marine Mammal Working Group (IAMMWG, 2023). See **Section 11.4.2** for further information.

<sup>2</sup> SCANS blocks are defined by the Small Cetaceans in European Atlantic and North Sea Waters regional study of cetacean densities (see **Table 11.5**, **Section 11.5.4**, and **Section 11.6.1** for further information).

Stakeholder	Stakeholder issue ID	Date, document, forum	Stakeholder comment	How is this addressed in the EIA Report
MD-LOT and NatureScot	318, 332, 478, 488, 489	12 May 2023 MD-LOT Scoping Opinion (Scottish Government, 2023).	The Scottish Ministers note they are broadly content with the approach to assessment laid out at Scoping. However, in line with the NatureScot representation, the Developer must fully implement the advice regarding PAM and collision risk and engage with NatureScot and Marine Scotland on this as required. Additionally, the Cumulative Effects Framework (CEF) should be utilised in the cumulative assessment, if available at the time. However, the approach to cumulative impact assessments for marine mammal interests, requires agreement with NatureScot, before the submission of the EIA Report.	<p>The Project commits to using PAM as a mitigation measure in line with current JNCC guidance (details are included in <b>Volume 4: Outline Marine Mammal Mitigation Protocol</b>).</p> <p>See response to Stakeholder issue ID 475 regarding PAM for monitoring, and response to Stakeholder issue ID 476 regarding collision risk.</p> <p>The CEF was not available at the time of writing the EIA Report; therefore, the interim Population Consequences of Disturbance (iPCoD) modelling tool is used to assess population-level consequences of disturbance for the five key species, from the project alone and cumulatively. Other species are assessed qualitatively due to lack of demographic data as discussed in email correspondence (Nov 2024 - May 2025).</p>
MD-LOT and NatureScot	476	12 May 2023 MD-LOT Scoping Opinion (Scottish Government, 2023).	NatureScot note they are not yet certain of a collision risk from floating foundation mooring lines. Their understanding is that the impact pathway may be more around the mooring lines having ghost gear entanglement and this then causing an entanglement issue. At this stage we suggest there may be value in carrying out a review of other static, moored objects (oil & gas platforms, moored vessels) to understand if collisions have been recorded.	As advised by NatureScot, a review of publicly available data regarding the risks of collision and entanglement has been undertaken to inform the EIA Report. The references considered are provided in the context of the relevant assessment in <b>Section 11.10.6</b> . The review identified static and abandoned commercial fishing gear as a known impact pathway for collision and entanglement as well as research into the impact pathway from renewable

Stakeholder	Stakeholder issue ID	Date, document, forum	Stakeholder comment	How is this addressed in the EIA Report
				energy installations. Data was found to be unavailable regarding impact pathways from the other moored objects suggested by NatureScot.
NatureScot	481	12 May 2023 MD-LOT Scoping Opinion Appendix 1: Consultation Responses & Advice (Scottish Government, 2023).	NatureScot do not advise using the effective deterrent range (EDR) of 26km for UXO clearance, or 15km for piling as these are not site-specific and should be considered on a case-by-case basis. Instead, we would expect to see underwater noise modelled in order to better understand the distance at which noise may impact marine mammals. For geophysical surveys, however, we recommend using a 5km EDR as a precautionary approach, as recommended in JNCC's guidance on noise management in Special Areas of Conservation (SACs).	Activity-specific noise modelling has been undertaken, and the resultant impact ranges are utilised in the EIA Report project-alone assessment for piling and UXO clearance, rather than the EDR approach. EDRs are only used in the assessment of disturbance impacts from geophysical surveys, following a precautionary approach.
NatureScot	482	12 May 2023 MD-LOT Scoping Opinion Appendix 1: Consultation Responses & Advice (Scottish Government, 2023).	NatureScot offered comments on the relevant legislation and policy, technical guidance and data sources.	Corrections and additions have been made in the EIA Report based on the comments from NatureScot.
MD-LOT and NatureScot	316, 483	12 May 2023 MD-LOT Scoping Opinion Appendix 1: Consultation Responses & Advice (Scottish Government, 2023).	NatureScot advise that numbers of grey seals will be far higher within the SACs during the breeding season compared to August counts, which is the rationale for designation of grey seal SACs. At other times of year, numbers are much lower. It would be useful to present both the August counts, and the pup production numbers for grey seals within the SACs, as this would give a much more accurate picture. The EIA and Habitat Regulations Appraisal (HRA) will need to consider the breeding	Recent, publicly available data on grey seal August counts and pup production in the region are included in <b>Volume 3, Appendix 11.1</b> and considered in the EIA Report.

Stakeholder	Stakeholder issue ID	Date, document, forum	Stakeholder comment	How is this addressed in the EIA Report
			numbers, but we note that all the SACs mentioned will be outside the 20km (grey seal) and 50km (harbour seal) connectivity distances, so an assessment for HRA is unlikely to be needed.	
<b>MD-LOT and NatureScot</b>	316, 484	12 May 2023 MD-LOT Scoping Opinion Appendix 1: Consultation Responses & Advice (Scottish Government, 2023).	Section 5.6.29 of the Scoping Report states that SCANS-III density maps will be used to calculate site-specific densities. We support this approach for most species, but for bottlenose dolphin in the inshore cable route, the recently published 'East coast of Scotland bottlenose dolphins: estimate of population size 2015-2019' (Hammond <i>et al.</i> , 2021) should be used.	As SCANS-IV data has been published since the Scoping Report, these latest data are used to inform density estimates. Where SCANS-IV data are missing, SCANS-III data have been used.. Population sizes and density estimates for the coastal bottlenose dolphin population from Arso Civil <i>et al.</i> (2021); upon which Hammond <i>et al.</i> (2021) is based) and Cheney <i>et al.</i> (2024) are used to inform this Chapter.
<b>MD-LOT and NatureScot</b>	319, 475, 488, 490, 491	12 May 2023 MD-LOT Scoping Opinion Appendix 1: Consultation Responses & Advice (Scottish Government, 2023).	NatureScot advise that the EIA Report may indicate that potential effects other than habitat change and entanglement may require monitoring. NatureScot recommend that PAM should be considered for pre-, during and post-construction monitoring. It is likely that NatureScot will advise that marine mammal monitoring is secured.	We acknowledge NatureScot's recommendation regarding the potential need for monitoring of effects beyond habitat change and entanglement, and the suggestion to consider PAM during pre-construction, construction, and post-construction stages. These considerations are addressed within the EIA Report, which concludes that impacts on marine mammals are not significant across all relevant receptors. Based on these findings, we do not currently propose additional monitoring beyond what has already been outlined as mitigation measures in <b>Volume 4: Outline Marine Mammal Mitigation Protocol</b> and other embedded environmental measures

Stakeholder	Stakeholder issue ID	Date, document, forum	Stakeholder comment	How is this addressed in the EIA Report
				<p>presented in <b>Table 11.10</b>. Following consent however, a detailed review of existing data and knowledge gaps relating to the interactions between floating offshore wind technology and marine mammals will be undertaken. This review will evaluate the use of appropriate monitoring approaches, which will include the deployment of Passive Acoustic Monitoring (PAM) during different stages of development and collaborative strategic monitoring initiatives. The aim of this review will be to inform post-consent discussions with stakeholders on a potential proportionate marine mammal study. This is recorded as Commitment M-229 in <b>Volume 4: Project Environmental Monitoring Plan</b>.</p>

## 11.4 Scope of the assessment

### 11.4.1 Overview

11.4.1.1 This Section sets out the scope of the EIA for marine mammals. This scope has been developed as the Project's design has evolved and responds to stakeholder feedback received to-date, as set out in **Section 11.3**.

### 11.4.2 Spatial scope and study area

11.4.2.1 The spatial scope of the marine mammal assessment is defined at two spatial scales. A regional marine mammal study area has been defined (**Volume 2, Figure 11.1: Regional marine mammal study area**). The site-specific marine mammal study area has also been defined as the OAA plus a 4km buffer (**Volume 2, Figure 11.2: Site specific marine mammal study area**). In addition, in order to reflect the highly mobile and wide-ranging nature of marine mammals. These study areas are described in this Section.

#### Regional marine mammal study area

11.4.2.2 For each cetacean species (whales, dolphins and porpoises), the regional-scale study area is largely defined by the species-specific management unit (MU), outlined by the Inter Agency Marine Mammal Working Group (IAMMWG, 2023). An MU typically refers to a geographical area in which the animals of a particular cetacean species are found, to which management of human activities is applied. It may be smaller than what is believed to be a 'population'<sup>3</sup>, to reflect spatial differences in human activities and their management (IAMMWG, 2023). Using MUs in the assessment of cetacean species allows consideration of the scale of movement of a species and its respective populations, whilst taking account of jurisdictional boundaries and the management of human activities.

11.4.2.3 The Project is located within the following species-specific MUs:

- harbour porpoise (*Phocoena phocoena*): North Sea (NS) MU;
- bottlenose dolphin (*Tursiops truncatus*): Coastal East Scotland (CES) MU and Greater North Sea (GNS) MU;
- short-beaked common dolphin (*Delphinus delphis*): Celtic and Greater North Seas (CGNS) MU;
- white-beaked dolphin (*Lagenorhynchus albirostris*): CGNS MU;
- Risso's dolphin (*Grampus griseus*): CGNS MU;
- Atlantic white-sided dolphin (*Lagenorhynchus acutus*): CGNS MU; and
- minke whale (*Balaenoptera acutorostrata*): CGNS MU;
- humpback whale (*Megaptera novaeangliae*): no MU defined for UK waters.

11.4.2.4 For seals, seal management areas (SMAs) refer to geographical areas which are defined based on the distribution of seal haul-out sites, for pragmatic reasons such as the ability to survey an SMA within one season, and the locations of jurisdictional boundaries (Special Committee on Seals (SCOS), 2022). SMAs are not explicit management divisions and

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<sup>3</sup> Defined as a collection of individuals of the same species found in the same area, where genetic variation occurs within the population and between other populations

should be combined appropriately when management is considered. The regional scale study area for seals is:

- grey seal (*Halichoerus grypus*): East Scotland and North Coast and Orkney SMA; and
- harbour seal (*Phoca vitulina*): East Scotland and North Coast and Orkney SMA.

### Site-specific marine mammal study area

11.4.2.5 The site-specific study area for all marine mammals is defined as the area which covers the OAA plus a 4km buffer, which is equivalent to the survey area covered by the digital aerial surveys (DAS) for the Project. The site-specific marine mammal study area provides an indication of the local presence of marine mammal species in the OAA and adjacent area.

### 11.4.3 Temporal scope

11.4.3.1 The temporal scope of the assessment of marine mammals is the entire lifetime of the Project, which therefore covers the pre-construction, construction, O&M, and decommissioning stages as set out in **Chapter 4: Project Description**. It is anticipated that the construction of the Project will commence in 2030, with the first phase becoming fully operational by 2037. It is anticipated that the second phase of the Project would become fully operational by 2040 and the third phase by 2043. The operational lifetime of the Project for each phase is expected to be 35 years.

### 11.4.4 Identified receptors

11.4.4.1 The spatial and temporal scope of the assessment enables the identification of receptors that may experience a change as a result of the Project. The receptors identified that may experience likely significant effects for marine mammals are outlined in **Table 11.2**.

**Table 11.2 Identified receptors requiring assessment for marine mammals**

Receptor group	Receptors included within group
<b>Cetaceans</b>	harbour porpoise; bottlenose dolphin; short-beaked common dolphin; white-beaked dolphin; Risso's dolphin; Atlantic white-sided dolphin; minke whale; and humpback whale.
<b>Pinnipeds</b>	grey seal; and harbour seal.

### 11.4.5 Potential effects

11.4.5.1 Potential effects on marine mammal receptors that have been scoped in for assessment are summarised in **Table 11.3**.

**Table 11.3 Potential effects for marine mammals**

Receptor	Activity or impact	Potential effect
<b>Construction stage</b>		
<b>Cetaceans and pinnipeds</b>	Underwater noise from pre-construction surveys, piling or UXO clearance.	Potential for direct effects including death, physical injury, temporary reduction in hearing sensitivity, behavioural disturbance or habitat displacement.
<b>Cetaceans and pinnipeds</b>	Underwater noise from other construction activities such as drilling, dredging, trenching, cable laying, installing drag embedment anchors, rock placement, suction caisson installation.	Potential for direct effects including physical injury, temporary reduction in hearing sensitivity, behavioural disturbance or habitat displacement.
<b>Cetaceans and pinnipeds</b>	Vessel collisions	Potential for death or physical injury resulting from a collision of a marine mammal with a vessel.
<b>Cetaceans and pinnipeds</b>	Underwater noise and physical presence of vessels.	Potential for behavioural disturbance from underwater noise and physical presence of vessels.
<b>Cetaceans and pinnipeds</b>	Changes to prey availability.	Potential for indirect effects from changes to prey availability or distribution due to the Project's activities on fish or benthic receptors.
<b>O&amp;M stage</b>		
<b>Cetaceans and pinnipeds</b>	Underwater noise associated with floating foundations including operational noise and mooring line strumming.	Potential for direct effects including injury, temporary reduction in hearing sensitivity, behavioural disturbance or habitat displacement.
<b>Cetaceans and pinnipeds</b>	Vessel collision	Potential for death or physical injury resulting from a collision of a marine mammal with a vessel.
<b>Cetaceans and pinnipeds</b>	Underwater noise and physical presence of vessels.	Potential for behavioural disturbance from underwater noise and physical presence of vessels.
<b>Cetaceans and pinnipeds</b>	Changes to prey availability.	Potential for indirect effects from changes to prey availability or distribution due to the impacts from the Project's activities on fish or benthic receptors.

Receptor	Activity or impact	Potential effect
<b>Cetaceans and pinnipeds</b>	Entanglement risk with mooring lines and dynamic array cables.	Potential for indirect effects including death or injury from entanglement with ghost gear caught of floating mooring lines and dynamic array cables.
<b>Cetaceans and pinnipeds</b>	Habitat loss or change.	Potential for habitat loss or a change in use of the Project site resulting from presence of the structures.
<b>Cetaceans and pinnipeds</b>	Physical barrier effects.	Potential for displacement or reduction in access to the Project site.
<b>Cetaceans and pinnipeds</b>	EMF.	Potential for disturbance or indirect effects from disturbance to prey species from the EMF emitted from subsea cables.
<b>Decommissioning stage</b>		
<b>Cetaceans and pinnipeds</b>	Vessel collisions	Potential for death or physical injury resulting from a collision of a marine mammal with a vessel.
<b>Cetaceans and pinnipeds</b>	Underwater noise and physical presence of vessels.	Potential for behavioural disturbance from underwater noise and physical presence of vessels.
<b>Cetaceans and pinnipeds</b>	Underwater noise from cable burial or retrieval.	Potential for direct effects including, physical injury, temporary reduction in hearing sensitivity, behavioural disturbance or habitat displacement.
<b>Cetaceans and pinnipeds</b>	Underwater noise from the removal of fixed infrastructure above the seabed (for example, driven piles).	Potential for direct effects including, physical injury, temporary reduction in hearing sensitivity, behavioural disturbance or habitat displacement.
<b>Cetaceans and pinnipeds</b>	Changes to prey availability.	Potential for indirect effects from changes to prey availability or distribution due to the impacts from the Project's activities on fish or benthic receptors.

## 11.4.6 Effects scoped out of assessment

- 11.4.6.1 A number of potential effects have been scoped out from further assessment, resulting from a conclusion of no likely significant effect. These conclusions have been made based on the knowledge of the baseline environment, the nature of planned works and the professional judgement on the potential for impact from such projects more widely. The conclusions follow (in a site-based context) existing best practice. Each scoped out activity or impact is considered in turn in **Table 11.4**.

**Table 11.4 Activities or effects scoped out of assessment**

Activity or impact	Rational for scoping out
<p><b>In-air noise disturbance of pinnipeds as a result of construction or decommissioning.</b></p>	<p>During the construction of the Project the majority of the noise will be transmitted through the underwater environment, though some noise will also be transmitted above water. This in-air noise has the potential, in some circumstances, to cause disturbance to seals hauled out. However, no designated haul-out sites or SACs are located within connectivity distance to the OAA or the proposed landfall sites. Therefore, the works are unlikely to cause disturbance to seals hauled out at established and designated haul-out sites.</p> <p>MD-LOT and NatureScot agreed that the impact of in-air noise disturbance to pinnipeds can be scoped out of the EIA, as stated in the Scoping Opinion.</p>
<p><b>Disturbance of habitat from sea floor attachments, for example anchors.</b></p>	<p>Anchoring is an integral part of the overall mooring system and there is a wide spectrum of anchoring and mooring solutions that could be used. These include drag embedment anchors, driven pile anchors, and suction anchors. The proportion of the anchor itself that interacts with the seabed is smaller than the size of the anchor, and any disturbance is short-lived, during installation. Although anchor points may cause increased sedimentation, scouring and liquefaction of habitats on the seabed, the activity of installation is short-lived and localised. Therefore, the works have no likely significant effect on marine mammals.</p> <p>MD-LOT and NatureScot agreed that the impact of disturbance of habitat from sea floor attachments can be scoped out of the EIA as stated in the Scoping Opinion.</p>
<p><b>Chemical pollution</b></p>	<p>Re-suspension of contaminants from sediment, release of anti-fouling substances, and vessel- or wind turbine generator (WTG)-related pollution including increased traffic, oil and fluid spill, and accidental collision (Bailey <i>et al.</i>, 2014; Maxwell <i>et al.</i>, 2022) may occur intermittently throughout the lifetime of the Project. All vessels will be compliant to the International Convention for the Prevention of Pollution from Ships (MARPOL). Throughout this Project, there will be development and adherence to a Project Environmental Monitoring Programme (PEMP; in line with the Outline PEMP), which is to include a Marine Pollution Contingency Plan (MPCP) and development and adherence to a Vessel Management and Safety Plan. To reduce the risk at decommissioning, a decommissioning programme will be developed and adhered to.</p>

Activity or impact	Rational for scoping out
	<p>The addition of chemical pollution may directly impact marine mammals and indirectly by affecting their prey. The introduction of chemical pollution is likely to be short-lived and localised and with the correct control measures adopted throughout the life cycle of the Project, the risk is further mitigated. Therefore, chemical pollution has no likely significant effect on marine mammals.</p> <p>MD-LOT and NatureScot agreed that the impact of chemical pollution can be scoped out of the EIA as stated in the Scoping Opinion.</p>

### 11.4.7 Consideration of the draft Sectoral Marine Plan

11.4.7.1 This Chapter has considered the content of the draft Updated Sectoral Marine Plan (dSMP) in relation to marine mammals. The Project falls within one of eight OAA within the highlighted North East region of Scotland. Key environmental risks highlighted for marine mammals within this region include: displacement of species such as grey seals, bottlenose dolphins, white-beaked dolphins and minke whale from underwater noise, and quantifying the impact of key species.

11.4.7.2 Impacts of underwater noise (including potential injury, disturbance and displacement) from various activities and stages of the Project have been assessed in the following sections:

- Auditory injury during pre-construction surveys (**Section 11.9.2**), installation of WTGs, offshore substations and reactive compensation platforms (RCPs) (**Section 11.9.3**), other construction activities (**Section 11.9.4**) and UXO clearance (**Section 11.9.11**);
- Disturbance and/or barrier effects from increased underwater noise during pre-construction surveys (**Section 11.9.6**), installation of WTGs, offshore substation and RCP (**Section 11.9.7**), other construction activities (**Section 11.9.8**), vessel presence and traffic (**Sections 11.9.10, 11.10.4, and 11.11.5**), UXO clearance (**Section 11.9.12**), operational and mooring line noise (**Section 11.10.7**) and during decommissioning activities (**Section 11.11.2**).

11.4.7.3 The Strategic Environmental Assessment Environmental Report, which underpins the dSMP, highlights uncertainty regarding baseline conditions for marine mammal distribution, foraging range and population within or migrating through Scottish waters. Due to the wide-ranging nature of many marine mammal species, these data gaps are required to be filled by programmes, such as ScotMER to help to fill in evidence gaps across the wider scale (for example, regional or national). Literature reviews of regional studies, such as SCOS or Small Cetaceans in European Atlantic and North Sea (SCANS) have been used alongside site-specific surveys to inform the baseline, refer to **Volume 3, Appendix 11.1** for further details. It is important that planning decisions are based on up-to-date ecological reports and survey data. However, it is difficult to set a specific timeframe over which reports, or survey data, should be considered valid, as this will vary in different circumstances. In some cases, there will be specific guidance on this but in circumstances where such advice does not already exist, CIEEM provides general advice (CIEEM, 2019) which have been followed when choosing data to inform the baseline:

- data of less than 12 months of age is considered valid by CIEEM in most cases;
- data of 12 to 18 months of age is considered valid in most cases; however, if a highly mobile species is present on the site or in the wider area, this can create a new feature of relevance to the assessment which may require additional data collection; and

- data of between 18 months and 3 years of age, involving mobile species or circumstances where habitat for its management has changed significantly since the original data were collected, will likely need updated surveys and/or desk study information.

11.4.7.4 Given this, it is recommended to be cautious of references used to inform the dSMP as some studies cite results from data which are over 20 years old (for example, Reid *et al.*, 2003). Statutory consultees typically require two years of baseline data collection for offshore wind farm developments to cover both seasonality and interannual variation. Therefore, data less than 12 months old would be considered as very recent data. This dataset is generally valid for a minimum of three years before a baseline change would have to be considered. The site-specific surveys conducted for the Project occurred across two years between April 2021 and March 2023. As these surveys are within two to three years of this assessment, it is within the window of validity for baseline characterisation and is being supported by literature review of more recent data, or neighbouring DAS data from other offshore wind farms in the North East region. The **Volume 3, Appendix 11.1** notes years of data collection for every source used in this assessment.

11.4.7.5 The dSMP also refer to density classifications of 'low', 'moderate', or 'high' usage. These classifications have not been used in this assessment as they originate from an outdated paper and the classifications have not been defined as to what number of animals per kilometre squared equates to which level of usage. These classifications can only be used as a relative to other species and is subjective. Therefore, this assessment is following a precautionary approach and current best practice, to use the highest recorded density of marine mammal receptors which overlap the site. These densities are also shown as proportions of the MU and UK portion of the MU populations. Limitations of data acquisition methods are included in **Section 11.5.4**. **Section 11.8** describes how these assessments consider a worst-case scenario that exceeds the level of impact found in a real-life scenario.

## 11.5 Methodology for baseline data gathering

### 11.5.1 Overview

11.5.1.1 Baseline data collection has been undertaken to obtain information over the study areas described in **Section 11.4**. **Volume 3, Appendix 11.1** provides a detailed review of publicly available data and site-specific data which have been used for characterisation of the marine mammal baseline. A summary of the current and future baseline conditions are presented in **Section 11.6**.

### 11.5.2 Desk study

11.5.2.1 The data sources that have been collected and used to inform this marine mammal assessment are summarised in **Table 11.5**. **Volume 3, Appendix 11.1** also lists other data sources examined that were identified as not being suitable to take forward to detailed examination and therefore the EIA Report.

**Table 11.5 Data sources used to inform the marine mammals chapter**

Source	Date	Summary	Coverage of study area
<b>Spatial model of cetacean density in European Atlantic waters based on SCANS-IV Summer 2022 survey data (Gilles <i>et al.</i>, 2025)</b>	Data collected: June to August 2022.	The report describes the density surface modelling for those cetacean species for which sufficient data were obtained during SCANS-IV surveys. Species included harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale.	Full coverage of regional study area and site-specific study area.
<b>Updated habitat-based at-sea distribution maps for harbour and grey seals in Scotland (Carter <i>et al.</i>, 2025)</b>	Data collected: 2005 to 2022.	This report provides updated habitat-based models of at-sea distribution for harbour and grey seals in Scottish and adjacent waters (updated from Carter <i>et al.</i> , 2022).	Full coverage of the regional study area and site-specific study area.
<b>Estimates of cetacean abundance in European Atlantic waters in Summer 2022 from the SCANS-IV aerial and shipboard surveys (Gilles <i>et al.</i>, 2023)</b>	Data collected: June to August 2022	SCANS-IV report provides estimates of cetacean abundance and density in European Atlantic waters in Summer 2022 using the SCANS-IV aerial and shipboard surveys. The Project is located within SCANS-IV block NS-E and NS-D.	Full coverage of regional study area and site-specific study area.
<b>Updated abundance estimates for cetacean MUs in UK waters (Revised 2022) (IAMMWG, 2023)</b>	Data collected: June to July 2016 (with regards to latest MU abundance estimates, which are based on SCANS-III).	Report provides abundance estimates for the seven most common cetacean species found in UK waters. MUs were defined across UK waters and abundance estimates were calculated for each species within their respective MU.	Full coverage of regional study area and site-specific study area.
<b>Modelled density surfaces of cetaceans in European Atlantic waters in Summer 2016 from the SCANS-III aerial and shipboard surveys (Lacey <i>et al.</i>, 2022)</b>	Data collected: June to July 2016.	Report provides modelled density surfaces of cetaceans in European Atlantic waters in Summer 2016 using the SCANS-III aerial and shipboard surveys, as well as data from SCANS-II/CODA.	Full coverage of regional study area and site-specific study area.
<b>Sympatric seals, satellite tracking and protected areas: Habitat-based distribution estimates for</b>	Data collected: 2005 to 2019.	This report provides estimates of at-sea distribution for both grey and harbour seals from haul-outs in the British Isles (UK, Ireland and the Isle of Man). The predictions are based on regional models of habitat preference. Estimates are calculated	Full coverage of the regional study area and site-specific study area.

Source	Date	Summary	Coverage of study area
<b>conservation and management (Carter <i>et al.</i>, 2022)</b>		using satellite tracking (telemetry tagging) and abundance data (haul-out counts).	
<b>Estimates of cetacean abundance in European Atlantic waters in Summer 2016 from the SCANS-III aerial and shipboard surveys (Hammond <i>et al.</i>, 2021)</b>	Data collected: June to July 2016.	SCANS-III report on cetacean abundance following vessel and aerial surveys of the North Sea and European Atlantic continental shelf waters conducted in July 2016. Species included harbour porpoise, bottlenose dolphin, white-beaked dolphin, and minke whale. The Project is located within SCANS-III block T and R.	Full coverage of regional study area and site-specific study area.
<b>Regional baselines for marine mammal knowledge across the North Sea and Atlantic areas of Scottish waters (Hague <i>et al.</i>, 2020)</b>	Data collected: 1979 to 2019.	This report collates and provides information on the abundance and distribution of marine mammal species in the Scottish Northern North Sea region and Scottish Atlantic waters, with a focus on what were the draft plan option sites identified in the Draft Sectoral Marine Plan for Offshore Wind Energy for Scotland.	Full coverage of regional study area and site-specific study area.
<b>Site-specific survey information from nearby offshore windfarms; Royal HaskoningDHV, 2023; HiDef Aerial Surveying Limited, 2023a; APEM, 2024a; HiDef Aerial Surveying Limited, 2023b; Moray Offshore Renewables Ltd., 2012; Moray Offshore Windfarm (West) Limited, 2018)</b>	Data collected: 2010 to 2023.	These reports present the site-specific survey information collected by monthly DAS for nearby offshore wind farms including Green Volt Offshore Wind Farm (DAS data collected between May 2020 – Apr 2022), Muir Mhòr Offshore Wind Farm (Apr 2021 – Mar 2023), Caledonia Offshore Wind Farm (May 2021 – Apr 2023), Salamander Offshore Wind Farm (Mar 2021 – Feb 2023), Moray East (Apr 2010 – Mar 2012), and Moray West (Apr 2016 – Mar 2017).	Partial coverage of regional study area only.
<b>Existing Offshore Wind Farm data (for example Graham <i>et al.</i>, 2015, 2016, 2020, 2021; Benhemma-Le Gall <i>et al.</i>, 2021, 2023; Fernandez-Betelu <i>et al.</i>, 2022)</b>	Data collected: multiple years.	Various studies have reported on marine mammal responses to Offshore Wind Farm construction and operation which have been used to inform this marine mammal chapter. Key sources include the Strategic Marine Mammal Monitoring Programme, completed on behalf of Moray East Offshore Wind Farm and Beatrice Offshore Wind Farm.	Partial coverage of regional study area only.

Source	Date	Summary	Coverage of study area
<b>Existing data reporting on bottlenose dolphin distribution and abundance in Scottish waters (Cheney <i>et al.</i>, 2012; 2013; 2014a; 2014b; Quick <i>et al.</i>, 2014; Graham <i>et al.</i>, 2015; 2016; 2017; Cheney <i>et al.</i>, 2018; Arso Civil <i>et al.</i>, 2019; 2021; Cheney <i>et al.</i>, 2024)</b>	Data collected: multiple years.	Various studies have focused of the distribution, abundance and behaviour of the resident population of bottlenose dolphins found in the Moray Firth with links to further sites across the UK and Ireland. These reports cover data for bottlenose dolphin protected in the Moray Firth SAC and CES MU. Reports include: Condition monitoring of bottlenose dolphin within the Moray Firth SAC; Reports from photo-identification (photo-ID) surveys and PAM surveys; Moray Firth Marine Mammal Monitoring Programme developed in 2014 (studies of reproduction, survival rates, assessments of trends in abundance and patterns of distribution); and Wider east coast of Scotland population inclusive of photo-ID data in the Firth of Forth and Firth of Tay.	Partial coverage of regional study area only.
<b>Scientific advice on matters related to the management of seal populations by the SCOS (SCOS, 2020; 2021; 2022; 2023; 2024)</b>	Data collected: multiple years.	Under the Conservation of Seals Act 1970 and the Marine (Scotland) Act 2010, the Natural Environment Research Council (NERC) has a duty to provide scientific advice to the government on matters related to seal population management. SCOS has been appointed to formulate this advice on behalf of NERC. There have been numerous reports collated by SCOS that identify any conservation and management issues, including ecology, behaviour, population trends and estimates, important areas and the status of both grey and harbour seals in the UK.	Full coverage of the regional study area and site-specific study area.
<b>Existing data on grey and harbour seals in Scottish waters (for example Russell <i>et al.</i>, 2019; Sharples <i>et al.</i>, 2012; Jones <i>et al.</i>, 2017; Onoufriou <i>et al.</i>, 2016)</b>	Data collected: multiple years.	Various studies have focused of the distribution, abundance and behaviour of grey seal and harbour seal in the UK. These studies include, but are not limited to the following: Telemetry tagging studies to identify the distribution of grey and harbour seals in the UK; findings of harbour seal aerial surveys conducted in Orkney, the north coast of Scotland, the Moray Firth and the Firth of Tay carried out in August 2012; and investigations into the interactions between seals and vessels.	Partial coverage of regional study area only.

### 11.5.3 Site surveys

- 11.5.3.1 The site surveys that have been conducted and used to inform this marine mammal assessment are summarised in **Table 11.6**.

**Table 11.6 Site surveys undertaken**

Survey type	Scope of survey	Coverage of study area
<b>MarramWind site-specific digital aerial surveys (DAS) between April 2021 and March 2023 (APEM, 2024b)</b>	Monthly DAS conducted by APEM Ltd between April 2021 and March 2023 for site-specific baseline characterisation of marine birds and marine mammals. The survey area included the MarramWind OAA plus a 4km buffer.	Full coverage of site-specific study area, partial coverage of the regional study area.

### 11.5.4 Data limitations

- 11.5.4.1 Information on spatial and temporal patterns of species distribution is vital for understanding spatio-temporal use and potential impacts to marine mammals from the Project. However, such accurate data (in terms of quantity, quality and location) for highly mobile species in the marine environment are challenging to obtain. There is no single solution for routine monitoring of marine mammals. Although, there are various methods for studying marine mammals which can be used effectively and in-combination with one another, which will result in a more complete picture of the spatio-temporal distribution of marine mammal species. This Section summarises some of the data constraints of key data sources used in this assessment.

#### Broadscale surveys

- 11.5.4.2 There is a baseline level of knowledge of marine mammals at a UK-wide scale. In the last decade, data on cetacean occurrence have been collated with environmental data to predict habitat-correlated abundance and distribution at a UK-wide scale (for example, Paxton *et al.*, 2016; Waggitt *et al.*, 2019). These studies often include a range of different survey techniques, such as digital aerial, visual aerial and vessel based. They therefore incorporate differing methodologies and observation methods. Distribution maps from such broadscale studies need careful interpretation, and outputs do not always represent absolute densities, fine-scale distributions, or the latest trends. However, they may be used as a general illustration of relative densities and broad-scale distribution over longer periods of time.
- 11.5.4.3 SCANS surveys provide sightings, density, and abundance estimates at a regional spatial scale. The surveys have been specifically designed to generate comprehensive abundance estimates for cetaceans in European Atlantic waters and the North Sea. The surveys are designated to provide equal coverage probability within the survey blocks, in order to generate an unbiased abundance estimate for each survey block. Both aerial and boat-based survey methodologies were used and designed to correct for availability and detection bias and allow the estimation of absolute abundance (Hammond *et al.*, 2021). However, these surveys do not provide fine-scale spatial or temporal information on species abundance and distribution as they are conducted periodically (conducted every five to ten years) and only during the Summer months. This limitation means that the data may not

accurately reflect species distribution and abundances throughout the year, particularly for those species with seasonal movements. For example, there is a potential for overestimation of average annual abundance for species with greater presence during the Summer period when using SCANS estimates alone. Furthermore, the SCANS surveys do not provide sufficiently fine-scale monitoring of coastal species due to their design, such as bottlenose dolphin populations. As a result, these populations may be underrepresented in broad-scale survey outputs.

- 11.5.4.4 Data available for pinnipeds within the Project area comprise counts of haul-out sites and collated telemetry tagging data, which have informed recent studies on at-sea density and abundance of grey and harbour seals in UK waters (Carter *et al.*, 2020; 2022; 2025). Telemetry tagging data are valuable, as they can provide information on habitat use, and diel and seasonal changes in behaviour, although such studies typically have low sample sizes. Consequently, caution must be applied when extrapolating such studies to the population-level, and/or to sites from which little or no telemetry data exist.

### Digital aerial surveys

- 11.5.4.5 DAS collect either still imagery based on a grid design or video footage along predetermined transects within a study area. The aim of DAS is to survey large, remote areas in a short period of time. DAS offer various benefits for marine surveys such as reducing disturbance to marine wildlife due to the flight altitudes, providing a comprehensive and permanent data record, and is cost-effective to survey large offshore areas. However, as with any survey method, this technique has limitations.
- 11.5.4.6 Although DAS can capture fauna within metres of the sea surface, this survey technique has availability bias, whereby fauna submerged more than a couple metres below the surface can be hidden and may not be detected during a survey. Depending on the ground sampling distance, flight height and speed of the aircraft, there could be detection errors due to poor image quality, leading to missed detections or incorrectly or imprecisely identifying a species during post-processing. Post-processing digital data can also be a source of error, as it requires human interpretation of a two-dimensional subject and can be subject to inconsistencies in classification and annotation. DAS is also constrained by environmental conditions, where surveys require adequate light, clear weather and calm sea conditions to ensure the footage has a high enough quality to allow for good detection rates.

### Bottlenose dolphin sources

- 11.5.4.7 Numerous studies have contributed valuable insights into the population dynamics of bottlenose dolphins along the east coast of Scotland, particularly within the Moray Firth SAC (for example, Cheney *et al.*, 2012, 2014b, 2018, 2024). Broader regional research have also been undertaken encompassing areas such as the Firth of Tay, Firth of Forth, and coastal waters near Aberdeen (for example, Arso Civil *et al.*, 2019, 2021; Quick *et al.*, 2014).
- 11.5.4.8 These studies primarily rely on photo-identification and PAM, which are highly effective for assessing population structure, individual movements, and long-term trends. However, a key limitation of these methodologies is their inability to generate spatially explicit density estimates.
- 11.5.4.9 As a result, while these studies significantly enhance our understanding of coastal bottlenose dolphin distribution and populations, they are not directly applicable for producing spatially explicit density estimates. Therefore, in the absence of robust density estimates for coastal bottlenose dolphin populations, a uniform density has been generated for the Project using the most recent CES population estimate (detailed in **Volume 3, Appendix 11.1**). The uniform density estimate also has a limitation, that individuals are not

evenly spread across the CES, nevertheless using a uniform density estimate remains the most practical approach.

### Passive acoustic monitoring

- 11.5.4.10 One of the key gaps for marine mammals is lack of knowledge on diurnal and seasonal variation in cetacean presence. Many of the data and information sources are gathered during daylight hours and many datasets, such as SCANS, are just a 'snapshot' from the Summer months. Therefore, any changes in occurrence within the day and across seasons is not captured for many of the cetacean species over regional or local (site-specific) spatial scales.
- 11.5.4.11 PAM is a typical method to complement visual surveys as they are not constrained by weather or light availability. However, PAM can only detect individuals that are vocalising within range and directionality of the hydrophones during the monitoring period. Detectability of species can be reduced by masking caused by increased background noise levels due to vessel noise, heavy rainfall, or high sea states, for example. Some species will be difficult to detect depending on the background noise and species behaviour, such as low frequency (LF) vocalisations of baleen whales (for example, minke whale), which can be masked by vessel noise (Cholewiak *et al.*, 2018; Risch *et al.*, 2019), and seals are particularly difficult to detect due to their low vocalisation rates (Hayes *et al.*, 2004; Stone, 2015).
- 11.5.4.12 Long-term PAM surveys, such as East Coast Scotland Marine Mammal Acoustic Array Surveys (ECOMMAS) or Scottish Passive Acoustic Network (SPAN) aim to bridge this data gap of diurnal and seasonal variation. However, the moorings for these monitoring programmes are more coastal in distribution. This means that its use is limited for offshore areas such as the Project's OAA.

### Summary of data limitations

- 11.5.4.13 To gain a greater understanding of marine mammals within the Project area, the assessment brings together a wide variety of data sources, including site-specific surveys and publicly available literature, to provide the most robust assessment of potential impacts to marine mammals. A variety of data sources will ensure that the identified data gaps and limitations are bridged, and that the assessment is using the best approach to inform species presence in the Project area. There are no known data limitations at the time of this study that affect the robustness of the assessment of this EIA Report.

## 11.6 Baseline conditions

### 11.6.1 Current baseline

- 11.6.1.1 A summary of the marine mammal baseline environment is provided in the following sections. Full details of the review undertaken to develop the marine mammal baseline is provided in **Volume 3, Appendix 11.1**.

### Summary of existing baseline

- 11.6.1.2 The marine mammal species that have potential to occur within the vicinity of the Project and that have density and abundance data available are:
- harbour porpoise;
  - bottlenose dolphin;

- short-beaked common dolphin;
- white-beaked dolphin;
- Risso's dolphin;
- Atlantic white-sided dolphin;
- minke whale;
- harbour seal; and
- grey seal.

- 11.6.1.3 These species all have density and abundance estimates available for the Project area and therefore will be assessed quantitatively. In addition, humpback whale will also be included in the assessment using a qualitative approach, as there are no abundance or density estimates available for this species. To note, both Atlantic white-sided dolphin and humpback whale have been included as a precautionary measure and to reflect the advice given by NatureScot to nearby developments (Marine Scotland, 2022).
- 11.6.1.4 The most robust, *i.e.*, recent and spatially-relevant, density estimates for each species were selected from available data sources and are presented in **Table 11.7**. Site-specific density estimates derived from the DAS (see **Volume 3, Appendix 11.1**) have been considered in the impact assessment where calculated for a species (specifically harbour porpoise, white-beaked dolphin, Risso's dolphin, and grey seal). Regional-scale density estimates were also used where predicted impact ranges are greater than the site-specific survey area, such as disturbance from piling, or where DAS density estimates were not available (for example Carter *et al.*, 2022; Carter *et al.*, 2025; Gilles *et al.*, 2023; Gilles *et al.*, 2025). For activities where Project-specific densities calculated from density surfaces are not appropriate, such as UXO clearance, where exact locations are unknown, uniform densities from SCANS-IV (Gilles *et al.*, 2023; 2025) were used across the full impact range.
- 11.6.1.5 Large-scale surveys like SCANS are not designed to estimate abundance for small, coastal populations. Therefore, for bottlenose dolphins, a density of 0.116 individuals/km<sup>2</sup> was applied within 2km of the mainland coast. This value better reflects the species' known coastal distribution within the CES MU (see **Volume 3, Appendix 11.1** for the methodology). Beyond this coastal area, a uniform density based on SCANS was applied.
- 11.6.1.6 The assessment presents both the populations within the MU as assigned by the IAMMWG (2023), alongside the UK-specific portion of the MU. This approach provides a more accurate representation of the populations likely to be affected by potential impact pathways and aligns with advice previously issued by NatureScot for nearby developments (Marine Scotland, 2025). For both pinniped species (grey and harbour seals), the Project spans two SMAs: East Scotland and North Coast and Orkney. In certain scenarios, the potential impact range may also extend into the Moray Firth SMA. Accordingly, the assessment will consider potential effects on populations across all three SMAs where relevant.
- 11.6.1.7 Humpback whales are included in the assessment due to an increase in opportunistic sightings in the Firth of Forth during Winter months. However, due to the absence of a defined MU, abundance and density estimates, there is insufficient empirical data to support a quantitative assessment for this species. This species has therefore been assessed qualitatively.
- 11.6.1.8 **Table 11.7** summarises all density estimates used in this Chapter. Each impact assessment utilises the most appropriate density estimate, depending on the nature and spatial extent of the impact. **Paragraph 11.8.2.6** clearly identifies which estimates were applied to each impact, along with the rationale.

**Table 11.7 Species, MU size and density estimate recommended for use in the quantitative impact assessment for the Project**

Species	MU	MU refence population	UK MU reference population	Density (individuals/km <sup>2</sup> )	Reference
Harbour porpoise	NS	346,601	159,632	0.752	Derived from SCANS-IV density surfaces (Gilles <i>et al.</i> , 2025).
				0.5985	SCANS-IV survey block NS-D (Gilles <i>et al.</i> , 2023).
				0.087	Site-specific DAS.
Bottlenose dolphin	CES	226		0.116 (within 2km of the coast)	Calculated from Cheney <i>et al.</i> (2024).
				0.0298 (beyond 2km of the coast)	SCANS-III survey block R (Hammond <i>et al.</i> , 2021).
	GNS	2,022	1,885	0.001	Derived from SCANS-IV density surfaces (Gilles <i>et al.</i> , 2025).
				0.0298	SCANS-III survey block R (Hammond <i>et al.</i> , 2021).
Short-beaked common dolphin	CGNS	102,656	57,417	0.017	Derived from SCANS-IV density surfaces (Gilles <i>et al.</i> , 2025).
White-beaked dolphin		43,951	34,025	0.416	Derived from SCANS-IV density surfaces (Gilles <i>et al.</i> , 2025).
				0.1775	SCANS-IV survey block

Species	MU	MU refence population	UK MU reference population	Density (individuals/km <sup>2</sup> )	Reference
					NS-E (Gilles <i>et al.</i> , 2023).
				0.023	Site-specific DAS.
Risso's dolphin		12,262	8,687	0.0702	SCANS-IV survey block NS-E (Gilles <i>et al.</i> , 2023).
				0.002	Site-specific DAS.
Atlantic white-sided dolphin		18,128	12,293	0.0146	SCANS-IV survey block NS-E (Gilles <i>et al.</i> , 2023).
Minke whale		20,118	10,288	0.05	Derived from SCANS-IV density surfaces (Gilles <i>et al.</i> , 2025).
				0.0419	SCANS-IV survey block NS-D (Gilles <i>et al.</i> , 2023).
Humpback whale	Qualitative assessment				
Grey seal	East Scotland SMA	6,298		0.01 (grid-cell specific)	Carter <i>et al.</i> (2025).
				0.0021	Site-specific DAS.
	North Coast & Orkney SMA	34,266		0.01 (grid-cell specific)	Carter <i>et al.</i> (2025).
				0.0021	Site-specific DAS.
	Moray Firth SMA	1,365		0.01 (grid-cell specific)	Carter <i>et al.</i> (2025).
				0.0021	Site-specific DAS.
Harbour seal	East Scotland SMA	383		0.0000011 (Grid-cell specific)	Carter <i>et al.</i> (2022).

Species	MU	MU refence population	UK MU reference population	Density (individuals/km <sup>2</sup> )	Reference
	North Coast & Orkney SMA	1,951			
	Moray Firth SMA	1,365			

### Designated sites

- 11.6.1.9 Designated sites considered within this Chapter are shown in **Table 11.8**, in order of distance from the Project. The Project OAA is not located within any designated sites, but the ECC overlaps with the Southern Trench MPA which is designated for minke whale (**Volume 2, Figure 11.3: Marine mammal designated sites**).
- 11.6.1.10 Potential impacts on designated sites within the National Site Network, which includes Special Areas of Conservation (SACs) and Special Protection Areas (SPAs), designated under domestic legislation transposing the EC Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC), are assessed through the Habitats Regulations Appraisal (HRA). Accordingly, impacts to marine mammal SACs are addressed in the accompanying **Report to Inform Appropriate Assessment (RIAA)** submitted alongside the EIA Report for the Project.
- 11.6.1.11 MPAs are designated under the Marine (Scotland) Act 2010 and are therefore considered independently from SACs and SPAs. Under the 2010 Act, public authorities must ensure that any authorised activity does not pose a significant risk to the achievement of the site's conservation objectives (Section 83(4) of the 2010 Act). As such, potential impacts on MPAs, including those with marine mammal features, are assessed separately and presented in **Nature Conservation Marine Protected Area Assessment**.

**Table 11.8 Designated sites for the protection of marine mammals**

Species	Designated site name	Distance from (km)	
		OAA	Offshore export cable corridor
Minke whale	Southern Trench MPA	53.59	0.00
Grey seal	Ythan Estuary seal haul-out site	105.67	27.04
Bottlenose dolphin	Moray Firth SAC	150.57	89.25
Harbour seal	Firth of Tay and Eden Estuary SAC	204.79	136.89
Harbour seal	Sanday SAC	142.26	158.54
Grey seal	Isle of May SAC	228.68	161.51

Species	Designated site name	Distance from (km)	
		OAA	Offshore export cable corridor
Grey seal	Berwickshire and North Northumberland Coast SAC	245.12	180.08
Grey seal	Faray and Holm of Faray SAC	155.53	169.80
Risso's dolphin	North-east Lewis MPA	293.76	254.88
Minke whale	Sea of the Hebrides MPA	332.34	259.98
Harbour porpoise	Southern North Sea SAC	291.24	264.18

## 11.6.2 Future baseline

- 11.6.2.1 In accordance with the EIA Regulations, the EIA Report includes a description of the current environmental baseline and how it may evolve in the absence of the Project. This provides essential context for assessing potential impacts on marine mammals.
- 11.6.2.2 Although there is inherent uncertainty over the 35-year operational lifetime of each phase of the Project, the current baseline is considered sufficient for assessment purposes. Whilst there will be natural variability of marine mammal populations, the baseline has been informed by the most recent as well as long-term datasets, which indicate current trends in populations and distribution and provide context for potential future baseline.
- 11.6.2.3 Future changes to the baseline may result from broad environmental shifts, particularly those driven by climate change. Climate change is expected to influence marine mammal populations through a range of pathways, including altered prey availability, altered habitat suitability, increased disease susceptibility, and greater exposure to pollutants (Boyd and Hanson, 2021; Martay *et al.*, 2023). For example, Townhill *et al.* (2024) identified a decline in harbour porpoise biomass in the central North Sea, linked to reduced sand eel availability following declines in phytoplankton productivity.
- 11.6.2.4 There is growing evidence of range shifts among marine mammals, with some warmer-water species moving northward in response to rising sea temperatures and changes in prey distribution (Martin *et al.*, 2023; Simmonds and Elliott, 2008; MacLeod, 2009). Species with more restricted habitat preferences, such as harbour porpoise and minke whale, may be particularly vulnerable to habitat loss if such shifts continue (Evans and Bjørge, 2013).
- 11.6.2.5 Although there is currently no conclusive evidence that climate change has directly impacted seals, it is anticipated to become a key driver of future population changes. Townhill *et al.* (2024) predicts declines in grey and harbour seal biomass along the UK coast due to rising temperatures, reduced salinity, and lower primary productivity. Observations such as early moulting in Cornish grey seals in August 2023 (Cornish Seal Sanctuary, 2023) may already reflect seasonal shifts. Additionally, sea level rise and increased storm activity could degrade or eliminate key haul-out and breeding sites, particularly in low-lying coastal areas, potentially increasing pup mortality (Gazo *et al.*, 2000; Lea *et al.*, 2009).
- 11.6.2.6 Species responses to climate change are complex and may be further influenced by anthropogenic pressures such as construction, pollution, and fishing (Poloczanska *et al.*, 2016). Predicting future population trajectories remains challenging due to limited

monitoring at appropriate spatial and temporal scales. The timing and extent of climate-driven changes are also uncertain.

- 11.6.2.7 Importantly, any climate-related impacts on marine mammals will occur independently of the Project. Given the scale of predicted effects, no significant change in the assessed impact significance is anticipated as a result of climate change.

## 11.7 Basis for EIA Report

### 11.7.1 Maximum design scenario

- 11.7.1.1 The process of assessing using a parameter-based design envelope approach means that the assessment considers a maximum design scenario whilst allowing the flexibility to make improvements in the future in ways that cannot be predicted at the time of submission of the planning application, marine licences applications and section 36 consent.
- 11.7.1.2 The assessment of the maximum adverse scenario for each receptor establishes the maximum potential adverse effect and as a result effects of greater adverse significance would not arise should any other scenario (as described in **Chapter 4: Project Description**) to that assessed within this Chapter be taken forward in the final Project design.
- 11.7.1.3 The maximum design scenario parameters that have been identified to be relevant to marine mammals are outlined in **Table 11.9** and are in line with the project design envelope (**Chapter 4: Project Description**).

**Table 11.9 Maximum design scenario for impacts on marine mammals**

Activity / impact	Maximum design scenario parameter	Justification
<b>Construction</b>		
<b>Impact C1: Auditory injury (PTS) from increased underwater noise during pre-construction surveys</b>	<b>Indicative pre-construction geophysical survey equipment parameters may include:</b> <ul style="list-style-type: none"> <li>• Multibeam Echo Sounder (MBES);</li> <li>• Sidescan Sonar (SSS);</li> <li>• Ultra-short Baseline (USBL);</li> <li>• Sub-bottom Profiler (SBP); and</li> <li>• Ultra-High Resolution Seismic (UHRS) sparkers.</li> </ul>	These types of geophysical surveys and duration represents the maximum potential for underwater noise from geophysical surveys which has the potential to cause auditory injury (PTS) of marine mammals. PTS can reduce individual's ability to communicate, forage, and navigate.
<b>Impact C2: Auditory injury (PTS) from increased underwater noise during installation of driven piles</b>	Construction window of up to 12 years.  <b>WTG anchor installation with driven piles:</b> <ul style="list-style-type: none"> <li>• 8 driven pile anchors per floating unit, total 1,800 driven piles;</li> <li>• maximum pile length: 30m;</li> <li>• maximum pile diameter: 3m;</li> <li>• maximum hammer energy: 3,500kJ;</li> <li>• maximum number of driven piles per day per location is 2;</li> <li>• maximum number of concurrent piling locations is 2;</li> <li>• maximum hours of piling per driven pile is 2.35; and</li> <li>• maximum number of piling days is 1,800 (assuming one driven pile installed per day).</li> </ul> <b>Offshore substation foundation installation with driven piles:</b> <ul style="list-style-type: none"> <li>• 4 offshore substations with jacket foundations secured by driven piles;</li> <li>• 48 driven piles (12 per offshore substation);</li> <li>• maximum pile diameter: 3m;</li> <li>• maximum pile length: 95m;</li> <li>• maximum hammer energy: 3,500kJ;</li> <li>• maximum number of driven piles per day per location is 2;</li> </ul>	Impulsive noise created during piling for the installation of the offshore substations and RCP foundations, and WTG anchors, has the potential to cause auditory injury (PTS) of marine mammals. PTS can reduce individual's ability to communicate, forage, and navigate.  The scenario with the maximum number of piling days represents the temporal worst case.  The scenario with the maximum predicted impact range for underwater noise represents the spatial worst case. This is described in <b>Section 11.8.3</b> .

Activity / impact	Maximum design scenario parameter	Justification
	<ul style="list-style-type: none"> <li>• maximum number of concurrent piling locations is 2;</li> <li>• maximum hours of piling per driven pile is 2.35; and</li> <li>• maximum number of piling days is 48 (assuming one pile installed per day).</li> </ul> <p><b>RCP foundation installation with driven piles:</b></p> <ul style="list-style-type: none"> <li>• 2 RCPs with jacket foundation secured by driven piles;</li> <li>• 8 driven piles (4 per RCP);</li> <li>• maximum pile diameter: 3m;</li> <li>• maximum pile length: 95m;</li> <li>• maximum hammer energy: 3,500kJ;</li> <li>• maximum number of driven piles per day per location is 2;</li> <li>• maximum number of concurrent piling locations is 2;</li> <li>• maximum hours pilling per driven pile is 2.35; and</li> <li>• maximum number of piling days is 8 (assuming one pile installed per day).</li> </ul> <p><b>Maximum number of piling days: 1,800 (WTG anchors) + 48 (offshore substations) + 8 (RCPs) = 1,856 days.</b></p>	
<p><b>Impact C3: Auditory injury from increased underwater noise during other construction activities</b></p>	<p><b>Array cable installation:</b></p> <ul style="list-style-type: none"> <li>• 225 array cables;</li> <li>• total array cable length of 680km; and</li> <li>• cable burial method of ploughing.</li> </ul> <p><b>Offshore export cable installation:</b></p> <ul style="list-style-type: none"> <li>• 5 offshore export cable trenches (these may include more than one cable per trench);</li> <li>• 140km offshore grid transmission route length per trench; and</li> <li>• cable burial method of ploughing.</li> </ul>	<p>Impulsive noise has a greater risk of causing marine mammals injury compared to non-impulsive noise; however, non-impulsive sound (as generated by these other construction activities) over a long period can cause PTS if the sound source is loud enough and within an individual's hearing sensitivity.</p> <p>The types of construction activity and duration of construction represents the maximum potential for underwater noise from other construction activities. <b>Section 11.9.4</b> assesses the various activities considered for other construction noise sources to account for the worst-case scenario.</p>

Activity / impact	Maximum design scenario parameter	Justification
<b>Impact C4: Indirect effects on marine mammals via changes in prey availability</b>	See worst case assessment scenario for the benthic, epibenthic and intertidal (including shellfish) ecology assessment ( <b>Chapter 10: Benthic, Epibenthic and Intertidal Ecology</b> , Table 10.7, Impacts C1 to C5) and for the fish ecology assessment ( <b>Chapter 13: Fish Ecology</b> , Table 13.7, Impacts C1 to C8).	Potential change to prey availability and distribution due to increased noise could negatively affect foraging of marine mammals.
<b>C5: Disturbance from increased underwater noise during pre-construction surveys</b>	Refer to Impact C1.	These types of geophysical surveys and duration represents the maximum potential for underwater noise from geophysical surveys which has the potential to cause disturbance of marine mammals. Disturbance can reduce individual's ability to communicate, forage, and navigate.
<b>Impact C6: Disturbance from increased underwater noise during installation (for example anchor piles)</b>	Refer to Impact C2.	<p>Impulsive noise created during pile driving for installation of the offshore substations and RCP foundations, or WTG anchor, has the potential to cause disturbance or displacement of marine mammals. Disturbance can result in temporary displacement from breeding and foraging sites and can reduce individual's ability to communicate, forage, and navigate.</p> <p>The scenario with the maximum number of piling days represents the temporal worst case.</p> <p>The scenario with the maximum predicted impact range for underwater noise represents the spatial worst case.</p>
<b>Impact C7: Disturbance from other construction activities</b>	Refer to Impact C3.	<p>Non-impulsive sound has the potential to disturb or inhibit an individual's ability to communicate if the noise is above the ambient soundscape.</p> <p>The type of construction activity and duration of construction represents the maximum potential</p>

Activity / impact	Maximum design scenario parameter	Justification
		for underwater noise from other construction activities.
<b>Impact C8: Vessel collisions from increased vessel presence and traffic</b>	<p>See worst case assessment scenario for the shipping &amp; navigation assessment in <b>Chapter 15: Shipping and Navigation</b>, Table 15.7.</p> <p>Up to 10 vessels would be on site at any one time. It is estimated that approximately 3,838 individual vessels trips would be required over the 12-year construction stage.</p>	<p>Vessel collision with marine mammals can result in injury or death.</p> <p>The maximum number of vessels and associated vessel movements represents the maximum potential for collision risk.</p>
<b>Impact C9: Disturbance from increased vessel presence and traffic</b>	Refer to Impact C8.	<p>Local disturbance from vessel presence and increased noise can influence surface behaviour, induce avoidance behaviour, and disrupt foraging.</p> <p>The maximum number of vessels and associated vessel movements represents the maximum potential for disturbance.</p>
<b>Impact C10: Auditory injury from unexploded ordnance (UXO) clearance</b>	<p>The type, size and number of possible UXO that might require clearance is currently unknown. The primary method of clearance will be low-order, with high-order being assessed as the worst-case scenario.</p> <p>An illustrative assessment is presented using charge weights (Trinitrotoluene (TNT) equivalent) ranging from 25 to 750kg, with an additional donor weight of 0.5kg, for high order detonation. A charge weight of 0.25kg is used to provide an illustrative assessment of a low order (deflagration) detonation.</p>	<p>Detonation of UXO could result in direct trauma or auditory damage causing PTS. PTS can reduce individual's ability to communicate, forage, and navigate.</p> <p>UXO clearance will be licensed under a separate Marine Licence but is included in the EIA Report for illustrative purposes.</p> <p>The maximum UXO charge size and clearance method will determine the greatest noise impacts and the worst-case scenario.</p>
<b>Impact C11: Disturbance from UXO clearance</b>	Refer to Impact C10.	Detonation of UXO could result in disturbance and behavioural change.

Activity / impact	Maximum design scenario parameter	Justification
		<p>UXO clearance will be licensed under a separate Marine Licence but is included in the EIA Report for illustrative purposes.</p> <p>The maximum UXO charge size and clearance method will determine the greatest noise impacts and the worst-case scenario.</p>
<b>O&amp;M</b>		
<p><b>Impact O1: EMF from cables</b></p>	<p>See Table 9.5 of <b>Chapter 9: Electromagnetic Fields</b> for the detailed design parameters for the maximum design scenarios for the array and offshore export cables.</p> <p>EMF analysis has determined that these parameters will create the maximum design scenario:</p> <ul style="list-style-type: none"> <li>• 8 buried 66kV array cables in close proximity to each will emit EMF at 50 micro tesla (<math>\mu\text{T}</math>) over a distance of approximately 0.8m from each array cable.</li> <li>• for unburied array cables this attenuates to 0.1<math>\mu\text{T}</math> over 40m and 0.05<math>\mu\text{T}</math> by 60m distance from the cable;</li> <li>• 5 HVDC offshore export cables will emit EMF at 50<math>\mu\text{T}</math> zone to approximately 1.1m around a monopole cable, and approximately 11m around any single pole of the bipole cable; and</li> <li>• 5 HVAC offshore export cables will emit EMF at 50<math>\mu\text{T}</math> zone to approximately 1.15m around the cable.</li> </ul>	<p>The scenario generates the maximum field that might affect marine mammals.</p> <p>The design, number and maximum spatial extent of the array and export cables represent the worst-case scenario for EMF impacts on marine mammals.</p> <p>The maximum length and operating current of the array and offshore export cables will result in the greatest potential for EMF effects. The minimum target cable burial depth represents the worst-case scenario as EMF exposure will be reduced with greater burial depth.</p> <p>Dynamic array cables represent the worst-case scenario for EMF due to being suspended in the water column and having a greater attenuation of EMF compared to buried cables.</p>
<p><b>Impact O2: Vessel collisions from increased vessel presence and traffic</b></p>	<p>See worst case assessment scenario for the shipping and navigation assessment in Table 15.7 of <b>Chapter 15: Shipping and Navigation</b>.</p> <p>Peak of up to seven O&amp;M vessels offshore with up to 364 round trips to port per year.</p>	<p>The maximum number of vessels and associated vessel movements represents the maximum potential for collision risk.</p>

Activity / impact	Maximum design scenario parameter	Justification
<p><b>Impact O3: Disturbance from increased vessel presence and traffic</b></p>	<p>Refer to Impact O2.</p>	<p>The maximum number of vessels and associated vessel movements represents the maximum potential for disturbance.</p>
<p><b>Impact O4: Long term displacement / habitat change / barrier effects due to offshore wind farm structures</b></p>	<p>Each phase will be operational for 35 years.</p> <p><b>WTGs: 452.74km<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• maximum mooring line footprint of 2,010,619.298m<sup>2</sup> / 2.011km<sup>2</sup> (per floating unit); total 452.47km<sup>2</sup> for 225 floating units;</li> <li>• 8 anchors per floating unit, total number of anchors 8 x 225 =1,800;</li> <li>• worst-case assumed: drag embedment anchor; and</li> <li>• maximum total area of seabed covered by 1 anchor: 12m x 12.5m = 150m<sup>2</sup>, total 270,000m<sup>2</sup> for 1,800 anchors.</li> </ul> <p><b>Array cables: 2.04km<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• 225 array cables;</li> <li>• secondary protection rock placement, localised: concrete mattresses and bags;</li> <li>• 680km total array cable length;</li> <li>• 136km length of unburied cable;</li> <li>• conservative cable corridor swathe width of 15m assumed for areas of cable protection, and;</li> <li>• maximum total area of seabed covered by cable protection based on conservative 136km x 0.015km = 2.04km<sup>2</sup>.</li> </ul> <p><b>SDCs: 47,880m<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• 45 SDCs;</li> <li>• assumed worst-case is gravity base foundations; and</li> <li>• dimensions of SDC including cable protection: 38m x 28m, footprint is 1,064m<sup>2</sup> and total 47,880m<sup>2</sup> for 45 SDCs.</li> </ul> <p><b>Offshore substations: 39,600m<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• 4 offshore substations with jacket foundations secured by suction caisson;</li> </ul>	<p>The maximum design scenario is defined by the maximum area of seabed lost by the footprint of the anchors on the seabed, offshore substation and RCP jacket foundations, scour and cable protection, cable crossings and mooring lines in the water column represents the maximum potential for habitat loss / change and barrier effects.</p> <p>Four offshore substations are considered the maximum design scenario over subsea substations due to having the largest seabed footprint.</p> <p>Maximum design scenario footprints for cable protection have been determined based on:</p> <ul style="list-style-type: none"> <li>• 20% of total cable length requiring cable protection for the array cables; and</li> <li>• 20% of total cable trench length requiring cable protection for the offshore export cables.</li> </ul>

Activity / impact	Maximum design scenario parameter	Justification
	<ul style="list-style-type: none"> <li>• maximum seabed footprint (including scour protection): 110m x 90m, footprint is 9,900m<sup>2</sup> and total 39,600m<sup>2</sup> for 4 offshore substations.</li> </ul> <p><b>Offshore export cables: 10.5km<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• 5 offshore export cable trenches;</li> <li>• 140km offshore grid transmission rout length per trench;</li> <li>• conservative cable corridor swathe width of 15m assumed for areas of cable protection, and;</li> <li>• maximum seabed footprint (including cable protection): 140km x 0.015km = 2.1km<sup>2</sup> per cable trench and total 10.5km<sup>2</sup> for 5 cable trenches;</li> </ul> <p><b>Cable crossings: 231,000m<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• 6 cable crossings per trench within the OAA with construction footprint of 150m x 11m = 1,650m<sup>2</sup>, total of 49,500m<sup>2</sup> for 6 cable crossings for 5 cable trenches; and</li> <li>• 22 cable crossings along the offshore export cable corridor with construction footprint of 150m x 11m = 1,650m<sup>2</sup>, total of 181,500m<sup>2</sup> for 22 cable crossings for 5 cable trenches.</li> </ul> <p><b>RCPs: 8,450m<sup>2</sup></b></p> <ul style="list-style-type: none"> <li>• 2 RCPs with jacket foundations secured by suction caisson;</li> <li>• maximum seabed footprint (including scour protection): 65m x 65m = 4,225m<sup>2</sup> and total 8,450m<sup>2</sup>.</li> </ul> <p><b>Maximum long-term habitat loss = 465,607,000m<sup>2</sup> (465.607km<sup>2</sup>).</b></p>	
<p><b>Impact O5: Entanglement in lines and cables for example mooring lines and array cables</b></p>	<p><b>Mooring lines:</b></p> <ul style="list-style-type: none"> <li>• 1,800 moorings lines in total (8 mooring lines per WTG);</li> <li>• 800m radius per individually moored floating unit (maximum mooring footprint of 2,010,619.298m<sup>2</sup> or 2.011km<sup>2</sup>;</li> <li>• catenary mooring line; and</li> <li>• mooring line material of rope, links, chain buoyancy and / or clump weights.</li> </ul>	<p>The design, dimensions and maximum spatial extent of the mooring lines and array cables represent the maximum potential for entanglement.</p>

Activity / impact	Maximum design scenario parameter	Justification
	<p><b>Array cables:</b></p> <ul style="list-style-type: none"> <li>• up to 225 array cables</li> <li>• 136km of unburied array cable (assuming a worst case of 20% of cable length cannot be buried).</li> </ul> <p>The presence of the moorings and dynamic cables will be restricted to the array area only.</p> <p>The operational lifetime of the Project is 35 years per phase.</p>	
<p><b>Impact O6: Increased underwater noise for example operational noise and mooring noise</b></p>	<p><b>WTGs:</b></p> <ul style="list-style-type: none"> <li>• up to 225 WTGS;</li> <li>• 1,800 moorings lines in total (8 mooring lines per WTG);</li> <li>• 800m radius per individually moored floating unit (maximum mooring footprint of 2,010,619.298m<sup>2</sup> or 2.011km<sup>2</sup>; and</li> <li>• mooring line material of rope, links, chain buoyancy and / or clump weights.</li> </ul> <p>The operational lifetime of the Project is 35 year per phase.</p>	<p>The design, number and capacity of the WTGs, and the design, dimensions and maximum spatial extent of the mooring lines, will lead to the maximum underwater noise that represents the worst-case scenario for noise-related impacts.</p> <p>There are no reliable noise thresholds that would be recommended to identify disturbance for rare / intermittent impulses of this type. Mooring lines associated with floating WTGs have been described as producing a ‘snapping’ noise related to tension release. As any snapping occurs at an average rate of less than one snap per hour, disturbance leading to avoidance behaviour is considered unlikely. The semi-submersible floating unit are the worst-case scenario in this instance as it is not a taut system.</p>
<p><b>Impact O7: Indirect impacts on marine mammals via changes in prey availability</b></p>	<p>See worst case assessment scenario for the benthic, epibenthic and intertidal (including shellfish) ecology assessment (<b>Chapter 10: Benthic, Epibenthic and Intertidal Ecology</b>, Impacts O1 to O7) and for the fish ecology (<b>Chapter 13: Fish Ecology</b>, Impacts O1 to O11).</p>	<p>Potential change to prey availability and distribution could negatively affect foraging of marine mammals.</p>

Activity / impact	Maximum design scenario parameter	Justification
<b>Decommissioning</b>		
<b>Impact D1: Auditory injury from increased underwater noise.</b>	The worst-case design scenario will be equal to (or less than) that of the construction stage. Refer to Impacts C1, C2, C3 and C9.	Refer to Impacts C1, C2, C3 and C9.
<b>Impact D2: Disturbance from decommissioning activities.</b>	The worst-case design scenario will be equal to (or less than) that of the construction stage. Refer to Impacts C5, C6 and C10.	Refer to Impacts C5, C6 and C10.
<b>Impact D3: Vessel collisions from increased vessel presence and traffic.</b>	The worst-case design scenario will be equal to (or less than) that of the construction stage. Refer to Impact C7.	Refer to Impact C7.
<b>Impact D4: Disturbance from increased vessel presence and traffic.</b>	The worst-case design scenario will be equal to (or less than) that of the construction stage. Refer to Impact C8.	Refer to Impact C8.
<b>Impact D5: Indirect effects on marine mammals via changes in prey availability.</b>	The worst-case design scenario will be equal to (or less than) that of the construction stage. Refer to Impact C4.	Refer to Impact C4.

## 11.7.2 Embedded environmental measures

- 11.7.2.1 As part of the Project design process, a number of embedded environmental measures have been adopted to reduce the potential for adverse impacts on marine mammals. These embedded environmental measures have evolved over the development process as the EIA has progressed and in response to consultation.
- 11.7.2.2 These measures also include those that have been identified as good or standard practice and include actions that would be undertaken to meet existing legislation requirements. As there is a commitment to implementing these embedded environmental measures, and also to various standard sectoral practices and procedures, they are considered inherently part of the design of the Project and are set out in the EIA Report.
- 11.7.2.3 **Table 11.10** sets out the relevant embedded environmental measures within the design and how these affect the marine mammal assessment.
- 11.7.2.4 Further detail on the embedded environmental measures in **Table 11.10** is provided in the **Volume 3, Appendix 5.2: Commitments Register**, which sets out how and where particular embedded environmental measures will be implemented and secured.

**Table 11.10 Relevant marine mammal embedded environmental measures**

ID	Environmental measure proposed	Project stage measure introduced	How the environmental measures will be secured	Relevance to marine mammal assessment
M-028	An <b>Outline Scour Protection Plan</b> has been submitted within this Application ( <b>Volume 4</b> ), and includes details of the need, type, quantity and installation methods for scour protection. A Final Scour Protection Plan will be completed prior to construction commencing and will include measures during the O&M stage such as periodic inspection and maintenance requirements and will be submitted to MD-LOT for approval.	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	The method of installation could have an impact (for example, disturbance) on marine mammals; therefore, an appropriate installation method will be used to limit impacts on marine mammals.
M-032	An <b>Outline Marine Mammal Mitigation Protocol</b> (MMMP) has been submitted with this Application ( <b>Volume 4</b> ). The Final MMMP will be completed prior to construction and submitted to MD-LOT for approval. The MMMP will be adhered to and subsequently mitigate potential impacts from underwater noise on marine mammals and fish through good or standard practice actions in order to meet legislative requirements.	Scoping	s.36 conditions and marine licences conditions.	The MMMP includes mitigation protocols to minimise the risk of injury to marine mammals from piling, UXO clearance, and pre-construction surveys. Development of and adherence to a MMMP will ensure that potential impacts from underwater noise on marine mammals are mitigated.
M-033	An <b>Outline Marine Pollution Contingency Plan</b> (MPCP) (Appendix to the <b>Environmental Management Plan</b> (EMP)) has been submitted with this Application ( <b>Volume 4</b> ). This Outline MPCP outlines details of procedures to protect personnel working and to safeguard the marine environment and mitigation measures in the event of an accidental pollution event arising from offshore operations relating to the Project. The Final MPCP will be completed prior to construction commencing and submitted to MD-LOT for approval and will include relevant key emergency contact details.	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	Development of and adherence to a MPCP will help to prevent or mitigate the potential risk of accidental pollution, in turn reducing or preventing risks to marine mammals.

ID	Environmental measure proposed	Project stage measure introduced	How the environmental measures will be secured	Relevance to marine mammal assessment
M-039	<p>An <b>Outline Vessel Management and Navigation Safety Plan</b> has been submitted with this Application (<b>Volume 4</b>). The Final Vessel Management and Navigation Safety Plan will be completed prior to construction commencing and submitted to MD-LOT for approval. The Final Plan will:</p> <ul style="list-style-type: none"> <li>a) confirm the types and numbers of vessels that will be engaged on the Project;</li> <li>b) consider vessel coordination including indicative transit route planning;</li> <li>d) describe measures put in place by the Project related to navigational safety, including information on Safety Zones, charting construction buoyage, temporary lighting and marking; and</li> <li>e) provide a means of notification of Project activity to other sea users (e.g. via Notice to Mariners).</li> </ul>	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	The Vessel Management and Navigation Safety Plan will include management of vessel transit routes and speeds which will reduce potential impacts on marine mammals (for example, collision risk or disturbance).
M-054	<p>A detailed Cable Burial Risk Assessment (CBRA) will be undertaken to enable informed judgements about burial depth. This should reduce the risk of buried cables reemerging whilst also limiting the amount of sediment disturbance to that which is necessary. The array and export cables will typically be buried at a target burial depth between 1m to 2m below the seabed surface. The final depth of the cable will be dependent on the seabed mobility and CBRA. The CBRA will manage and mitigate risks from loading and sediment transport across the seabed. The CBRA will be included within the Final Cable Plan.</p>	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	Buried cables will reduce the risk of EMF and entanglement impacts on marine mammals.
M-057	<p>Burial of the cables where possible and / or use of external cable protection such as rock placement and / or concrete mattresses. Concrete mattresses only used in isolation in non-fished areas to ensure no snagging issues for fisheries industry. Where appropriate, nature-inclusive design options will be considered in the selection and placement of cable protection measures.</p>	Scoping Amended at EIA Report.	Project description.	This will reduce the risk of EMF and entanglement impacts on marine mammals.

ID	Environmental measure proposed	Project stage measure introduced	How the environmental measures will be secured	Relevance to marine mammal assessment
M-105	An <b>Outline Piling Strategy</b> has been submitted with this Application ( <b>Volume 4</b> ). The Final Piling Plan will be completed prior to construction commencing and submitted to MD-LOT for approval. It will detail the method of pile installation and associated underwater noise levels. It will describe any mitigation measures to be implemented (e.g. soft start and ramp up measures, or the use of acoustic deterrent devices) prior to and during pile installation to manage the effects of underwater noise.	Scoping Amended at EIA Report.	Piling strategy is required under Section 36 and marine licences conditions.	This will reduce the risk of auditory injury and disturbance from underwater noise during pile installation on marine mammals.
M-106	The development of and adherence to a Decommissioning Programme. The Decommissioning Programme will outline measures for the decommissioning of the Project. The Decommissioning Programme would be submitted prior to construction commencing to MD-LOT and approved by Scottish Ministers prior to construction.	Scoping Amended at EIA Report.	Required under Sections 105 and 114 (Energy Act 2004) and marine licences conditions.	Development of and adherence to a decommissioning programme will help mitigate the potential risks that could arise for marine mammals during the decommissioning stage.
M-114	Use of 'low order' techniques such as deflagration for UXO disposal, where possible and required.	Scoping	Required under the Habitats Regulations and marine licences conditions.	This will reduce the risk of auditory injury and disturbance on marine mammals from UXO disposal.
M-115	UXO Management Plan to mitigate any potential for UXO within the offshore construction area and also disposal once encountered.	Scoping Amended at EIA Report.	s.36 conditions and marine licences conditions.	This will reduce the risk of auditory injury and disturbance on marine mammals from UXO disposal.
M-120	An <b>Outline Construction Method Statement (CMS)</b> has been submitted with this Application ( <b>Volume 4</b> ).  The Final CMS will be completed prior to construction commencing and submitted to MD-LOT for approval. The Final CMS will include:	EIA Report.	s.36 conditions and marine licences conditions.	The CMS will provide details of construction methods and guides the delivery of mitigation to reduce the potential risks that could arise for marine mammals during construction.

ID	Environmental measure proposed	Project stage measure introduced	How the environmental measures will be secured	Relevance to marine mammal assessment
	<p>a) details of the commence dates, duration and phasing of key elements of construction, working areas, the construction procedures and good working practices;                      b) details of the roles and responsibilities; and                      c) details of how the construction related mitigation step proposed are to be delivered.</p>			
<p><b>M-121</b></p>	<p>An <b>Outline Environmental Management Plan (EMP)</b> has been submitted with this Application (<b>Volume 4</b>) and includes the following Appendix:                      - <b>Outline Marine Pollution Contingency Plan.</b></p> <p>The Final EMP will be completed prior to construction commencing and submitted to MD-LOT for approval. The Final EMP will be implemented by the contractor(s). The contractor(s) will ensure that the relevant environmental measures within the EMP and health and safety procedures are implemented. The Final EMP will identify the project management structure roles and responsibilities with regard to managing and reporting on the environmental impact of the construction and O&amp;M stages. Other measures that feed into the EMP include:</p> <ul style="list-style-type: none"> <li>- A Waste Management Plan (WMP) will be developed as an Appendix of the EMP post-submission to manage all waste generated during the construction and operation stages of the Project. The WMP will be appended to the Environmental Management Plan. The WMP will follow the principles of the waste hierarchy (Department for Environment, Food &amp; Rural Affairs, 2001) which consists of: prevention, re-use, recycle, other recovery and disposal.</li> <li>- The Final EMP will include a Chemical Risk Assessment to identify, evaluate and mitigate potential environmental and health risks associated with the use, storage and disposal of hazardous substances during O&amp;M and decommissioning stages of the Project.</li> </ul>	<p>EIA Report.</p>	<p>s.36 conditions and marine licences conditions.</p>	<p>The EMP includes mitigation protocols to minimise the risk of injury to marine mammals from piling, UXO clearance, and pre-construction surveys.</p>

ID	Environmental measure proposed	Project stage measure introduced	How the environmental measures will be secured	Relevance to marine mammal assessment
	The EMP will be the securing mechanism for many measures.			
<b>M-122</b>	Development of and adherence to a Offshore Operations and Maintenance Plan, which will confirm the Project's operations and maintenance activities. This will be submitted to MD-LOT for approval post-consent.	EIA Report.	s.36 conditions and marine licences conditions.	The OOMP will outline the O&M activities and help mitigate the potential risks that could arise for marine mammals during the O&M stage.
<b>M-186</b>	Crossing or laying of cables over or adjacent to known or future cables will be subject to crossing and / or proximity agreements.	EIA Report.	Secured by commercial agreements with pipeline and cable operators.	This has the potential to manage EMF impacts on marine mammals.
<b>M-187</b>	Where offshore export cables must cross third party infrastructure, such as existing cables and pipelines, both the third-party asset and the installed cables will be protected.	EIA Report.	Secured by commercial agreements with pipeline and cable operators.	This will reduce the risk of EMF impacts on marine mammals.

## 11.8 Methodology for EIA Report

### 11.8.1 Introduction

- 11.8.1.1 The project-wide approach to assessment is set out in **Chapter 5: Approach to the EIA**. Whilst this has informed the approach that has been used in this marine mammal assessment, it is necessary to set out how this methodology has been applied, and adapted as appropriate, to address the specific needs of the marine mammal assessment.
- 11.8.1.2 In some instances, the Project will retain flexibility in terms of the options for methods and approaches to be applied during the construction stage. Where this is the case, for each combination of impact and receptor, the assessment will be based on a precautionary worst-case scenario. Where this approach is taken it will be clearly indicated and will include a definition of the worst-case scenario for the specific assessment.

### 11.8.2 Significance evaluation methodology

#### Overview

- 11.8.2.1 The criteria for determining the significance of effects comprises a two-stage process that involves defining the sensitivity of receptors and the magnitude of the impacts from the Project. This Section describes the criteria applied in this Chapter to assign values to the sensitivity of the receptors (**Table 11.11**) and the magnitude of potential impacts (**Table 11.12**). The terms used to define sensitivity and magnitude are based on those which are described in further detail in **Chapter 5: Approach to the EIA**.
- 11.8.2.2 Both sensitivity and magnitude are assessed on a four-level scale: **high**, **medium**, **low** and **negligible**. Magnitude is also defined in terms of whether the impact is adverse, neutral, or positive (see **Chapter 5: Approach to the EIA**).

#### Sensitivity of receptor

- 11.8.2.3 Sensitivity refers to the potential of a receptor to be significantly affected (NatureScot, 2018). The sensitivity criteria for marine mammals is provided in **Table 11.11**. The sensitivity is assessed by evaluating each receptor's adaptability or tolerance to potential impacts, considering also the recoverability from the effect. Professional judgement is used when considering the information available on the responses of various marine mammal species to different stimuli (for example, underwater noise) and whether their ecology makes them sensitive to potential impacts.
- 11.8.2.4 The value of the receptor is not included in the definitions of criteria used to determine the sensitivity of marine mammals. All marine mammals are considered to have a very high value given that all are either listed under Annex II of the Habitats Directive as species of Community Interest or are listed under Annex IV of the Habitats Directive as species in need of strict protection (EPS).

**Table 11.11 Receptor sensitivity criteria for marine mammals**

Sensitivity	Definition
<b>Negligible</b>	<p><b>Adaptability:</b> The receptor is able to avoid or adapt to an impact so that individual survival and reproduction rates are not affected.</p> <p><b>Tolerance:</b> The receptor is able to tolerate the proposed form of change without any impact on survival or reproduction rates.</p> <p><b>Recoverability:</b> The effect on the receptor is anticipated to be short-term and temporary, and the receptor will have the ability to fully recover once the impact has ended.</p>
<b>Low</b>	<p><b>Adaptability:</b> The receptor has reasonable ability to avoid or adapt to an impact so that individual survival and reproduction rates are unlikely to be affected.</p> <p><b>Tolerance:</b> The receptor has reasonable tolerance to accommodate the proposed form of change with unlikely change in the survival or reproductive rates.</p> <p><b>Recoverability:</b> The effect on the receptor is anticipated to be medium-term once the impact has ended and the receptor will have the ability to fully recover from an impact.</p>
<b>Medium</b>	<p><b>Adaptability:</b> The receptor has limited ability to avoid or adapt to an impact so that individual survival and reproduction rates may be affected.</p> <p><b>Tolerance:</b> The receptor has limited tolerance to accommodate the proposed form of change and individual survival and reproduction rates may be affected.</p> <p><b>Recoverability:</b> The effect on the receptor is anticipated to be long-term and the receptor will have limited ability to recover from any impact on vital rates (reproduction and survival rates).</p>
<b>High</b>	<p><b>Adaptability:</b> The receptor cannot avoid or adapt to an impact so that individual survival and reproduction rates are affected.</p> <p><b>Tolerance:</b> The receptor has no tolerance to accommodate the proposed form of change and effect will cause a change in both individual reproduction and survival rates.</p> <p><b>Recoverability:</b> The effect on the receptor is anticipated to be permanent and the receptor will not have any ability to recover from an impact on vital rates (reproduction and survival rates).</p>

### Magnitude of impact

11.8.2.5 In assigning magnitude, the duration, frequency and probability of the impact, as well as the consequences of the effect, which takes into account the scale of effect relative to the population, are considered. The magnitude criteria for marine mammals is provided in **Table 11.12**. It is based upon the technical expert's experience and judgement as well as available information from the literature and Project-specific modelling.

**Table 11.12 Impact magnitude criteria for marine mammals**

Magnitude	Definition
Negligible	<p><b>Duration:</b> The impact is anticipated to result in a change to the receptor that will last a day at most.</p> <p><b>Frequency:</b> The impact will occur once or infrequently throughout a relevant project stage.</p> <p><b>Probability:</b> The effect is unlikely to occur.</p> <p><b>Consequences (adverse):</b> The impact would result in a very short term, recoverable change to a very small proportion of the population and would not alter the population size or trajectory.</p> <p><b>Consequences (positive):</b> Very minor benefit to the supporting habitat influencing foraging efficiency of a limited number of individuals but not increasing population health and/or size.</p>
Low	<p><b>Duration:</b> The impact is anticipated to result in a change to the receptor that will last days at most.</p> <p><b>Frequency:</b> The impact will occur occasionally throughout a relevant Project stage.</p> <p><b>Probability:</b> The effect may occur.</p> <p><b>Consequences (adverse):</b> The impact would result in a short-term or intermittent change to a small proportion of the population but is unlikely to alter the population trajectory.</p> <p><b>Consequences (positive):</b> Short term benefit to the supporting habitat resulting in increased reproductive potential but unlikely to increase population health and/or size.</p>
Medium	<p><b>Duration:</b> The impact is anticipated to result in a change to the receptor that will last for up to one year.</p> <p><b>Frequency:</b> The impact will occur frequently throughout a relevant project stage.</p> <p><b>Probability:</b> The effect is reasonably expected to occur.</p> <p><b>Consequences (adverse):</b> The impact would have a temporary change on medium proportion of individuals or a permanent impact on a small proportion of the population, although would not affect the long-term viability of the population.</p> <p><b>Consequences (positive):</b> Increase in population health and/or size as a result of benefits to the supporting habitat.</p>
High	<p><b>Duration:</b> The impact is anticipated to result in a permanent change to the receptor.</p> <p><b>Frequency:</b> The impact will occur constantly throughout the relevant project stage.</p> <p><b>Probability:</b> The impact is reasonably expected to occur.</p>

Magnitude	Definition
	<p><b>Consequences (adverse):</b> The impact would have a permanent change on a sufficient number of individuals to affect the long-term viability of the population or favourable conservation status.</p> <p><b>Consequences (positive):</b> Long term increase in the population size.</p>

### Significance evaluation

11.8.2.6 The significance of the effect upon marine mammals is determined by correlating the magnitude of the impact and the sensitivity of the receptor. The particular method employed for this assessment is presented in **Table 11.13**.

**Table 11.13 Matrix used for the assessment of significance of the effect**

		Magnitude of impact			
		High	Medium	Low	Negligible
Sensitivity of receptor	High	Major (Significant)	Moderate (Potentially Significant)	Minor (Not Significant)	Negligible (Not Significant)
	Medium	Moderate (Potentially Significant)	Moderate (Potentially Significant)	Minor (Not Significant)	Negligible (Not Significant)
	Low	Minor (Not Significant)	Minor (Not Significant)	Negligible (Not Significant)	Negligible (Not Significant)
	Negligible	Minor (Not Significant)	Negligible (Not Significant)	Negligible (Not Significant)	Negligible (Not Significant)

11.8.2.7 During the assessment of effects for each identified receptor, the value in **Table 11.11** will be combined with the magnitude of change from **Table 11.12** to produce an overall significance rating based on the evaluation matrix shown in **Table 11.13**. As a general rule, **Major** and **Moderate** effects are considered to be **Significant** and **Minor** and **Negligible** effects are considered to be **Not Significant**. However, professional judgement is applied, where appropriate, to determine significance of effect. Where effects are assessed, according to the matrix in **Table 11.13** to be **Potentially Significant** in EIA terms, professional judgement is applied to determine whether they are **Significant** or **Not Significant**. For the marine mammals assessment, an effect significance of **Moderate** or more is considered a '**Significant**' effect in EIA terms. A level of effect of **Minor** or less is considered '**Not Significant**' in EIA terms.

### 11.8.3 Assessment methodology for injury and disturbance from underwater noise during piling

- 11.8.3.1 The noise levels generated by piling were predicted by Subacoustech Environmental Ltd using their INSPIRE (Impulse Noise Sound Propagation and Impact Range Estimator) v5.3 model. Full details of the underwater noise terminology, modelling and the resulting impact areas and ranges are detailed in **Volume 3, Appendix 8.1**.
- 11.8.3.2 The Project design comprises the installation of up to 225 WTGs on floating units (with up to eight driven pile anchors per WTG), four offshore substations with a jacket foundation (requiring up to 12 driven piles per offshore substation) and two RCPs with a jacket foundation (requiring up to four driven piles per RCP).
- 11.8.3.3 The assessment of auditory injury and disturbance assumes piling at a single location alone (**Volume 2, Figure 11.4: Underwater noise modelling locations used for the piling assessment**). The worst-case scenario assumes up to two piles are installed at a single location in a single day (i.e., within any 24-hours). The modelling has been undertaken for at seven locations within the Project area, to ensure that the worst-case scenario is captured. The selection of the modelling locations for piling considered water depths, bathymetry and distance to shore when identifying the maximum design scenarios. Piling activities were modelled for driven pile anchors at one location within the OAA (the north corner), offshore substations were modelled in the four corners of the OAA (north, south-east, south-west and west corners), and RCPs were modelled at two locations within the cable corridor (north and south points).
- 11.8.3.4 Early in the Project's design evolution process, the southerly and northerly RCP locations were selected at locations along the offshore export cable corridor for the purposes of underwater noise modelling. These were in locations of relatively shallow and deeper water respectively. As the Project's design evolution progressed, the northerly RCP location was discounted as it was considered to be in an inappropriate location between the onshore and offshore substation locations (i.e. not close enough to the mid-point between the two substations) for the electrical engineering requirements of the Project's transmission. Therefore, the underwater noise modelling outputs for the northerly RCP location presented in **Volume 3, Appendix 8.1** have not been considered in this Chapter. It has not been deemed necessary to model an additional or replacement RCP location because the driven pile installation techniques (and therefore the maximum design parameters) used for the RCPs and offshore substations are the same, so the underwater noise modelling outputs for the RCPs and offshore substations can be directly compared. The underwater noise modelling has considered noise propagation in relatively shallow water (via the southerly RCP location) and relatively deep water (via the offshore substations). The outputs are therefore representative of the variable water depths, distances from shore, and bathymetry across the Offshore Red Line Boundary where driven piles may be installed.
- 11.8.3.5 The north (N) corner of the OAA, which has been modelled for both driven pile anchors and offshore substations, is in some of the deeper waters (117m) of the OAA and therefore has the greatest potential for sound propagation. The south-east (SE) corner of the OAA has a modelled depth of 116m, followed by 109m in the south-west corner (SW), and 103m in the west (W) corner. The two modelling locations within the cable corridor for RCP locations had water depths of 74m and 111m at the south (S) and N locations, respectively.
- 11.8.3.6 For each location, the following scenarios were used for modelling:
- offshore substations and RCP: 3m driven pile diameter, 95m length installed to 0.5m proud of the seabed, installed with a maximum blow energy of 3,500kJ; and
  - driven pile anchor: 3m driven pile diameter, 30m length installed to 0.5m proud of the seabed, installed with a maximum blow energy of 3,500kJ.

11.8.3.7 Both of these scenarios have been modelled following the installation scenario described in **Table 11.14**.

**Table 11.14 Summary of the soft start and ramp up scenario for offshore substations, RCP and driven pile anchors piling**

Energy (kJ)	320 (9%)	490 (14%)	630 (18%)	1,330 (38%)	2,170 (62%)	2,660 (76%)	2,835 (81%)	3,500 (100%)
No. of strikes	180	180	180	150	180	150	2,331	150
Duration (s)	1,800	360	360	300	360	300	4,662	300

3,501 strikes over 2 hours 20 minutes 42 seconds per pile.  
 7,002 strikes over 4 hours 41 minutes 24 seconds for two piles sequentially installed.

11.8.3.8 A final location within the S corner of Buchan Offshore Wind Farm OAA was also modelled at 88.6m to estimate impact ranges during a concurrent piling scenario with the Project. This location represents simultaneous installation of offshore substations driven piles at the western corner of the OAA and at the southern corner of the nearby Buchan Offshore Wind Farm. The parameters applied for the Buchan location were consistent with those used for the Project offshore substation scenarios.

### Approach to permanent threshold shift and temporary threshold shift-onset

11.8.3.9 It is widely documented that marine mammals are sensitive to underwater noise (Hildebrand, 2009; National Marine Fisheries Service (NMFS), 2018; 2024; Nowacek *et al.*, 2007; OSPAR 2009; Richardson *et al.*, 1995; Southall *et al.*, 2019; 2021). Underwater noise has the potential to impact marine mammals if the frequency of the noise is within their hearing range. Marine mammal species have different hearing sensitivity thresholds resulting in different species detecting underwater noise at varying frequency bands (NMFS, 2018; 2024; Southall *et al.*, 2019).

11.8.3.10 Sound propagates through the water in a series of pressure waves. These waves comprise of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). Due to these changes in pressure, the unit for measuring sound is usually referenced to the Pascal (Pa) and due to the medium of water, underwater sound is referenced to 1 micro Pa ( $\mu\text{Pa}$ ). The decibel (dB) is a relative unit used to express the ratio of two values of acoustic power and is typically expressed as ten times the logarithm in base 10 ( $10 \times \log_{10}$ ).

11.8.3.11 There are different metrics which can be used as measures of underwater sound pressure. Key metrics used in this report are as follows:

- Sound pressure level (SPL or  $L_{p,pk}$ ): The maximum sound pressure during a stated time interval. A peak sound pressure may arise from a positive or negative sound pressure. This quantity is typically useful as a metric for a pulsed waveform.
- Root mean square SPL ( $SPL_{rms}$ ): The square root of the mean square pressure, where the mean square pressure is the time integral of squared sound pressure over a specified time interval divided by the duration of the time interval.

- Sound exposure level (SEL): a measure of the sound pressure squared over a stated period of time or noise event and is normalised to one second.
  - Cumulative SEL ( $SEL_{cum}$  or  $L_{E,p,t}$  (where ‘t’ represents the time of sound exposure or multiple instances of a noise source)): representative of the total acoustic energy of a noise source taking place across 24-hours.
- 11.8.3.12 Impacts to marine mammals from underwater noise range from changes in behaviour and masking that affect communication and listening space, and/or locating prey (Basran *et al.*, 2020; Dunlop, 2016; Erbe *et al.*, 2016; Heiler *et al.*, 2016; Pine *et al.*, 2019; Pirootta *et al.*, 2012; Wisniewska *et al.*, 2018), displacement and disturbance (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Graham *et al.*, 2019; Pirootta *et al.*, 2014; Stone *et al.*, 2017), or injury and mortality (Reichmuth *et al.*, 2019; Schaffeld *et al.*, 2019).
- 11.8.3.13 A number of studies have provided suggestions for exposure limits for marine mammals, but the more precautionary threshold of injury presented in Southall *et al.* (2007), later updated in 2019, are advised to be followed for impact assessments (JNCC, 2020). Although the NMFS has released updated technical guidance (NMFS, 2024) on assessing the effects of underwater and in-air anthropogenic sound on the hearing of marine mammal species, these thresholds are currently only implemented under the jurisdiction of the NMFS and are not currently endorsed by Scottish regulators. Therefore, at the time of writing this EIA Report chapter and under NatureScot advice, the Southall *et al.* (2019) thresholds have been used to inform this assessment.
- 11.8.3.14 Noise exposure criteria are typically represented by dual exposure metrics including the frequency weighted SEL (expressed in dB re.  $\mu Pa^2-s$  or  $\mu Pa^2s$ ) and the unweighted SPL (expressed in units relative to 1  $\mu Pa$  in water; ISO 18406, 2017; Juretzek *et al.*, 2021). The terms ‘weighted’ and ‘unweighted’ relate to hearing sensitivities (for example, frequencies of sound detectable to an individual) of marine fauna and are traditionally based on species audiograms. Southall *et al.* (2019) propose the  $SPL_{peak}$  being either unweighted or flat weighted across the entire frequency band of a functional hearing group (FHG; **Table 11.15**) because the direct mechanical damage to the auditory system that is associated with high peak sound pressures is not frequency dependent and is therefore restricted to the audible frequency range of a species.

**Table 11.15 Marine mammal hearing ranges as described in Southall *et al.* (2019)**

FHG	Species	Generalised hearing ranges	Estimated region of peak sensitivity
<b>Very high frequency (VHF) cetaceans</b>	Harbour porpoise.	275 Hertz (Hz) to 160 Kilohertz (kHz).	12kHz to 140kHz.
<b>High frequency (HF) cetaceans</b>	Bottlenose dolphin, common dolphin, white-beaked dolphin, Atlantic white-sided dolphin and Risso’s dolphin.	150Hz to 160kHz.	8.8kHz to 110kHz.
<b>Low frequency (LF) cetaceans</b>	Minke whale and humpback whale.	7Hz to 35kHz.	200Hz to 19kHz.
<b>Phocid carnivores in water (PCW)</b>	Grey seal and harbour seal.	50Hz to 86kHz.	1.9kHz to 30kHz.

- 11.8.3.15 Auditory injury in marine mammals occur when the sound levels are greater than the threshold for the species hearing sensitivities. This causes a permanent threshold shift (PTS) onset, where the hearing sensitivity is reduced after noise exposure with no hearing recovery in the impacted frequencies (Tougaard, 2021). PTS can occur instantaneously (via impulsive noise sources such as piling) or cumulatively (*i.e.*, exposed to the injurious sound source over an extended period). The level of injury depends on the duration, frequency and intensity of the sound source and received level. Whilst PTS is considered a permanent effect, the most likely response of an animal exposed to noise levels that could induce PTS is to flee the ensonified area. Therefore, animals exposed to these noise levels are likely to actively avoid hearing damage by moving away from the area.
- 11.8.3.16 Another auditory effect is described as temporary threshold shift (TTS) in hearing, where an individual experiences a temporary increase in the threshold of hearing (*i.e.*, the minimum intensity needed for a sound to be audible) at a specific frequency that returns to its pre-exposure baseline over time (Tougaard, 2021). TTS-onset is not regarded as injury given its temporary nature. Any impacts relating to the effects of TTS are considered to be captured in the quantitative assessment of disturbance; however, text on TTS is included for completeness.
- 11.8.3.17 To quantify the impact of underwater noise on marine mammals with regard to PTS and TTS, the instantaneous ( $SPL_{peak}$ ) and cumulative ( $SEL_{cum}$ , over 24-hours) PTS and TTS-onset impact ranges (the area around the piling location within which the noise levels exceed the PTS or TTS-onset thresholds for the relevant FHG) are determined using the thresholds presented by Southall *et al.* (2019; **Table 11.16**). Unweighted  $SPL_{peak}$  values are included in this assessment for instantaneous PTS and TTS. The  $SPL_{peak}$  criterion is typically used to calculate the occurrence of 'instantaneous' PTS.
- 11.8.3.18 The  $SEL_{cum}$  thresholds considers the SEL received by an animal and the duration of exposure, accounting for the accumulated exposure over a 24-hour period. Southall *et al.* (2019) recommends the application of  $SEL_{cum}$  for the individual activity alone (*i.e.*, not for multiple activities occurring within the same area or over the same time). To inform this impact assessment, sound modelling has considered the  $SEL_{cum}$  over a piling event. It is important to note that the physiological damage that sound energy can cause is mainly restricted to energy occurring in the frequency range of a species' hearing range. Therefore, for the  $SEL_{cum}$ , sound has been weighted based on species group specific weighting curves presented in Southall *et al.* (2019). Further information on the modelling approach and the methods used to calculate PTS and TTS-onset impact ranges is provided in **Volume 3, Appendix 8.1**.

**Table 11.16 PTS and TTS-onset thresholds for impulsive noise (Southall *et al.*, 2019)**

Species	FHG	Cumulative PTS ( $SEL_{cum}$ dB re 1 $\mu$ Pa <sup>2</sup> s weighted)	Instantaneous PTS ( $SPL_{peak}$ dB re 1 $\mu$ Pa unweighted)	Cumulative TTS ( $SEL_{cum}$ dB re 1 $\mu$ Pa <sup>2</sup> s weighted)	Instantaneous TTS ( $SPL_{peak}$ dB re 1 $\mu$ Pa unweighted)
Harbour porpoise	VHF cetacean	155	202	140	196
Dolphin species	HF cetacean	185	230	170	224
Baleen whale species	LF cetacean	183	219	168	213
Seal species	PCW	185	218	170	212

- 11.8.3.19 The current set of TTS-onset thresholds presented by Southall *et al.* (2019; **Table 11.16**) define a TTS-onset as the exposure required to produce a 6dB shift in the hearing threshold. However, data upon which these thresholds are based for TTS-onset in marine mammals from impulsive noise, such as piling, is extremely limited. It has been necessary to determine exposure functions for TTS in order to estimate the levels at which the onset of PTS could occur, as experiments inducing PTS in animals is considered unethical. Predicted exposures of 40dB of TTS are considered to result in PTS onset (Southall *et al.*, 2007). For the purposes of developing these thresholds, TTS was considered to be “*the minimum threshold shift clearly larger than any day-to-day or session-to-session variation in a subject’s normal hearing ability*”, and which “*is typically the minimum amount of threshold shift that can be differentiated in most experimental conditions*” (Southall *et al.*, 2007). Thus, using a threshold for the onset of TTS would typically result in overestimates of potential ranges at which ecologically significant effects could occur. Furthermore, as TTS-onset is defined primarily as a means of predicting PTS-onset, there is currently no threshold for TTS-onset that would indicate a biologically significant amount of TTS. Therefore, it was not possible to carry out a quantitative assessment of the sensitivity, magnitude, or significance of the impact of TTS on marine mammals.
- 11.8.3.20 The number of individuals that may be affected by PTS relative to the reference population was quantified by multiplying the onset impact ranges by the density estimates for each species and calculating the proportion of the reference population.

## Behavioural disturbance

### Dose-response functions

- 11.8.3.21 A species-specific dose-response approach was used for the assessment of disturbance to marine mammals from underwater noise during piling. This approach was based on current best practice methodology to provide evidence-based estimates rather than the fixed behavioural threshold approach.
- 11.8.3.22 The application of a dose-response function is used to quantify the probability of a response from an animal to a stressor or stimulus, which will vary according to the dose of stressor or stimulus received by the animal (Dunlop *et al.*, 2017). Therefore, it is based on the assumption that not all animals in an impact zone will respond, unlike traditional methods of threshold assessment.
- 11.8.3.23 For the purpose of this assessment, the dose is the received single-strike sound exposure level (SEL<sub>ss</sub>) which is considered to be best practice for this type of assessment (Southall *et al.*, 2021). SEL<sub>ss</sub> contours at 5dB intervals generated by noise modelling (see **Volume 3, Appendix 8.1**) were overlain on species density surfaces to quantify the number of animals receiving each SEL<sub>ss</sub>, and subsequently the number of animals likely to be disturbed based on the dose-response curve.
- 11.8.3.24 This impact assessment for cetaceans uses the dose-response curve that was developed by Graham *et al.* (2017b) for harbour porpoise, using data collected during the first six weeks of piling during Phase 1 of the Beatrice Offshore Wind Farm. Following the development of this dose-response curve, additional data from the remaining piling events have been processed and showed that the responses of harbour porpoises to piling noise diminishes over the construction period (Graham *et al.*, 2019). Further studies have also demonstrated that measured behavioural responses of harbour porpoise to piling were much lower than those predicted from the Graham *et al.* (2017b) dose-response function (Thompson *et al.*, 2025). Therefore, the use of the dose-response curve from the initial piling event in this assessment can be considered conservative.

- 11.8.3.25 In the absence of species-specific dose-response data for dolphins or whales, this dose-response curve has been adopted for all cetaceans; however, it is considered that the application of the harbour porpoise dose-response curve to other cetacean species is highly over-precautionary. This is because harbour porpoises are highly responsive to anthropogenic disturbance, with multiple studies showing response via avoidance and/or reduced vocalisation to various anthropogenic noise sources (for example, Benhemma-Le Gall *et al.*, 2021; Brandt *et al.*, 2013; Brandt *et al.*, 2018; Thompson *et al.*, 2013; Thompson *et al.*, 2020; Sarnocińska *et al.*, 2020). Other cetacean species, including bottlenose dolphin and common dolphin, have shown less of a response to underwater noise in comparison to harbour porpoise (for example, Fernandez-Betelu *et al.*, 2021; Kastelein *et al.*, 2006; Stone *et al.*, 2017).
- 11.8.3.26 For seals, the dose-response function used is derived from harbour seal telemetry data collected during piling activities at the Lincs Offshore Wind Farm in 2011-2012 and is presented in Whyte *et al.* (2020). The study presented the percentage change in harbour seal density around the Lincs Offshore Wind Farm with received noise levels. It has conservatively assumed that all seals will be disturbed at  $SEL_{ss} > 180\text{dB re } 1 \mu\text{Pa}^2\text{s}$ . There are no corresponding data for grey seals and, as such, the harbour seal dose-response function is applied to the grey seal disturbance assessment. This is considered an appropriate proxy for grey seal as both species are categorised within the same FHG. However, it is likely to result in an over-estimation of grey seal response as this assessment has concluded that grey seals are less sensitive to behavioural disturbance from underwater noise than harbour seals, therefore the application of the harbour seal dose-response function to grey seal is considered conservative.

#### Level B harassment – fixed noise threshold

- 11.8.3.27 The numbers of animals predicted to experience behavioural disturbance using the United States (US) NMFS Level B harassment thresholds for strong disturbance (NMFS, 2005) are presented alongside the dose-response assessment methodology to provide context on the potential extent of disturbance. This approach has been taken given the absence of species-specific empirical data for dolphin and whale species, and that the application of the harbour porpoise dose-response curve (Graham *et al.*, 2017b) is highly over-precautionary.
- 11.8.3.28 In the US, under the 1994 Amendments to the Marine Mammal Protection Act, Level B harassment is defined as having the potential to disturb a marine mammal or marine mammal stock in the wild, by causing disruption of behavioural patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering, but which does not have the potential to injure a marine mammal or marine mammal stock in the wild (NMFS, 2005).
- 11.8.3.29 The threshold predicts that Level B harassment will occur when an animal is exposed to received sound levels above 160dB re 1 $\mu$ Pa (rms) from non-explosive impulsive sound sources, such as seismic airguns, impact piling, or intermittent sound sources, such as non-tactical or scientific sonar (Guan and Brookens, 2021; NMFS, 2022). The threshold is based on studies of whale responses to playback signals from air guns above 160dB re 1 $\mu$ Pa (rms), which showed that the animals exhibited an avoidance response (Malme *et al.*, 1984). Beyond the 160dB re 1 $\mu$ Pa (rms) threshold, the behavioural responses are likely to become less severe, for example, minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al.*, 2007). However, it is important to note that marine mammal responses to disturbance will depend on the individual and the context. For example, previous experience and acclimatisation will affect whether an individual exhibits an aversive response to noise, particularly in a historically noisy area.

## Underwater noise assumptions

11.8.3.30 The subsea noise model assumptions and limitations highlighted in **Volume 3, Appendix 8.1** are summarised below:

- The modelling assumed the maximum hammer energy would be reached at all locations, whereas this is unlikely to be the case.
- The soft-start and ramp up procedure simulated does not allow for short pauses in piling (for example, for realignment) and therefore the modelled SEL<sub>cum</sub> is likely to be an overestimate since, in reality, these pauses will reduce the time between noise exposures that animals experience whilst fleeing.
- The modelling assessment assumes that all animals swim directly away from the noise source at a constant and conservative average speed. A constant fleeing speed of 2.1 m/s was used for LF cetaceans (for example, minke whale; SNH, 2016), 1.52 m/s for HF cetaceans (for example, dolphin species; Bailey and Thompson, 2006), 1.4 m/s for VHF cetaceans (for example, harbour porpoise; SNH, 2016) and 1.8 m/s for PCW (for example, seals; SNH, 2016). Swim speeds vary depending on the activity of the individual and how the swim speed was measured. For example, Otani *et al.* (2000) recorded an average swim speed for harbour porpoise across horizontal and vertical movements; however, the authors note that horizontal speed was significantly faster than vertical speed and cite a maximum speed of 4.3 m/s. Similarly, Leatherwood *et al.* (1982) reported harbour porpoise swim speeds of approximately 6.2 m/s. Therefore, the swim speeds used in the assessment are considered to be a precautionary estimate of flee speeds as marine mammals are expected to be able to swim at much faster speeds under stress conditions (Kastelein *et al.*, 2018). The calculated cumulative PTS- and TTS-onset impact ranges represent the minimum starting distances from the piling location for animals to flee and prevent them from receiving a dose higher than the threshold.
- The use of the SEL<sub>cum</sub> metric is described as an equal-energy rule where exposures of equal energy are assumed to produce the same noise-induced threshold shift regardless of how the energy is distributed over time. This means that for intermittent noise, such as piling, the equal-energy rule overestimates the effects since the quiet periods between noise exposures will allow some recovery of hearing compared to continuous noise.
- The model overestimates the noise exposure an animal receives since it does not account for any time that marine mammals spend at the surface and the reduced sound levels near the surface.
- Although this assessment assumes 225 WTGs as the maximum design scenario, a less impactful option considered by the Project includes up to 126 WTGs. In addition, it has been assumed during this assessment that all WTG mooring lines will be secured by driven pile anchors. However, a number of anchoring options is being considered by the Project including drag embedment anchors and suction anchors (refer to **Volume 4: Outline Construction Method Statement** for further detail). Similarly, it has been assumed that the jacket foundations for offshore substations and RCP will all be secured using driven piles. However, other foundation options are available for this Project, such as suction caisson foundations.

11.8.3.31 These assumptions lead to a conservative determination of the impact ranges, and therefore a precautionary assessment.

### *Assumptions associated with permanent threshold shift-onset*

- 11.8.3.32 There are no empirical data on the PTS-onset threshold for auditory injury for marine mammals, as to test this would be unethical. Therefore, PTS-onset thresholds are estimated based on extrapolating from TTS-onset thresholds developed across a series of previous and ongoing studies to evaluate and predict the risk of various kinds of effects of noise on marine mammals. The TTS-onset thresholds used in this assessment are taken from Southall *et al.* (2019), which builds on those previously presented by Southall *et al.* (2007) and influenced by new analytical methods presented by Finneran (2016) and guidance by the NMFS (2016, 2018). For impulsive noise, such as piling, TTS-onset is defined at the lowest level that exceeds natural recorded variation in hearing sensitivity (6dB) and assume that PTS-onset occurs from exposures resulting in 40dB or more of TTS measured approximately four minutes after exposure (NMFS, 2018).
- 11.8.3.33 Furthermore, the assessment assumes that all animals within the PTS-onset impact ranges are impacted. However, the dose-response function adopted by Donovan *et al.* (2017) predicts that only 18-19% of animals will actually experience PTS at the PTS-onset threshold level. Therefore, the number of animals predicted to experience PTS are an over-estimate and therefore precautionary.

### *Characteristics of impulsive noise*

- 11.8.3.34 Marine mammals have greater sensitivity to impulsive noise (with respect to hearing damage), which is reflected in the noise exposure risk thresholds for example lower SELs are specified for impulsive noise compared to non-impulsive noise (Southall *et al.*, 2007). Therefore, PTS-onset is predicted to occur at lower weighted SEL<sub>cum</sub> than for non-impulsive sounds (Southall *et al.*, 2007). However, the sound signal of certain sound sources, such as impact piling, lose their impulsive characteristics over distance to the sound source as a result of propagation effects, and could potentially be characterised as non-impulsive beyond a certain distance (Offshore Renewables Joint Industry Programme (ORJIP), 2024; Southall *et al.*, 2019). Generally, the change in noise characteristics with increasing distance result in exposures becoming less physiologically damaging, as the sharp transient peaks become less prominent (ORJIP, 2024; Southall *et al.*, 2007). As the PTS-onset thresholds for impulsive noise are lower than for non-impulsive noise (Southall *et al.*, 2007), the estimated risk of auditory damage is therefore likely to be overestimated where impulsive noise becomes non-impulsive as a result of propagation.
- 11.8.3.35 Hastie *et al.* (2019) used the signal duration, rise time, crest factor, and peak pressure divided by signal duration to estimate the transition from impulsive to non-impulsive characteristics of impact piling noise during offshore wind turbine foundation installation at the Wash, southeast England and in the Moray Firth, northeast Scotland. The study found that the noise signal experienced a high degree of change in its impulsive characteristics with increasing distance, with the greatest change occurring within ~10km from the source but on average, this transition occurred from 3.5km from the source (Hastie *et al.*, 2019). Predicted PTS-onset impact ranges based on the impulsive noise thresholds may therefore be overestimates in cases where the impact ranges lie beyond this. As the assessment in this Chapter assumes no change in the impulsivity of noise and applies the impulsive noise thresholds throughout the propagation range of the noise, it can be considered precautionary.

### *Predicting the response of an animal to underwater noise*

- 11.8.3.36 The ability to predict the number of animals potentially exposed to levels of noise that may cause an impact is uncertain. The high spatial and temporal variation in marine mammal abundance and distribution in any area makes it difficult to predict how many animals may

be present within the range of noise impacts. All methods for determining at-sea abundance and distribution suffer from a range of biases and uncertainties.

- 11.8.3.37 Limited empirical data is available to inform predictions relating to the extent to which animals may experience auditory damage or display responses to noise. The current methods for predicting behavioural responses are based on received sound levels. However, factors other than noise levels will also influence the probability of response and the strength of response, such as previous experience, behavioural and physiological context, proximity to activities, duty cycle and pulse characteristics of the sound. It is not possible to adequately take these factors into account when predicting a behavioural response at present. This assessment makes use of the monitoring work that has been carried out during the construction of the Beatrice Offshore Wind Farm and therefore uses recent and regionally-relevant information on disturbance to harbour porpoise from piling noise (Graham *et al.*, 2017a; Graham *et al.*, 2019).

#### 11.8.4 Assessment methodology for injury and disturbance from underwater noise during UXO clearance

- 11.8.4.1 The noise levels generated from UXO clearance were predicted by Subacoustech Environmental Ltd. Full details of the underwater noise modelling and resulting impact ranges are detailed in **Volume 3, Appendix 8.1**.
- 11.8.4.2 As the detailed pre-construction surveys have not yet been completed, it is not possible at this time to determine if or how many items of UXO will require clearance. A variety of explosive types and sizes need to be considered when modelling potential noise from UXO clearance. Within the model, it has been assumed that the maximum explosive charge in each device is present and either detonates with clearance (high-order) or a clearance method such as deflagration (low-order). Though, to note, UXO may have undergone degradation and burying over time which would reduce the noise impact to the surrounding environment.
- 11.8.4.3 A selection of explosive sizes has been considered based on what might be present, and in each case, it has been assumed that the maximum explosive charge in each device is present and detonates with the clearance. The range of charge weights (TNT equivalent) for the potential UXO devices that have been modelled range from 25kg to 907kg (**Table 11.17**). In each case, an additional donor weight of 0.25kg has been included to initiate detonation. Low-order deflagration has also been assessed, which assumes that the donor or shaped charge (charge weight of 0.25kg) detonates fully to initiate a burnout of the explosive but without the follow-up detonation of the UXO. No mitigation that would affect the noise emissions (for example bubble curtains) has been considered within the modelling.
- 11.8.4.4 The preferred clearance method is low-order clearance, with high-order detonation considered a worst-case scenario and used only as a last resort, in line with the UXO Joint Position Statement (UK Government, 2025; Marine Directorate, 2025). Both methods are included in the impact assessment. Estimation of the source noise level for each charge weight has been carried out in accordance with the methodology of Soloway and Dahl (2014). Unweighted UXO clearance source levels for each charge weight are presented in **Table 11.17**.

**Table 11.17 Unweighted SPL and SEL source levels used for UXO modelling**

Charge weight (kg) (TNT equivalent)	SPL source level (dB re 1 $\mu$ Pa at 1m)	SEL source level (dB re 1 $\mu$ Pa <sup>2</sup> s at 1m)
0.25 (low order)	269.8	215.2
25 + donor	284.9	228
55 + donor	287.5	230.1
120 + donor	290	232.3
240 + donor	292.3	234.2
525 + donor	294.8	236.4
698 + donor	295.7	237.1
750 + donor	296.0	237.3
907 + donor	296.6	237.9

### Approach to permanent threshold shift and temporary threshold shift-onset

- 11.8.4.5 The PTS-onset thresholds used to assess the potential for auditory injury to marine mammals during UXO clearance are those presented in Southall *et al.* (2019) for impulsive noise (**Table 11.16**). It is currently advised by UK statutory nature conservation bodies that these thresholds should be used for impact assessment from UXO detonation on marine mammals. However, the suitability of these criteria is currently being discussed because there is a lack of empirical evidence regarding UXO detonations using these metrics, particularly, the range-dependent characteristics of the peak sounds, and whether current propagation models can accurately predict the range at which these thresholds are reached.
- 11.8.4.6 The TTS-onset thresholds are also presented (**Table 11.16**), although it is important to note that there is currently no threshold for TTS-onset that would indicate a biologically significant impact as a result of TTS. However, SPL<sub>peak</sub> and SEL<sub>ss</sub> impact ranges for TTS-onset from Southall *et al.* (2019) are used in this assessment as a proxy for the extent of behavioural disturbance (in the absence of a robust scientific understanding and methodology to assess the effect of disturbance from UXO clearance). This approach has also been applied in recent UXO clearance assessments, including projects such as Muir Mhòr, Green Volt, Seagreen, Caledonia and Berwick Bank.

### Behavioural disturbance

- 11.8.4.7 Unlike piling, there are no dose-response functions available that describe the short-term spatial extent of the behavioural impact on marine mammals from UXO clearance. Explosive sound sources, like piling, are categorised as ‘impulsive’; however, the number of pulses and overall duration of noise emission which drive the behavioural response are significantly different. Behavioural responses to a single UXO detonation are expected to be a one-off startle response or aversive behaviour; while during piling the series of pulses that are emitted are expected to continuously drive animals out of the impacted area, enabling a dose-response to be quantified. Therefore, the empirically derived dose-response curves used for assessment of behavioural disturbance for piling are not applicable to the assessment of UXO clearance.

- 11.8.4.8 Due to the lack of empirical studies, there is limited understanding of the effect of disturbance from UXO clearance on marine mammals, meaning that assessments can only provide an indication of the number of animals at risk based on limited evidence. For the purposes of this assessment, TTS-onset will be used as a proxy for disturbance.

### Underwater noise assumptions

- 11.8.4.9 The subsea noise model assumptions and limitations highlighted in **Volume 3, Appendix 8.1** are summarised below:
- The attenuation of the noise from UXO detonation has been accounted for in calculations using geometric spreading and a sound absorption coefficient, primarily using the methodologies cited in Soloway and Dahl (2014), which establishes a trend based on measured data in open water. This method does not account for variable bathymetry, seabed type or level of potential burial below the seabed surface.
  - An attenuation correction was added to the Soloway and Dahl (2014) equations for the absorption of sound over long ranges (i.e., of the order of thousands of metres), based on measurements of high intensity noise propagation taken in the North Sea and Irish Sea. It should be noted that, when comparing to measurements of noise from deflagration in the Moray Firth (Ocean Winds, 2024), the Soloway and Dahl (2014) calculations are likely to produce a higher, and therefore precautionary, prediction of noise levels than are seen in practice.
  - A further limitation in the Soloway and Dahl (2014) equations are that variations in noise levels at different depths are not considered. Where animals are swimming near the surface, the acoustics can cause the noise level, and hence the exposure, to be lower (MTD, 1996). The risk to animals near the surface may therefore be lower than indicated by the impact ranges and therefore the results presented can be considered conservative in respect of the impact at different depths.
  - An impulsive wave tends to be smoothed over distance, meaning the injurious potential of a wave at greater range can be even lower than just a reduction in the absolute noise level. Therefore, the initial pulse may transition into a non-impulsive sound wave at distance, suggesting that it may be more appropriate to use the non-impulsive criteria at greater ranges.
- 11.8.4.10 These assumptions lead to a conservative determination of the impact ranges, and therefore a precautionary assessment.

## 11.9 Assessment of effects: Construction stage

### 11.9.1 Introduction

- 11.9.1.1 This Section provides an assessment of the effects on marine mammals from the construction of the offshore elements of the Project. The assessment methodology set out in **Section 11.8** has been applied to assess effects to marine mammals from the Project.

## 11.9.2 Impact C1: Auditory injury from increased underwater noise during pre-construction surveys

### Overview

- 11.9.2.1 Geophysical and geotechnical surveys of the Project OAA and offshore export cable corridor will be conducted to determine the seabed preparation activities necessary in advance of construction. These surveys will be undertaken by a dedicated marine survey vessel and/or remotely operated vehicle (ROV) and will identify bedforms, obstacles and debris on the seabed within the OAA and offshore export cable corridor (**Volume 2, Figure 11.2**).
- 11.9.2.2 Geotechnical surveys involve physical sampling and testing of the seabed substrate (for example, boreholes, cone penetration tests) to determine sediment composition, strength, and stability. This sampling equipment is mechanical rather than acoustic in nature and does not generate significant underwater noise levels. As such, they are considered to not pose a risk of auditory injury to marine mammals and are excluded from further underwater noise assessment. However, a USBL may be used during a geotechnical survey; the assessment of impacts from the USBL is included under geophysical surveys.
- 11.9.2.3 Geophysical surveys involve acoustic mapping of the seabed using geophysical survey equipment commonly deployed in offshore wind farm site investigations. These systems are generally towed behind or mounted on survey vessels. ROVs may also be used for visual inspection of seabed features and debris; these are passive and do not generate underwater noise of concern. However, ROVs can be mounted with acoustic positioning systems, such as an USBL, to aid operators in locating their equipment underwater. Depending on the system's acoustic signal, these devices have the potential to impact marine mammals (Mikaelsen *et al.*, 2025).
- 11.9.2.4 As the specific survey equipment for the Project's pre-construction surveys has not yet been confirmed, this assessment is based on indicative equipment, with representative source levels and frequency characteristics, used in similar offshore wind farm developments. Final equipment specifications will be included in the final MMMP (M-032) prior to survey commencement. Once further detail on the survey parameters (e.g., equipment, method, transects, and timing) are known, future EPS risk assessment would be undertaken to ensure any risk of injury is mitigated for as mandated by EPS legislation.
- 11.9.2.5 Passive equipment such as magnetometers measure incoming signals, such as magnetic signatures, and do not emit sound; therefore, they pose no risk of auditory injury to marine mammals. These types of equipment are excluded from further consideration.
- 11.9.2.6 Indicative pre-construction geophysical survey equipment includes the following:
- MBES: emits acoustic waves in a fan shape to collect high resolution bathymetric data beneath its transceiver. The time taken for sound waves to reflect off the seabed and return to the transmitter is used to calculate water depth, in turn, allowing for high-resolution mapping of the seafloor. High-frequency systems provide more detailed images but are limited in depth range; low-frequency systems penetrate deeper water but produce lower resolution images. The sound pulses produced by MBES are highly directional.
  - SSS: uses conical or fan-shaped pulses to determine sediment characteristics and seabed features, providing detailed imagery of the seabed. Typically towed behind the vessel but may be pole mounted on the side of the vessel. The sound pulses produced by SSS have very strong directivity.

- SBP: uses low or high-frequency pulses to create detailed sub-surface sediment layers. Low frequencies penetrate deeper with lower resolution data; high frequencies provide higher resolution but shallower penetration. The sound pulses produced by SBP are highly directional.
- UHRS sparker: a form of SBP using an electrode to generate an acoustic impulse. UHRS sparkers have less directionality than other SBPs, as they are omnidirectional towards the seabed.
- USBL positioning systems: uses acoustic pulses between a vessel-mounted transceiver, and subsea transponder for precise accurate equipment positioning (for example, ROVs) or be used as a position referencing system for vessels under dynamic positioning during survey operations.

### Sensitivity of receptor

- 11.9.2.7 Hearing is a critical sensory mechanism for marine mammals, enabling them to navigate, communicate, and locate prey in the underwater environment (Southall *et al.*, 2007). PTS, which represents irreversible hearing damage, has the potential to impair these vital functions, such as foraging, mating, and predator avoidance, potentially affecting individual health and vital rates (Erbe *et al.*, 2018). Such impairment could disrupt essential life processes and lead to a decline in health, increased mortality risk, and reduced reproductive success.
- 11.9.2.8 In 2018, a Department of Business, Energy and Industrial Strategy (BEIS)-funded expert elicitation workshop brought together specialists to assess the nature, extent, and implications of PTS in UK marine mammal species (Booth *et al.*, 2019). Drawing on the most current and robust data, experts clarified that PTS does not equate to complete deafness, but rather a permanent reduction in hearing sensitivity across affected frequency bands. The severity and specific frequency range of PTS are key factors in evaluating its potential impact on vital rates. An introduction to PTS is included in **Section 11.8.3**.
- 11.9.2.9 The sensitivity of marine mammals to injury from pre-construction surveys is dependent on both the activity and the marine mammal species. **Table 11.18** provides a summary of typical source levels and frequency ranges for a variety of pre-construction survey equipment, as well as the overlap with marine mammal FHGs.

**Table 11.18 Comparison of indicative geophysical survey equipment’s sound characteristics compared to functional hearing groups**

Survey equipment	Typical source level (dB re 1µPa)	Expected frequency range	Frequency overlap with FHG			
			LF	HF	VHF	PCW
<b>MBES</b>	200-240 (L <sub>p,pk</sub> ; Hartley Anderson, 2020)	200-400kHz (Hartley Anderson, 2020)	No	No	No	No
	210-240 (L <sub>p,pk</sub> ; Lurton and Deruiter, 2011).					
<b>SSS</b>	210 (L <sub>p,pk</sub> ; Crocker and Fratantonio, 2016, Crocker <i>et al.</i> , 2019)	300–900kHz (Crocker and Fratantonio, 2016, Crocker <i>et al.</i> , 2019)	No	No	No	No

Survey equipment	Typical source level (dB re 1µPa)	Expected frequency range	Frequency overlap with FHG			
			LF	HF	VHF	PCW
<b>SBP</b>	185-250 ( $L_{p,pk}$ ; dependent on equipment type; Hartley Anderson, 2020) 174-247 ( $L_{p,rms}$ ) (dependent on equipment type; National Oceanic and Atmospheric Administration (NOAA), 2019)	0.1–22kHz (Hartley Anderson, 2020)	Yes	Yes	Yes	Yes
<b>UHRS sparker</b>	200-226 ( $L_{p,pk}$ ; Hartley Anderson, 2020)	0.1–5kHz (Hartley Anderson, 2020)	Yes	Yes	Yes	Yes
<b>USBL</b>	188-204 ( $L_{p,rms}$ ; NOAA, 2019) 187-206 ( $L_{p,rms}$ ; Jiménez-Arranz <i>et al.</i> , 2020)	17–50kHz (NOAA, 2019)	Yes	Yes	Yes	Yes

- 11.9.2.10 The indicative operational frequencies of the MBES and SSS sources (**Table 11.18**) are above that of the hearing range for all cetacean and seal FHG (**Table 11.15**). As there is no overlap between the hearing ranges of these species and the expected sound frequency of the equipment, there is expected to be no potential for reduction in the hearing abilities of either species. Therefore, there is no pathway for MBES or SSS to cause auditory injury (PTS) in marine mammals, and this impact is screened out of further assessment for MBES and SSS specifically.
- 11.9.2.11 The indicative operational frequencies of the SBP, UHRS sparker and USBL may fall within the estimated region of peak sensitivity for all cetacean and seal FHG, and therefore there is a pathway for effect. The indicative maximum source levels for the SBP exceeds the unweighted injury threshold for all FHG; the UHRS sparker exceeds the unweighted injury threshold for VHF and LF cetaceans, and seals; and the USBL exceeds the unweighted injury threshold for VHF cetaceans only (**Table 11.18**). There is therefore a risk of PTS identified, should the maximum source levels be used; if lower source levels are used then the level of risk and FHG at risk will likely reduce.
- 11.9.2.12 The SBP, UHRS sparker and USBL sources can be considered as sources that emit medium frequency noise. In comparison to broadband noise with high energy in the low frequency spectrum like piling, medium frequency noise attenuates more quickly in the marine environment, resulting in smaller impact ranges. It is noted that when the equipment is emitting higher frequency sounds (which have greater overlap with the marine mammal hearing ranges), the source level tends to be lower (Lurton and Deruiter, 2011) and thus is less likely to exceed the PTS-onset threshold. Furthermore, the risk of PTS from the USBL source is limited to one FHG (VHF cetaceans), and as the source level is only slightly higher than the unweighted PTS-onset threshold, the impact range from this equipment will be highly localised to the immediate vicinity of the source. Therefore, whilst there is a risk of auditory injury to marine mammal species from these sources, this risk is expected to be low. In addition, a 6dB elevation of the hearing threshold (i.e. PTS) somewhere within the frequency range of these equipment is likely to affect only a small region of marine mammal hearing, which is unlikely to result in changes to vital rates. Therefore, the sensitivity of marine mammals to PTS-onset from use of the SBP, UHRS sparker and USBL is assessed as **low**.

## Magnitude of impact

- 11.9.2.13 SBPs produce source levels that exceed PTS-onset thresholds for all marine mammal species. However, modelling indicates that the spatial extent of potential injury is very limited. The Department of Business, Energy and Industrial Strategy (BEIS; 2020) found PTS onset could occur within 23m for harbour porpoise, while Green Volt Offshore Wind Farm (2023) and Arklow Bank Wind Park 2 (Seiche Ltd, 2022) estimated maximum ranges of 330m and 517m respectively for VHF cetaceans.
- 11.9.2.14 USBL systems produce source levels below PTS-onset thresholds for LF cetaceans, HF cetaceans, and pinnipeds, indicating no risk of auditory injury. For VHF cetaceans (for example, harbour porpoise), source levels exceed the threshold by only 2dB. NMFS (2020) has determined that a USBL is unlikely to lead to incidental take<sup>4</sup>, and any risk is expected to be highly localised, short-term, and intermittent.
- 11.9.2.15 UHRS sparkers present a slightly higher risk profile. While HF cetaceans (dolphins) are not expected to experience auditory injury, other marine mammal groups may be at risk due to source levels exceeding PTS-onset thresholds. UHRS sparkers are less directional than other SBPs as they remain omnidirectional towards the seabed, resulting in a small but broader exposure area.
- 11.9.2.16 In summary, the area around the geophysical sources in which marine mammals may experience PTS is very limited. Although auditory injury would represent a permanent change, the risk is minimised through embedded mitigation measures included in the MMMP (M-032), such as use of marine mammal monitoring in a defined mitigation zone that encompasses the area in which PTS may occur, in line with JNCC guidelines (JNCC, 2017). Therefore, the magnitude of impact is assessed as **negligible** for all marine mammal species.

## Significance of residual effect

- 11.9.2.17 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.19**.
- 11.9.2.18 The magnitude of impact is deemed to be **negligible**, and the sensitivity is deemed to be **low** for all marine mammal receptors (**Table 11.19**). The effect of auditory injury from pre-construction surveys will, therefore, be **Negligible (Not Significant)** in EIA terms.

**Table 11.19 Significance of impact C1: Auditory injury from underwater noise from pre-construction surveys**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	<b>Negligible (Not Significant).</b>
Bottlenose dolphin	Negligible	Low	<b>Negligible (Not Significant).</b>
Risso's dolphin	Negligible	Low	<b>Negligible (Not Significant).</b>
Atlantic white-sided dolphin	Negligible	Low	<b>Negligible (Not Significant).</b>
White-beaked dolphin	Negligible	Low	<b>Negligible (Not Significant).</b>

<sup>4</sup> In the context of the NMFS incidental take guidance, "take" refers to the act of harassment, harm, pursuit, hunting, shooting, wounding, killing, trapping, capturing, or collecting of marine mammals.

Receptor	Magnitude	Sensitivity	Significance
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Negligible	Low	Negligible (Not Significant).
Humpback whale	Negligible	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

### 11.9.3 Impact C2: Auditory injury from increased underwater noise during installation of driven piles

#### Overview

11.9.3.1 The maximum assessment scenario relating to potential auditory injury to marine mammals from increased underwater noise during installation of driven piles are presented in **Table 11.9**. Where predicted effects are identified and the receptors are sensitive to the effects, an assessment of the magnitude of change for each effect has been completed based on the methodology provided in **Section 11.8.2**. The magnitude of change, and hence the significance of potential effects has been assessed on the assumption that the embedded measures from **Table 11.10** have been implemented as part of the Project. Further detail on underwater noise during installation can be found within **Volume 3, Appendix 8.1**.

#### Sensitivity of receptor

11.9.3.2 Research into auditory injury from typical piling sequences indicate that hearing impairment is most likely when the source frequencies overlap with the species' peak hearing sensitivity, rather than across the entire auditory range (Kastelein *et al.*, 2013a). Piling noise typically contains most of its energy between ~30–500 Hertz (Hz), peaking between 100–300Hz, with energy extending beyond 2 Kilohertz (kHz; Kastelein *et al.*, 2015; 2016). Experimental studies have shown that impulsive piling noise induces TTS in a narrow frequency band in both harbour porpoise and harbour seals (Finneran, 2015), with significant TTS observed at 4kHz and 8kHz respectively (Kastelein *et al.*, 2012a; 2012b; 2013b; 2016; 2017). Consequently, experts agreed that hearing threshold shifts due to piling are most likely to occur within the 2–10kHz range (Kastelein *et al.*, 2017). Furthermore, a PTS of 6–18dB within this narrow frequency band is unlikely to significantly impair the survival or reproductive capacity of affected individuals (Kastelein *et al.*, 2017).

#### Harbour porpoise (VHF cetaceans)

11.9.3.3 Harbour porpoises are classified as very high-frequency hearing cetaceans (Southall *et al.*, 2019), with a vocal and auditory range spanning 275Hz to 160kHz (NMFS, 2018; Southall *et al.*, 2019). Their peak hearing sensitivity lies in the upper range, particularly between 100–125kHz (Morell *et al.*, 2021), supporting their use of narrow-band high-frequency echolocation clicks for short-range communication and navigation.

11.9.3.4 At the BEIS-funded expert elicitation workshop, specialists assessed the risk of PTS from low-frequency impulsive noise (for example, piling, airguns) on harbour porpoises. They

concluded that the likelihood of PTS significantly affecting survival or reproduction was very low (Booth and Heinis, 2018).

- 11.9.3.5 Monitoring during offshore wind farm construction has shown that harbour porpoise detections decline hours before piling begins (Benhemma-Le Gall *et al.*, 2021; 2023; Brandt *et al.*, 2018; Graham *et al.*, 2019). For instance, acoustic detections dropped by up to 33% in the 48 hours prior to piling at Beatrice and Moray East offshore wind farms (Benhemma-Le Gall *et al.*, 2023). This is attributed to increased vessel activity and other construction noise acting as a deterrent, reducing the risk of auditory injury. Therefore, assuming porpoises are present at the site during piling is considered highly precautionary.
- 11.9.3.6 While PTS is permanent and irreversible, current evidence suggests it is unlikely to significantly affect harbour porpoise survival or reproductive success. This is because harbour porpoises are considered highly adaptable and with reasonable tolerance to any PTS that might occur, as it would only be in a very narrow band of hearing. Furthermore, it is likely that harbour porpoise would avoid the area where PTS may occur, due to the presence of vessels pre-piling. Despite their lack of recoverability from PTS, the overall sensitivity of harbour porpoise to PTS from underwater noise during piling is considered to be **low**.

#### *Dolphin species (HF cetaceans)*

- 11.9.3.7 The ecological consequences of PTS for bottlenose dolphin, Risso's dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and short-beaked common dolphin are uncertain. These species have been grouped together as they fall within the same FHG. The studies available have been used to inform this assessment.
- 11.9.3.8 Bottlenose dolphins have a vocal and hearing range from 200Hz to 150kHz. Their vocalisations include barks (0.2–16kHz), whistles (0.8–24kHz; peak 3.5–14.5kHz), and echolocation clicks (peak 15–135kHz; David, 2006; Nachtigall *et al.*, 2016). Risso's dolphins vocalise and hear between 4–128kHz, with peak hearing sensitivity at 11.2kHz and between 40–80kHz (Mooney *et al.*, 2015). White-beaked dolphins have a hearing range of 16–181kHz, with peak sensitivity between 50–64kHz (Nachtigall *et al.*, 2008). Atlantic white-sided dolphins vocalise between 2–200kHz, including whistles (5.6–19.6kHz), clicks (16–31kHz), and burst pulses (up to 200kHz; Calderan *et al.*, 2024). Short-beaked common dolphins have a hearing range estimated between 2–150kHz, with vocalisations including long-duration tonal calls with an emitted frequency range of 2–18kHz and clicks which are typically between 23–67kHz (Akkaya *et al.*, 2023). Therefore, piling noise occurs within the lower hearing range of HF cetaceans, and it is noted that the peak noise from piling is not centred around the species peak hearing sensitivities.
- 11.9.3.9 As with harbour porpoises, studies show that noise-induced threshold shifts are frequency-dependent and influenced by both the characteristics of the noise source and the species' hearing sensitivity. At the BEIS-funded expert elicitation workshop (Booth and Heinis, 2018), experts concluded that a 6dB PTS within the 2–10kHz range is unlikely to significantly affect the survival or reproduction of bottlenose dolphins. This conclusion is likely applicable to other dolphin species.
- 11.9.3.10 PTS is permanent and irreversible. However, current evidence suggests that PTS from piling is unlikely to affect the survival or reproductive success of dolphin species. As a result, bottlenose dolphin, Risso's dolphin, white-beaked dolphin, Atlantic white-sided dolphin, and short-beaked common dolphin are considered highly adaptable and with reasonable tolerance to PTS, though there is no potential for recovery from PTS. The sensitivity of dolphin species to PTS from underwater noise during piling is considered to be **low**.

### Minke and humpback whale (LF cetaceans)

- 11.9.3.11 Low-frequency noise generated during piling may be more likely to overlap with the hearing range of LF cetaceans such as minke and humpback whales. Although baleen whale hearing is not well understood, they may detect sound through bone conduction via the skull (Cranford and Krysl, 2015).
- 11.9.3.12 Due to the difficulty of studying large whales in controlled settings, there are no direct measurements of auditory thresholds for baleen whales. Their hearing range is therefore inferred from vocalisation bandwidths and behavioural responses.
- 11.9.3.13 Minke whales produce vocalisations between 50Hz and 9.4kHz (Edds-Walton, 2000; Gedamke *et al.*, 2001; Mellinger *et al.*, 2000; Risch *et al.*, 2013; 2014), with estimated hearing sensitivity from 4Hz to 15kHz (Ketten and Mountain, 2011; Boisseau *et al.*, 2021). Tubelli *et al.* (2012) suggest peak sensitivity between 30–100Hz and 7.5–25kHz for minke whale. Humpback whales vocalise across 20Hz to 24kHz, including songs, social calls, and repetitive tones (Au *et al.*, 2006; Recalde-Salas *et al.*, 2020; Stimpert *et al.*, 2011; Zoidis *et al.*, 2008; Palanca, 2021). Tubelli *et al.* (2018) estimate their most sensitive hearing range is between 15Hz to 9kHz.
- 11.9.3.14 PTS is permanent and irreversible, and in baleen whales PTS could potentially cause further biological effects including effects on vital rates (Erbe *et al.*, 2018). However, current evidence suggests that piling-related PTS is unlikely to significantly affect the survival or reproduction rates of minke and humpback whales, as only a small portion of their hearing range would be impacted. Minke and humpback whales are considered highly adaptable and with reasonable tolerance to PTS, though there is no potential for recovery from PTS. The sensitivity of minke and humpback whale to PTS from underwater noise during piling is considered to be **low**.

### Harbour and grey seal (PCW)

- 11.9.3.15 Seals use sound both in air and underwater for communication, predator avoidance, and reproductive interactions, though they rely less on hearing for foraging compared to cetaceans (Deecke *et al.*, 2002). Instead, they primarily use their highly-developed tactile sensory systems, though in some cases they may also respond to sounds from vocalising fish while hunting (Dehnhardt *et al.*, 2001; Schulte-Pelkum *et al.*, 2007).
- 11.9.3.16 At the BEIS-funded expert elicitation workshop (Booth *et al.*, 2019), experts concluded that the likelihood of PTS significantly affecting the survival or reproduction of harbour and grey seals was very low, assuming a 6dB PTS within the 2–10kHz range (Kastelein *et al.*, 2017).
- 11.9.3.17 During the construction of the Lincs Offshore Wind Farm, over 50% of tagged seals would have received a dose of sound greater than older published thresholds for PTS (from Southall *et al.*, 2007; Hastie *et al.*, 2015). However, updated criteria (Southall *et al.*, 2019), which increased the threshold for PTS in seals, indicates that the estimate of seals exposed to PTS would be lower. For example, Whyte *et al.* (2020) found predicted PTS-onset rates ranged from 0–17% of harbour seals, depending on the threshold used. Additionally, research on tagged harbour seals in the Wash has demonstrated clear displacement from areas near piling activity. Russell *et al.* (2016) reported a significant reduction in seal abundance, ranging from 19% to 83%, within a 25km radius of active piling compared to periods when piling was paused. This effect though was short-lived, with seals returning to typical distribution patterns within approximately two hours after piling ceased.
- 11.9.3.18 PTS is permanent and irreversible; however, as seals do not primarily rely on hearing for foraging, the likelihood of an effect on biological rates is lower compared to cetaceans. Expert elicitation predicted that the likelihood of significant effects on survival or reproduction is very low, though it is noted that UK seal populations have shown mixed

trends over the same time period as offshore wind farm construction. Overall, harbour and grey seals are considered highly adaptable and with reasonable tolerance to PTS, though there is no potential for recovery from PTS. The sensitivity of harbour and grey seals to PTS from underwater noise during piling is considered to be **low**.

## Magnitude of impact

- 11.9.3.19 The following Section provides the quantitative assessment of the impact of PTS from piling on marine mammals. The predicted maximum impact ranges and areas for auditory injury (PTS-onset) from piling for each marine mammal species are presented in and . This includes the prediction of impact for each of the seven modelling locations in the Project boundary. The results presented do not take into account any mitigation measures as a result of embedded measures. To estimate the number of individuals for each receptor impacted, the assessment applies the impact area and the species specific densities, with results presented in and . A precautionary approach has been taken in this impact assessment by using the higher value density estimate where multiple estimates were available.
- 11.9.3.20 shows results for instantaneous PTS ( $SPL_{peak}$ ) for piling locations. **Table 11.23** presents cumulative PTS ( $SEL_{cum}$ ) results for piling locations, assuming the worst-case scenario of two driven piles in 24-hours at a single location. **Table 11.23** presents concurrent piling scenarios between both offshore substations W and S corner of Buchan, as well as offshore substations SW and driven pile anchor N locations.
- 11.9.3.21 For harbour porpoise, the maximum instantaneous PTS-onset impact range for piling was 660m across all modelling locations (**Table 11.20**). This equates to one animal experiencing auditory injury (PTS) using the modelled surface density from SCANS-IV, equivalent to <0.01% of the reference population (**Table 11.21**). Using the cumulative PTS-onset thresholds, the maximum impact range was 3.4km (**Table 11.22**). This equates to a maximum of 25 animals experiencing PTS for driven piling using the modelled surface density from SCANS-IV, equivalent to 0.02% of the UK reference population (**Table 11.23**).
- 11.9.3.22 For dolphin species, the maximum instantaneous PTS-onset impact range for driven piling was less than 50m for all modelling locations (**Table 11.20**). This equates to less than one animal experiencing auditory injury (PTS), equivalent to <0.01% of all of the reference populations (**Table 11.21**). Using the cumulative PTS-onset thresholds, the maximum impact range for driven piling was 100m for all modelling locations (**Table 11.22**). This equates to less than one animal experiencing auditory injury (PTS) from driven piling (<0.01% of the UK reference population; **Table 11.23**). To note, the predicted PTS ranges do not overlap with the extent of the CES MU for bottlenose dolphin.
- 11.9.3.23 For minke whales (and humpback whales), the maximum instantaneous PTS-onset impact range for driven piling was less than 50m for all modelling locations (**Table 11.20**). This equates to less than one animal experiencing auditory injury (PTS), equivalent to <0.01% of the reference population (**Table 11.21**). Using the cumulative PTS-onset thresholds, the maximum impact range for driven piling was 25km, for the installation at the offshore substation N modelling location (**Table 11.22**). This equates to a maximum of 80 animals experiencing auditory injury (PTS) from driven piling using the SCANS-IV derived surface density, which is equivalent to 0.78% of the UK reference population (**Table 11.23**).
- 11.9.3.24 For harbour and grey seals in the East Scotland and North Coast and Orkney SMAs, the maximum instantaneous PTS-onset impact range for driven piling was 60m for all modelling locations (**Table 11.20**). This equates to less than one animal in the SMAs experiencing auditory injury (PTS), equivalent to <0.01% of the reference population (**Table 11.21**). Using the cumulative PTS-onset thresholds, the maximum impact range for piling was 100m for all modelling locations (**Table 11.22**). This equates to less than one animal experiencing auditory injury (PTS), equivalent to <0.01% of the reference population (**Table 11.23**).

- 11.9.3.25 Using cumulative PTS ( $SEL_{cum}$ ) thresholds, the greatest predicted impact from concurrent piling occurred between the offshore substation SW and driven pile anchor N locations for harbour porpoise and minke whale. There was no cumulative effect from concurrent piling for HF cetaceans and phocids in water (**Table 11.22**). The greatest predicted impact for harbour porpoise indicates an estimated maximum of 444 harbour porpoise to experience PTS, equating to 0.13% of the NS MU (0.28% of the UK MU; **Table 11.23**), and for minke whales a maximum of 205 whales are estimated to experience PTS, equating to 1.02% of the CGNS MU (1.99% of the UK MU; **Table 11.23**).
- 11.9.3.26 The impact is restricted to active piling days during the construction stage and is considered reasonably likely to occur. While PTS represents a permanent auditory injury, it is expected to affect only a small proportion of the population (as shown by the results in **Table 11.21** and **Table 11.23**) and is not anticipated to influence overall population trends. Whilst the effect on humpback whales cannot be assessed qualitatively due to the lack of density estimates and reference population, it is expected that this statement is also applicable to humpback whale. Consequently, the magnitude of impact is considered to be **low** for harbour porpoise, minke whale, and humpback whale, and **negligible** for dolphin and seal species.
- 11.9.3.27 Further, the effect is unlikely to occur due to the inclusion of embedded environmental measures including implementing a MMMP (M-032), to ensure that the risk of auditory injury from instantaneous PTS remains or is reduced to negligible levels; however, as a precautionary measure the magnitude for harbour porpoise, minke whale, and humpback whale will remain as **low**.

**Table 11.20 Summary of auditory injury instantaneous PTS ( $SPL_{peak}$ ) impact ranges from piling for all modelling locations**

FHG	Species	Parameter	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
<b>VHF cetacean</b>	Harbour porpoise	Maximum impact range (m)	660	660	650	650	640	540
		Area (km <sup>2</sup> )	1.3	1.3	1.3	1.3	1.3	0.91
<b>HF cetacean</b>	Bottlenose dolphin Risso's dolphin Atlantic white-sided dolphin White-beaked dolphin Short-beaked common dolphin	Maximum impact range (m)	<50	<50	<50	<50	<50	<50
		Area (km <sup>2</sup> )	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<b>LF cetacean</b>	Minke whale Humpback whale	Maximum impact range (m)	<50	<50	<50	<50	<50	<50
		Area (km <sup>2</sup> )	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<b>PCW</b>	Harbour seal Grey seal	Maximum impact range (m)	60	60	60	60	60	60
		Area (km <sup>2</sup> )	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

**Table 11.21 Predicted impact of instantaneous PTS ( $SPL_{peak}$ ) for marine mammals from piling for all modelling locations; # = number of animals disturbed; % = the percentage of the reference population; N/A = there is no overlap with the modelled impact range and the SMA**

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	1	1	1	1	1	1
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.5985 (Gilles <i>et al.</i> , 2023)	#	1	1	1	1	1	1
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.087 (site-specific DAS)	#	1	1	1	1	1	1
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.1775 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location						
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	0.023 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
<b>Bottlenose Dolphin</b>	0.116 (within 2km of the coast; Cheney <i>et al.</i> , 2024) and 0.0298 (beyond; Hammond <i>et al.</i> , 2021)	#	Impact ranges do not overlap with the CES MU.						
		% CES MU							
	0.001 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	0.0298 (Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	<1	<1	<1	
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	<b>Short-beaked common dolphin</b>	0.017 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1
			% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
% UK MU			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
Risso's dolphin	0.0702 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.002 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0419 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Harbour seal	0.0000011	#	<1	N/A	<1	<1	<1	N/A

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
	(Carter <i>et al.</i> , 2022)	% ES SMA	<0.01	N/A	<0.01	<0.01	<0.01	N/A
	0.0000011 (Carter <i>et al.</i> , 2022)	#	N/A	<1	N/A	N/A	N/A	<1
		% North Coast and Orkney SMA	N/A	<0.01	N/A	N/A	N/A	<0.01
Grey seal	0.01 (Carter <i>et al.</i> , 2025)	#	<1	N/A	<1	<1	<1	N/A
		% ES SMA	<0.01	N/A	<0.01	<0.01	<0.01	N/A
	0.01 (Carter <i>et al.</i> , 2025)	#	N/A	<1	N/A	N/A	N/A	<1
		% North Coast and Orkney SMA	N/A	<0.01	N/A	N/A	N/A	<0.01
	0.0021 (site-specific DAS)	#	<1	N/A	<1	<1	<1	N/A
		% ES SMA	<0.01	N/A	<0.01	<0.01	<0.01	N/A
		#	N/A	<1	N/A	N/A	N/A	<1
		% North Coast and Orkney SMA	N/A	<0.01	N/A	N/A	N/A	<0.01

**Table 11.22 Summary of auditory injury cumulative PTS (SEL<sub>cum</sub>) impact ranges from worst-case piling for all modelling locations; - = signifies where there is no cumulative effect between the two locations**

FHG	Species	Parameter	Modelling location							
			Single						Concurrent	
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N
<b>VHF Cetacean</b>	Harbour porpoise	Maximum Impact Range (m)	3,300	3,400	3,200	3,200	2,800	3,400	-	-
		Area (km <sup>2</sup> )	32	33	30	29	22	32	420	590
<b>HF Cetacean</b>	White-beaked dolphin Bottlenose dolphin Risso's dolphin Atlantic white-sided dolphin Short-beaked common dolphin	Maximum Impact Range (m)	100	100	100	100	100	100	-	-
		Area (km <sup>2</sup> )	0.1	0.1	0.1	0.1	0.1	0.1	-	-
<b>LF Cetacean</b>	Minke whale (Humpback whale)	Maximum Impact Range (m)	24,000	25,000	22,000	22,000	21,000	22,000	-	-
		Area (km <sup>2</sup> )	1,500	1,600	1,400	1,400	1,100	1,300	3,400	4,100
<b>PCW</b>	Harbour seal Grey seal	Maximum Impact Range (m)	100	100	100	100	100	100	-	-
		Area (km <sup>2</sup> )	0.1	0.1	0.1	0.1	0.1	0.1	-	-

**Table 11.23 Predicted impact of auditory injury cumulative PTS (SEL<sub>cum</sub>) for marine mammals from worst-case scenario piling for all modelling locations; # = number of animals disturbed; % = the percentage of the reference population; - = signifies where there is no cumulative effect between the two locations; N/A = there is no overlap with the modelled impact range and the SMA**

Species	Density (individuals/k m <sup>2</sup> )	Impact	Modelling location							
			Single						Concurrent	
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	25	25	23	22	17	25	316	444
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.09	0.13
		% UK MU	0.02	0.02	0.01	0.01	0.01	0.02	0.20	0.28
	0.5985 (Gilles <i>et al.</i> , 2023)	#	20	20	18	18	14	20	252	354
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.07	0.10
		% UK MU	0.01	0.01	0.01	0.01	0.01	0.01	0.16	0.22
	0.087 (site-specific DAS)	#	3	3	3	3	2	3	37	52
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.03

Species	Density (individuals/k m <sup>2</sup> )	Impact	Modelling location									
			Single						Concurrent			
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N		
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	-	-	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
	0.1775 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	<1	<1	-	-
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
	0.023 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	-	-
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
Bottlenose dolphin	0.116 (within 2km of the coast; Cheney <i>et al.</i> , 2024)	#	Impact ranges do not overlap with the CES MU						-	-		
		% CES MU							-	-		

Species	Density (individuals/k m <sup>2</sup> )	Impact	Modelling location								
			Single						Concurrent		
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N	
	and 0.0298 (beyond; Hammond <i>et al.</i> , 2021)										
	0.001 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	-	-	
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	
	0.0298 (Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	<1	<1	<1	-	-	
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-	
Short-beaked common dolphin	0.017 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	-	-	
			% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
			% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-

Species	Density (individuals/k m <sup>2</sup> )	Impact	Modelling location							
			Single						Concurrent	
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N
<b>Risso's dolphin</b>	0.0702 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	-	-
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
	0.002 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	-	-
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
<b>Atlantic white-sided dolphin</b>	0.0146 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	-	-
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	-	-
	0.05	#	75	80	70	70	55	65	170	205

Species	Density (individuals/k m <sup>2</sup> )	Impact	Modelling location							
			Single						Concurrent	
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N
Minke whale	(Gilles <i>et al.</i> , 2025)	% CGNS MU	0.37	0.40	0.35	0.35	0.27	0.32	0.85	1.02
		% UK MU	0.73	0.78	0.68	0.68	0.53	0.63	1.65	1.99
	0.0419 (Gilles <i>et al.</i> , 2023)	#	63	68	59	59	47	55	143	172
		% CGNS MU	0.31	0.33	0.29	0.29	0.23	0.27	0.71	0.85
		% UK MU	0.61	0.65	0.57	0.57	0.45	0.53	1.38	1.67
Harbour seal	0.0000011 (Carter <i>et al.</i> , 2022)	#	<1	N/A	<1	<1	<1	N/A	-	-
		% ES SMA	<0.01	N/A	<0.01	<0.01	<0.01	N/A	-	-
		#	N/A	<1	N/A	N/A	N/A	<1	-	-
		% North Coast and Orkney SMA	N/A	<0.01	N/A	N/A	N/A	<0.01	-	-
Grey seal	0.01	#	<1	N/A	<1	<1	<1	N/A	-	-

Species	Density (individuals/k m <sup>2</sup> )	Impact	Modelling location							
			Single						Concurrent	
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N	OSS W & S corner	OSS SW and driven pile anchor N
	(Carter <i>et al.</i> , 2025)	% ES SMA	<0.01	N/A	<0.01	<0.01	<0.01	N/A	-	-
		#	N/A	<1	N/A	N/A	N/A	<1	-	-
		% North Coast and Orkney SMA	N/A	<0.01	N/A	N/A	N/A	<0.01	-	-
	0.0021 (site-specific DAS)	#	<1	N/A	<1	<1	<1	N/A	-	-
		% ES SMA	<0.01	N/A	<0.01	<0.01	<0.01	N/A	-	-
		#	N/A	<1	N/A	N/A	N/A	<1	-	-
		% North Coast and Orkney SMA	N/A	<0.01	N/A	N/A	N/A	<0.01	-	-

### Significance of residual effect

- 11.9.3.28 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.24**.
- 11.9.3.29 The magnitude of impact is deemed to be **low** for harbour porpoise, minke and humpback whales and **negligible** for dolphin and seals species for auditory injury from underwater noise from piling (**Table 11.24**). The sensitivity of the receptor is **low** for injury from underwater noise from piling. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.24 Significance of C2: Auditory injury from underwater noise from piling**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

### 11.9.4 Impact C3: Auditory injury from increased underwater noise during other construction activities

#### Overview

- 11.9.4.1 Although impact piling is expected to produce the biggest impacts from noise during offshore construction and development (Bailey *et al.*, 2014), several other anthropogenic sources of noise may also occur such as cable laying, dredging, drilling, rock placement and trenching. These sources all produced continuous noise, which has the potential to cause injury to marine mammals due to cumulative exposure. These sources are together termed ‘other construction activities’, noting this term does not include pre-construction surveys, piling or UXO clearance. Each of these noise sources have been considered, and relevant biological noise criteria presented, in this Section.
- 11.9.4.2 **Table 11.25** provides a summary of the other construction activities that are expected to occur during the construction and operation of the Project. Further detail on other construction activity noise sources can be found within **Volume 3, Appendix 8.1**.

**Table 11.25 Summary of the possible noise making activities and estimated unweighted source levels for the different considered other construction activities noise sources**

Activity	Description	Estimated unweighted source level (dB re 1 µPa at 1m (RMS))
<b>Cable laying</b>	Noise from the cable laying vessel and other associated noise during the offshore cable installation.	171
<b>Drag embedment anchors</b>	An alternative mooring method for fixing WTGs to the seabed.	171
<b>Dredging</b>	Dredging may be required on site for seabed preparation work for certain foundation options, as well as for the installation of export cables and array cables. Both backhoe and suction dredging have been included.	165 (backhoe)
		186 (suction)
<b>Rock placement</b>	May be required on site for installation of offshore cables (cable crossings and cable protection) and scour protection around foundation structures.	172
<b>Suction caisson installation</b>	An alternative method for fixing the WTG foundations to the seabed. Underwater suction pumps are the primary source of noise.	192
<b>Trenching</b>	Plough trenching may be required during installation of the offshore cables.	172
<b>Vessel noise</b>	Jack-up barges for piling substructure and WTG installation. Other large and medium sized vessels to carry out other construction tasks and anchor handling. Other small vessels for crew transport and maintenance on site.	168 (large; >100m)
		161 (medium; <100m)

- 11.9.4.3 For the purpose of SEL calculations, all sources are conservatively assumed to operate constantly for 24-hours to represent a worst-case exposure scenario. Noise levels from these sources are relatively low, and both fleeing and stationary marine mammals were included in the assessment (refer to **Volume 3, Appendix 8.1** for further detail).

### Sensitivity of receptor

- 11.9.4.4 The sensitivity of marine mammals to injury from other construction activities is dependent on both the activity and the marine mammal species.
- 11.9.4.5 Cable laying (if not trenched) is generally considered to have a low potential for impacts to marine mammals due to the non-impulsive nature of the noise generated and that any generated noise is likely to be dominated by the vessel from which cable installation is taking place (Genesis, 2011). Vessel noise is continuous, and is dominated by sounds from propellers, thrusters, and various rotating machinery (for example, power generation, pumps). In general, support and supply vessels (50-100m) are expected to have broadband source levels in the range 165-180dB re 1 $\mu$ Pa, with the majority of energy below 1kHz (OSPAR 2009). Large commercial vessels (>100m) produce relatively loud and predominantly LF sounds, with the strongest energy concentrated below several hundred Hz. For porpoise, dolphins and seals, the hearing sensitivity below 1kHz is relatively poor and thus it is expected that a PTS at these LF ranges is unlikely to result in an impact to vital rates. Therefore, the sensitivity of porpoise, dolphins, and seals to PTS from cable laying is assessed as **low**. The LF noise produced during cable laying may be more likely to overlap with the hearing range of LF cetacean species such as minke and humpback whales. Therefore, the sensitivity of minke and humpback whales to PTS from cable laying is assessed as **medium**.
- 11.9.4.6 Dredging is described as a continuous broadband sound source, with the main energy below 1kHz; however, the frequency and source level can vary considerably depending on the equipment, activity, and environmental characteristics (Todd *et al.*, 2015). At the proposed development, dredging will potentially be required for seabed preparation work for foundations as well as for export cable and inter-array cable installations. The source level of dredging has been described to vary between 172-190dB re 1 $\mu$ Pa at 1m (based on SPL) with a frequency range of 45Hz to 7kHz (Evans, 1990, Thompson *et al.*, 2009, Verboom, 2014). It is expected that the underwater noise generated by dredging will be below the PTS-onset threshold (Todd *et al.*, 2015) and therefore the risk of injury is unlikely. For porpoise, dolphins and seals, the hearing sensitivity below 1kHz is relatively poor and therefore it is expected that a PTS at this frequency would result in little impact to vital rates. Therefore, the sensitivity of porpoise, dolphins, and seals to PTS from dredging is assessed as **low**.
- 11.9.4.7 The LF noise produced during dredging may be more likely to overlap with the hearing range of LF cetacean species such as minke and humpback whales. Therefore, the sensitivity of minke and humpback whales to PTS from dredging is precautionarily assessed as **medium**.
- 11.9.4.8 Underwater noise generation from trenching during cable installation is highly variable and dependent on the physical properties of the seabed that is being cut. At the North Hoyle Offshore Wind Farm, trenching activities had a peak energy between 100Hz–1kHz and in general the sound levels were only 10–15dB above background levels (Nedwell *et al.*, 2003), and therefore unlikely to exceed the PTS-onset thresholds.
- 11.9.4.9 For porpoise, dolphins and seals, the hearing sensitivity below 1kHz is relatively poor and therefore it is expected that a PTS at these LF ranges would result in little impact to vital rates. Therefore, the sensitivity of porpoise, dolphins, and seals to PTS from trenching is assessed as **low**.

- 11.9.4.10 The LF noise produced during trenching may be more likely to overlap with the hearing range of LF cetacean species such as minke and humpback whales. Therefore, the sensitivity of minke and humpback whales to PTS from trenching is precautionarily assessed as **medium**.
- 11.9.4.11 Rock placement noise generation is largely unknown. One study of rock placement activities in the Yell Sound in Shetland found that rock placement noise produced LF tonal noise from the machinery, but that measured noise levels were within background levels (Nedwell and Howell, 2004). It is highly likely that any generated noise is likely to be dominated by the vessel from which activities taking place. Therefore, the sensitivity of harbour porpoise, dolphins and seals to PTS from rock placement is expected to be **low**. The LF noise produced during rock placement may be more likely to overlap with the hearing range of LF cetacean species such as minke whales. Therefore, the sensitivity of minke whale to PTS from rock placement is precautionarily assessed as **medium**.

### Magnitude of impact

- 11.9.4.12 The modelled impact ranges for these sources are presented in **Table 11.26**. All marine mammals (assumed to flee) would have to be closer than 100m from the noise sources at the start of the activity to acquire the necessary exposure to induce PTS-onset as per Southall *et al.* (2019). The same is true for most modelling scenarios for stationary receptors with the exception of LF and VHF for some sources. LF cetaceans in the vicinity of suction bucket installation could experience PTS-onset if they were within 130m of the sound source for 24-hours. Additionally, VHF cetaceans could experience PTS-onset if they remained within 570m of suction dredging, 1.2km of rock placement, 780m of suction bucket installation, 900m of trenching or 1.1km of a large vessel (>100m) travelling at 10 knots over a 24-hour period. Given the highly mobile nature of marine mammals and their instinct to flee from noise sources that cause discomfort, the scenario of a receptor remaining stationary within these ranges is highly unlikely. In addition, all cumulative noise sources were modelled being operational for a 24-hour period, which is unlikely due to the transient and intermittent nature of the noise produced through these activities.
- 11.9.4.13 Any injury risk from other construction activities is predicted to be of local spatial extent, short term and intermittent (in the context of the construction stage duration) . Whilst injury would be a permanent effect, the risk is very low and would only affect a very small proportion of the receptor populations, which would not alter the population trajectory. Therefore, the magnitude of impact is assessed as **negligible** for all species assessed.

**Table 11.26 Summary of the impact ranges for the different noise sources related to the construction of the Project using non-impulsive criteria from Southall *et al.* (2019) for marine mammals assuming a fleeing and stationary receptor**

Southall <i>et al.</i> (2019) SEL <sub>cum</sub>	PTS (non-impulsive; fleeing)				PTS (non-impulsive; stationary)			
	LF (199dB)	HF (198dB)	VHF (173dB)	PCW (201dB)	LF (199dB)	HF (198dB)	VHF (173dB)	PCW (201dB)
<b>Cable laying</b>	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m
<b>Drag embedment anchors</b>	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m
<b>Dredging (backhoe)</b>	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m

Southall <i>et al.</i> (2019) SEL <sub>cum</sub>	PTS (non-impulsive; fleeing)				PTS (non-impulsive; stationary)			
	LF (199dB)	HF (198dB)	VHF (173dB)	PCW (201dB)	LF (199dB)	HF (198dB)	VHF (173dB)	PCW (201dB)
Dredging (suction)	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	570m	< 100m
Drilling	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m
Rock placement	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	1.2km	< 100m
Suction bucket installation	< 100m	< 100m	< 100m	< 100m	130m	< 100m	780m	< 100m
Trenching	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	900m	< 100m
Vessel noise (large)	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	1.1km	< 100m
Vessel noise (medium)	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m	< 100m

### Significance of residual effect

- 11.9.4.14 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.27**.
- 11.9.4.15 The magnitude of impact are deemed to be **negligible** for all marine mammal receptors and the sensitivity of the receptors are deemed to be **low** for all marine mammals except for minke and humpback whale which are assessed as **medium** sensitivity (**Table 11.27**). The effect of auditory injury from other construction activities will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.27 Significance of C3: Auditory injury from other construction activities.**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Negligible	Medium	Negligible (Not Significant).

Receptor	Magnitude	Sensitivity	Significance
Humpback whale	Negligible	Medium	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

### 11.9.5 Impact C4: Indirect effects on marine mammals via changes in prey availability

#### Overview

- 11.9.5.1 Marine mammals are dependent on prey for survival. As a result, there is the potential for indirect effects on marine mammals to occur as a result of impacts on their prey species or the habitats that support the prey species. The key prey species for the receptors within this assessment are presented in **Table 11.28**.
- 11.9.5.2 During the construction stage, potential pressures on prey species have been assessed in detail with the EIA Report, specifically in **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** and **Chapter 13: Fish Ecology**. Relevant impacts include:
- pre-construction seabed preparation, temporary habitat disturbance, and increases in suspended sediment concentrations (SSC) and smothering;
  - mortality, injury, and behavioural changes from underwater noise, vibration, and particle motion (for example, piling and UXO clearance);
  - potential indirect effects on prey dynamics;
  - release of sediment-bound contaminants, changes in water quality, and collision or entanglement risk; and
  - increased risk of introduction or spread of marine invasive non-native species (INNS).
- 11.9.5.3 Key prey species of marine mammals that have been assessed within **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** or **Chapter 13: Fish Ecology** have been highlighted in bold within **Table 11.28**. The severity and likelihood of these impacts vary depending on species mobility, life stage, and behavioural state at the time of exposure. These factors influence the ability of prey species to avoid or recover from the impact and are considered in the EIA Report's impact assessment.

**Table 11.28 Key prey species of the receptors**

Receptor	Key prey species	Region	Reference
Harbour porpoise	<b>Sandeel, whiting, small cod</b> , blue whiting, <b>cod, haddock, saithe</b> , rocklings, <b>herring, sprat, mackerel</b> , scad, cephalopods, molluscs, brown shrimp, crabs, isopods, amphipods, other crustaceans.	Scotland	Santos <i>et al.</i> (2004a)
Bottlenose dolphin	Catsharks, <b>sprat</b> , scad, conger eel, <b>Atlantic salmon</b> , blue whiting, <b>whiting, haddock, saithe, Norway pout, pout, small cod</b> , silvery cod, <b>ling, hake, Atlantic horse mackerel, Atlantic mackerel, gobies</b> , sand smelt, lanternfish, <b>flounder, plaice, dab</b> , brill, <b>sole</b> , squid and octopus species.	Scotland Ireland	Santos <i>et al.</i> (2001) Hernandez-Milian <i>et al.</i> (2015)
Risso's dolphin	Octopus, squid, sepiolids and <b>haddock</b> .	Scotland	MacLeod <i>et al.</i> (2014)
Atlantic white-sided dolphin	<b>Cod, true cod, hake, sole, sandeel, mackerel, whiting, goby, haddock</b> , squid, <b>herring, scad</b> , long rough dab, octopus.	Northeast Atlantic	Hernandez-Milian <i>et al.</i> (2016)
White-beaked dolphin	<b>Sandeel, herring, sprat, mackerel, Norway pout/poor cod, gobies</b> .	UK	Canning <i>et al.</i> (2008) Jansen <i>et al.</i> (2010) MacLeod (2013)
Short-beaked common dolphin	Squid, cuttlefish and octopus, <b>haddock, whiting, poor cod</b> .	Northeast Atlantic	Santos <i>et al.</i> (2004b)
Minke whale	Capelin, <b>herring</b> , krill, <b>mackerel</b> , blue whiting.	Scotland	Pierce <i>et al.</i> (2004)
Humpback whale	<b>Sandeel, saithe, dab, plaice, flounder</b> , bullrout, sprat, <b>cod, haddock, ling</b> , dragonet, <b>herring, poor cod, Norway pout, rockling, mackerel, whiting</b> , blue whiting, <b>lemon sole</b> .	Norwegian sea	Løviknes <i>et al.</i> (2021)
Harbour seal	<b>Saithe, whiting, cod, haddock, rockling, ling</b> , blue whiting, <b>hake, pollock, Norway pout, small cod, plaice, lemon sole, sandeel, dover sole, dab, herring, sprat, mackerel, salmonid</b> , wrasse, catfish.	Scotland	Wilson and Hammond (2016)
Grey seal	<b>Sandeel, whiting, small cod</b> , blue whiting, <b>cod, haddock, saithe</b> , rocklings, <b>herring, sprat, mackerel</b> , scad, cephalopods, molluscs, brown shrimp, crabs, isopods, amphipods, other crustaceans.	Scotland	Hammond and Wilson (2016)

## Sensitivity of receptor

- 11.9.5.4 Changes in prey availability have the potential to increase the energy expenditure required for foraging, as marine mammals may need to invest more effort in locating and capturing food. However, the majority of marine mammal species considered in this assessment are generalist feeders, capable of consuming a wide range of prey types (**Table 11.28**). This dietary flexibility significantly reduces the likelihood of increased energetic costs associated with shifts in prey distribution or abundance. An exception to this generalist feeding strategy is observed in Risso's dolphins, which predominantly prey on cephalopods (MacLeod *et al.*, 2014).
- 11.9.5.5 All marine mammal receptors assessed are highly mobile and routinely forage across extensive areas, enhancing their ability to adapt to changes in prey availability. Given their mobility and feeding adaptability, no significant impacts on the survival or reproductive success of any marine mammal receptor are anticipated as a result of changes in prey availability.
- 11.9.5.6 In light of the above considerations, marine mammals within the scope of this assessment are characterised by having the ability to adapt to or tolerate any changes resulting from changes in prey species. Marine mammals would recover from any impact to prey species in the short- to medium-term, and full recovery is expected without any effects on vital rates. Taking these factors into account, the overall sensitivity of the marine mammal receptors to changes in prey availability is considered to be **low**.

## Magnitude of impact

- 11.9.5.7 Potential impacts on prey species during the construction stage of the Project are described in detail in **Chapter 8: Underwater Noise, Chapter 10: Benthic, Epibenthic and Intertidal Ecology** and **Chapter 13: Fish Ecology** of the EIA Report.
- 11.9.5.8 **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** of the EIA Report has concluded that there will be no likely significant effects arising on benthic, epibenthic and intertidal species during the construction stage, which includes some prey species of marine mammals. For each of the impacts assessed on marine mammal prey species within **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**, the magnitude of impact was assessed as negligible to medium (depending on the impact), and the sensitivity of the receptor was assessed as low to medium (depending on the impact). As such, the significance of all impacts were assessed as negligible to minor, which is not significant in EIA terms.
- 11.9.5.9 **Chapter 13: Fish Ecology** of the EIA Report has concluded that there will be no likely significant effects arising on the fish species during the construction stage, which includes some prey species of marine mammals. For each of the impacts assessed on marine mammal prey species within **Chapter 13: Fish Ecology**, the magnitude of impact was assessed as very low to low (depending on the impact and receptor), and the sensitivity of all fish receptors were assessed as low to medium (depending on the impact and receptor). As such, the significance of all impacts were assessed as negligible to minor (depending on the species in question), which is not significant in EIA terms.
- 11.9.5.10 Most construction-stage impacts on benthic or pelagic species are expected to be temporary but recurring over the medium term. The risk of behavioural disturbance from piling is anticipated to be high in the near field, moderate in the intermediate field, and low in more distant areas. Despite this, no significant changes to the distribution or quality of marine mammal prey species are expected. As a result, any indirect effects on prey availability are likely to be minimal or imperceptible for marine mammal receptors and are not expected to lead to population-level changes.

11.9.5.11 Given the absence of significant impacts on fish species, and the high likelihood that any effects on prey availability would lead to only minimal or imperceptible changes for marine mammal receptors, the potential magnitude of indirect impacts on marine mammal prey is assessed as **negligible**.

### Significance of residual effect

11.9.5.12 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.29**.

11.9.5.13 The magnitude of impact is deemed to be **negligible**, and the sensitivity of the receptor are deemed to be **low** for changes to prey for all species. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.29 Significance of C4: Indirect effects on marine mammals via changes in prey availability**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Negligible	Low	Negligible (Not Significant).
Humpback whale	Negligible	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

## 11.9.6 Impact C5: Disturbance from increased underwater noise during pre-construction surveys

### Overview

- 11.9.6.1 Marine mammals may also be disturbed by the use of geophysical survey equipment during pre-construction activities, including MBES, SSS, SBP, UHRS sparkers and USBL.

### Sensitivity of receptor

- 11.9.6.2 Current understanding of behavioural disturbance from pre-construction surveys on marine mammals is limited, with most research focused on seismic airguns. Analysis of marine mammal observer reports from 1,196 seismic surveys (1994–2010) indicates that small cetaceans, including harbour porpoises, tend to avoid active airguns and survey vessels, typically up to ~1km (Stone *et al.*, 2017). Increased swimming speed during airgun activity was also observed (Stone, 2003; Stone *et al.*, 2017). Thompson *et al.* (2013) reported short-term disturbance in harbour porpoises during a North Sea seismic survey, but no long-term displacement. Harbour porpoises were detected within hours post-survey, with recovery times shortening over a 10-day period (Thompson *et al.*, 2013). Whilst not specific to geophysical surveys, Hoekendijk *et al.* (2018) concluded that short-term disturbances of harbour porpoise (such as that reported by Thompson *et al.*, 2013) are unlikely to significantly affect their energetics.
- 11.9.6.3 Studies on Risso's dolphin indicated no behavioural response recorded in relation to seismic airguns (Stone *et al.*, 2017), even at received levels of 100–140 dB re 1 $\mu$ Pa SPL<sub>rms</sub>. A study by Kavanagh *et al.* (2019) on the influence seismic surveys have on cetaceans, including baleen whales (for example, minke whales), indicated that exposure to seismic surveys led to significant decrease in the sightings of baleen whales (82% to 92%), with results being consistent with previous findings of localised spatial avoidance (Weller *et al.*, 2002; Stone and Tasker, 2006) and temporary displacement (Thompson *et al.*, 2013) of whale species in response to seismic noise. Additionally, Stone *et al.*, 2017 also report a significant reduction in detection rates of minke whales in response to airgun use.
- 11.9.6.4 Data on seismic airgun impacts on seals is limited, however there is data on other impulsive noise sources which can be considered. Grey seals altered foraging and movement behaviours during piling (Aarts *et al.*, 2018), and harbour seals returned to normal activity within two hours of cessation of the piling activity (Russell *et al.*, 2016). Therefore, it could be inferred that disturbance or displacement may occur during and following exposure to impulsive noise, but that it is short-term and fully recoverable. Seals' generalist diets, wide foraging ranges, and fat reserves suggest high adaptability and low risk to vital rates as a result of short-term disturbance (Booth *et al.*, 2019; Smout *et al.*, 2014; Stansbury *et al.*, 2015).
- 11.9.6.5 Given the available evidence, marine mammal receptors are considered to have high adaptability, reasonable tolerance, and strong recovery potential from disturbance. The sensitivity of all marine mammal receptors to disturbance from pre-construction surveys is assessed as **low**.

### Magnitude of impact

- 11.9.6.6 MBES and SSS used in shallow waters such as the Project area operate at high frequencies that fall outside the hearing range of marine mammals (JNCC, 2017; **Table 11.18**). This, in addition to the high frequencies attenuating quickly, that they operate at low power and are usually used during short-term surveys (JNCC *et al.*, 2010), results in a negligible risk of disturbance to marine mammals from MBES and SSS.

- 11.9.6.7 As for USBL surveys, Pace *et al.* (2021) conducted a sound verification study which found that these surveys may cause behavioural disturbance in marine mammals, but only within a limited spatial range, typically a few hundred metres. USBL systems emit medium-frequency sound within the hearing range of marine mammals, meaning animals in the vicinity of surveys may exhibit short-term behavioural responses, such as avoidance.
- 11.9.6.8 According to JNCC *et al.* (2010), SBPs emit sound energy directed downward toward the seabed, with signals of very short duration from a moving source. This is also applicable to UHRS sparkers. The lower frequencies used by SBPs and UHRS sparkers overlap with the hearing range of marine mammals and so may cause short-term behavioural responses such as avoidance. BEIS (2020) estimated a maximum disturbance range of 2.5km for harbour porpoises from SBPs, with an overall low risk of behavioural impact.
- 11.9.6.9 Additionally, JNCC guidance for assessing disturbance in harbour porpoise SACs recommends a 5km EDR for other (non-airgun) geophysical surveys (JNCC, 2020). This 5km EDR has therefore been applied to the assessment of disturbance of harbour porpoise from pre-construction surveys, and in the absence of species-specific guidance, is also applied to other marine mammal species (**Table 11.30**). To note, the EDR has been used to reflect that 'instantaneous' disturbance at any given time; it does not account for distance covered by the survey vessel per day. The number of each marine mammal species predicted to be within the 5km EDR is presented in **Table 11.30** and has been used to determine the magnitude of the potential disturbance effect from pre-construction surveys. The number has been presented as a proportion of the respective reference populations (see **Table 11.7** for reference).

#### Harbour porpoise (VHF cetaceans)

- 11.9.6.10 The maximum number of harbour porpoise predicted to be disturbed by pre-construction surveys is 60 animals using the derived SCANS-IV surface densities, equivalent to 0.02% of the NS MU (**Table 11.30**). The anticipated impact on harbour porpoises is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on harbour porpoises is classified as **low**.

#### Dolphin species (HF cetaceans)

##### Bottlenose dolphin

- 11.9.6.11 For bottlenose dolphins, the maximum number predicted to be disturbed by pre-construction surveys was four individuals (1.65% of the CES MU; assuming that the survey occurred fully within the CES MU) and three individuals (0.12% of the GNS MU; assuming the survey occurred fully within the GNS MU), using the 5km EDR (**Table 11.32**). The anticipated impact on bottlenose dolphin is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on bottlenose dolphin is classified as **low**.

##### Risso's dolphin

- 11.9.6.12 The maximum number of Risso's dolphin predicted to be disturbed by pre-construction surveys is six animals using the SCANS-IV block NS-E density, equivalent to 0.04% of the CGNS MU (**Table 11.30**). The anticipated impact on Risso's dolphin is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence

the overall population trajectory. Consequently, the magnitude of impact on Risso's dolphin is classified as **low**.

#### *Atlantic white-sided dolphin*

- 11.9.6.13 The maximum number of Atlantic white-sided dolphin predicted to be disturbed by pre-construction surveys is two animals using the SCANS-IV block NS-E density, equivalent to 0.01% of the CGNS MU (**Table 11.30**). The anticipated impact on Atlantic white-sided dolphin is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on Atlantic white-sided dolphin is classified as **low**.

#### *White-beaked dolphin*

- 11.9.6.14 The maximum number of white-beaked dolphin predicted to be disturbed by pre-construction surveys is 33 animals using the derived SCANS-IV surface densities, equivalent to 0.07% of the CGNS MU (**Table 11.30**). The anticipated impact on white-beaked dolphin is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on white-beaked dolphin is classified as **low**.

#### *Short-beaked common dolphin*

- 11.9.6.15 The maximum number of short-beaked common dolphin predicted to be disturbed by pre-construction surveys is two animals using the derived SCANS-IV surface densities, equivalent to <0.01% of the CGNS MU (**Table 11.30**). The anticipated impact on short-beaked common dolphin is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on short-beaked common dolphin is classified as **low**.

#### *Minke and humpback whale (LF cetaceans)*

- 11.9.6.16 The maximum number of minke whale predicted to be disturbed by pre-construction surveys is four animals using the derived SCANS-IV surface densities, equivalent to 0.02% of the CGNS MU (**Table 11.30**). The anticipated impact on minke whale is assessed as affecting only a small portion of the MU population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on minke whale is classified as **low**. Given that humpback whales are also low-frequency cetaceans and occur in low densities in the Project area on a seasonal basis only, they are conservatively assigned the same impact magnitude of **low**.

#### *Harbour and grey seal (PCW)*

##### *Harbour seal*

- 11.9.6.17 Using the 5km EDR, the maximum number of harbour seals predicted to be disturbed by pre-construction surveys is less than one animal, equivalent to <0.01% of the ES SMA. The location of the survey has been assessed as being fully in the ES SMA as this provides the worst-case scenario, due to the lower reference population estimate of the overlapping SMAs with the Project. These effects are expected to be temporary and intermittent and

thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on harbour seal is classified as **negligible**.

*Grey seal*

11.9.6.18 Using the 5km EDR, the maximum number of grey seals predicted to be disturbed by pre-construction surveys is one animal, equivalent to 0.01% of the ES SMA. The location of the survey has been assessed as being fully in the ES SMA as this provides the worst-case scenario, due to the lower reference population estimate of the overlapping SMAs with the Project. The anticipated impact on grey seal is assessed as affecting only a small portion of the SMAs population. These effects are expected to be temporary and intermittent and thus are considered recoverable and unlikely to influence the overall population trajectory. Consequently, the magnitude of impact on grey seal is classified as **low**.

**Table 11.30 Predicted impact of disturbance to marine mammals from pre-construction surveys using a 5km EDR; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	60
		% NS MU	0.02
		% UK MU	0.04
	0.5985 (Gilles <i>et al.</i> , 2023)	#	48
		% NS MU	0.01
		% UK MU	0.03
	0.087 (site-specific DAS)	#	7
		% NS MU	<0.01
		% UK MU	0.01
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	33
		% CGNS MU	0.07
		% UK MU	0.10
	0.1775	#	14

Species	Density (individuals/km <sup>2</sup> )	Impact	
	(Gilles <i>et al.</i> , 2023)	% CGNS MU	0.03
		% UK MU	0.04
	0.023 (site-specific DAS)	#	2
		% CGNS MU	<0.01
		% UK MU	<0.01
<b>Bottlenose dolphin</b>	0.116 (within 2km of the coast) and 0.0298 (beyond)	#	4
		% CES MU	1.65
	0.001 (Gilles <i>et al.</i> , 2025)	#	1
		% GNS MU	<0.01
		% UK MU	<0.01
	0.0298 (Hammond <i>et al.</i> , 2021)	#	3
		% GNS MU	0.11
		% UK MU	0.12
	<b>Short-beaked common dolphin</b>	0.017 (Gilles <i>et al.</i> , 2025)	#
% CGNS MU			<0.01
% UK MU			<0.01
<b>Risso's dolphin</b>	0.0702 (Gilles <i>et al.</i> , 2023)	#	6
		% CGNS MU	0.04
		% UK MU	0.06
	0.002	#	1

Species	Density (individuals/km <sup>2</sup> )	Impact	
	(site-specific DAS)	% CGNS MU	<0.01
		% UK MU	<0.01
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	2
		% CGNS MU	0.01
		% UK MU	0.01
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	4
		% CGNS MU	0.02
		% UK MU	0.04
	0.0419 (Gilles <i>et al.</i> , 2023)	#	4
		% CGNS MU	0.02
		% UK MU	0.03
Harbour seal	Carter <i>et al.</i> (2022) grid-specific densities	# ES SMA	<1
		% ES SMA	<0.01
		# North Coast and Orkney SMA	<1
		% North Coast and Orkney SMA	<0.01
Grey seal	Carter <i>et al.</i> (2025) grid-specific densities	# ES SMA	1
		% ES SMA	<0.01
		# North Coast and Orkney SMA	<1
		% North Coast and Orkney SMA	<0.01

## Significance of residual effect

- 11.9.6.19 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.31**.
- 11.9.6.20 The magnitude of impact is deemed to be **negligible** for harbour seals and **low** for all other marine mammal receptors and the sensitivity of the receptor are deemed to be **low** for disturbance from increased underwater noise during pre-construction surveys. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.31 Significance of C5: Disturbance from increased underwater noise during pre-construction surveys**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

## 11.9.7 Impact C6: Disturbance from increased underwater noise during installation (for example, anchor piles)

### Overview

- 11.9.7.1 Underwater noise generated during the construction stage has the potential to cause behavioural disturbance in marine mammals. Documented responses include temporary avoidance, displacement from preferred habitats, altered foraging or social behaviours, and stress-related effects (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Pirota *et al.*, 2014; Stone *et al.*, 2017). While such effects are often reversible, repeated or prolonged changes can reduce individual fitness, particularly if they result in reduced access to prey or disruption of breeding and calving behaviours (Nabe-Nielsen *et al.*, 2018). The severity of a marine mammal's response to disturbance depends on individual sensitivity, prior exposure, and environmental context. In historically noisy areas, habituation may reduce aversive reactions.

- 11.9.7.2 Graham *et al.* (2017) demonstrated species-specific dose-response relationships during piling at the Beatrice Offshore Wind Farm in the Moray Firth, Scotland. For harbour porpoise, the probability of occurrence (measured as porpoise positive minutes) increased exponentially with distance from the source. Graham *et al.* (2017) estimated a 100% probability of disturbance at an (un-weighted) SEL of 180dB re 1 $\mu$ Pa<sup>2</sup>s, 50% at 155dB re 1 $\mu$ Pa<sup>2</sup>s, which dropped to approximately 0% at an SEL of 120dB re 1 $\mu$ Pa<sup>2</sup>s. Dose-response modelling, based on Graham *et al.* (2017) for harbour porpoise, is considered more precautionary and spatially explicit compared to other thresholds of disturbance (for example, Level B harassment), and so has been used in this assessment as the primary method for estimating disturbance. It is acknowledged that this approach may over-estimate disturbance for species other than harbour porpoise, for example, bottlenose dolphins, which are known to exhibit site fidelity and behavioural plasticity (Culloch, 2004; Corr *et al.*, 2024).
- 11.9.7.3 Similarly, a telemetry study undertaken by Russell *et al.* (2016) investigating the behaviour of tagged harbour seals during piling at the Lincs Offshore Wind Farm in the Wash found that there was a proportional response at different received noise levels. Dividing the study area into a 5km-by-5km grid, the authors modelled received SEL<sub>ss</sub> levels and matched these to corresponding densities of harbour seals in the same grids during non-piling versus piling periods to show change in usage. The study found that there was a significant decrease in harbour seal numbers during piling at predicted received SELs between 142dB and 151dB re 1 $\mu$ Pa<sup>2</sup>s.
- 11.9.7.4 A quantitative assessment of behavioural disturbance from impact piling has been undertaken using current best-practice methodologies, incorporating dose-response modelling and species-specific considerations where available.

## Sensitivity of receptor

### Harbour porpoise (VHF cetaceans)

- 11.9.7.5 Harbour porpoises are particularly vulnerable to disturbance, with the main impact being loss of foraging opportunities (Nabe-Nielsen *et al.*, 2018). They are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently to maintain a high metabolic rate with little energy remaining for fat storage (Rojano-Doñate *et al.*, 2018; Wisniewska *et al.*, 2016). Therefore, there is a risk of changes to their overall fitness if they are displaced from high-quality foraging grounds or if their foraging efficiency is disturbed, and they are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. However, results from studies using tags suggest that harbour porpoise are able to respond to short-term reductions in food intake and may have some resilience to disturbance (Wisniewska *et al.*, 2016).
- 11.9.7.6 Several studies have shown that harbour porpoises are displaced during periods of piling (for example, Benhemma-Le Gall *et al.*, 2021; Brandt *et al.*, 2016; Graham *et al.*, 2019;). For example, monitoring of harbour porpoise during piling at Beatrice Offshore Wind Farm indicated that porpoises were displaced from the immediate vicinity of the piling activity with a 50% probability of response occurring at approximately 7km from the first piled location (Graham *et al.*, 2019). However, the 50% probability of response reduced to 1.3km by the final piling location, suggesting that the response of harbour porpoise diminished over the construction period (Graham *et al.*, 2019). In addition, studies in the German North Sea at eight offshore wind farms recorded declines in porpoise detection of >90% at noise levels above 170dB compared to a baseline period of 24 to 48 hours (Brandt *et al.*, 2016). A decline in detections of 25% at noise levels between 145 and 150dB showed a decrease in effect with increase in distance from the piling location (Brandt *et al.*, 2016). Furthermore, the detection rates showed that animals were only displaced from the area for a short period

(one to three days; Brandt *et al.*, 2011; Brandt *et al.*, 2016; Brandt *et al.*, 2018; Dähne *et al.*, 2013).

- 11.9.7.7 Recent studies at two offshore wind farms in Scotland showed that detections of clicks (associated with echolocation) and buzzing (a vocalisation associated with prey capture), in the short range (2km), did not cease in response to piling, suggesting that porpoises were not completely displaced from the piling area (Benhemma-Le Gall *et al.*, 2021). Furthermore, the study suggests that animals that experience displacement may be able to compensate for missed foraging opportunities and increased energy expenditure of fleeing the piling area as detections of both clicks and buzzing were positively related to the distance from the piling activity (Benhemma-Le Gall *et al.*, 2021), which could be due to an increase in foraging activities beyond the piling impact range. At an expert elicitation workshop in 2019, specialists agreed that harbour porpoise juvenile and adult survival rates were unlikely to be significantly affected by missed foraging opportunities as a result of disturbance from piling (Booth *et al.*, 2019).
- 11.9.7.8 Based on the above, harbour porpoises are considered to be of high adaptability, reasonable tolerance, have high recoverability. Taking these factors into account, the overall sensitivity of harbour porpoise to disturbance from increased underwater noise during installation is considered to be **low**.

### Dolphin species (HF cetaceans)

#### Bottlenose dolphin

- 11.9.7.9 A study of bottlenose dolphin response to impulsive noise (including the piling campaigns of Beatrice Offshore Wind Farm and Moray East Offshore Wind Farm, northeast Scotland), suggest that these activities did not cause displacement of the species from the southern coast of the Moray Firth (Fernandez-Betelu *et al.*, 2021). At the small temporal scale, dolphin detections increased, and the species remained within the predicted impacted area close to the offshore activities, for a median of two hours per day, on days with impulsive noise. This could be due to modifications in group size and/or behaviour, or changes in vocalisation rate or amplitude in response to impulsive noise generated by offshore activities. It is also important to note that bottlenose dolphin occurrence is largely influenced by various natural drivers, such as prey abundance, which could be deemed of higher importance in affecting their occurrence than noise pressures. Other studies in the Cromarty Firth (within the Moray Firth on the northeast of Scotland) have suggested small spatial and temporal scale disturbance of bottlenose dolphins from piling activities have occurred previously, as evidenced by a slight reduction of the presence, detection positive hours, and the encounter duration in the vicinity of construction works, although dolphins were not excluded entirely from the area (Graham *et al.*, 2017).
- 11.9.7.10 There is potential for behavioural disturbance from piling to result in disruption in foraging and resting activities, leading to an increase in travel and energetic costs in bottlenose dolphins (Marley *et al.*, 2017a; Pirota *et al.*, 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that while there is potential for disturbance to affect bottlenose dolphin behaviour and health, which will then impact vital rates and population dynamics, individuals are able to compensate for immediate behavioural responses to disturbances (caused by vessel activity). This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance.
- 11.9.7.11 Based on the above, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, have high recoverability, and are of very high value. Taking these factors into account, the overall sensitivity of bottlenose dolphin to disturbance from increased underwater noise during installation is considered to be **low**.

### *Risso's dolphin*

- 11.9.7.12 There is limited information on the response of Risso's dolphin to piling and or other impulsive noise sources, such as seismic surveys. The frequency range of seismic airguns may be similar to that of low-frequency noise produced by piling, although its duration and cumulative acoustic energy levels will differ. A study on the effects of seismic operations in UK waters showed no response by Risso's dolphin to seismic airguns (Stone *et al.*, 2017). During controlled experiments where Risso's dolphin were exposed to simulated military sonar (SPLs of 135dB re 1µPa), no clear behavioural response was recorded (Southall *et al.*, 2011). Given the limited information on the effects of disturbance on Risso's dolphins, bottlenose dolphins can be used as a proxy given that both species are HF cetaceans.
- 11.9.7.13 Based on the above, Risso's dolphins are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of Risso's dolphin to disturbance from increased underwater noise during installation is considered to be **low**.

### *Atlantic white-sided dolphin*

- 11.9.7.14 There are no studies on the response of Atlantic white-sided dolphins to piling or other noise sources. Given this, bottlenose dolphins can be used as a proxy given that both species are HF cetaceans.
- 11.9.7.15 Based on the above, Atlantic white-sided dolphins are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of Atlantic white-sided dolphin to disturbance from increased underwater noise during installation is considered to be **low**.

### *White-beaked dolphin*

- 11.9.7.16 There are no studies on the response of white-beaked dolphins to piling. Rasmussen *et al.* (2016) played different amplitude modulated tones and synthetic pulse-bursts, with behavioural responses in white-beaked dolphin observed in 90 out of 123 playbacks, with received levels varying between 153 and 161dB re 1 µPa for pulse-burst signals. Stone *et al.* (2017) observed that white-beaked dolphins reacted negatively to airgun noise, which indicates sensitivity to LF noise. Given the limited information on the effects of disturbance on white-beaked dolphins, bottlenose dolphins can be used as a proxy given that both species are HF cetaceans.
- 11.9.7.17 Based on the above, white-beaked dolphins are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of white-beaked dolphin to disturbance from increased underwater noise during installation is considered to be **low**.

### *Short-beaked common dolphin*

- 11.9.7.18 There is limited information on the response of common dolphin to piling or other impulsive noise sources, such as seismic surveys. The frequency range of seismic airguns may be similar to that of low-frequency noise produced by piling. However, duration and cumulative acoustic energy levels will differ. Culloch *et al.* (2016) observed no reduction in the occurrence of common dolphins in the vicinity of construction related activities, including seismic surveys, during the construction of a gas pipeline in Broadhaven Bay. Similarly, Stone *et al.* (2017) and Kavanagh *et al.* (2019) also observed no response from common dolphins in the vicinity of seismic surveys. Kavanagh *et al.* (2019) sighted 154 individuals during both active and inactive periods during seismic surveys compared to 304 visual sightings and 11 acoustic and visual detections recorded by Stone *et al.* (2017). In contrast,

Goold (1996) found that seismic surveys did have a negative impact on common dolphin occurrence over a relative short range of around 1km from the sound source.

- 11.9.7.19 The above studies show contrasting evidence on the disturbance effects of impulsive noise sources on common dolphins. Based on the above, while also using bottlenose dolphins as a proxy given that both species are HF cetaceans, common dolphins are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of common dolphin to disturbance from increased underwater noise during installation is considered to be **low**.

### *Minke and humpback whale (LF cetaceans)*

#### *Minke whale*

- 11.9.7.20 There is limited information on the behavioural responses of minke whales to underwater noise from piling, hence their responses to other impulsive underwater noise sources are considered. A study on the behavioural responses of minke whale to sonar signals showed that they displayed prolonged avoidance, an increase in swim speed directly away from the source, and cessation of feeding at an estimated received SPL of 146dB re 1  $\mu$ Pa and long-term (six hour) avoidance of the area at an estimated received SPL of 158dB re 1  $\mu$ Pa (Sivle *et al.*, 2015). A study detailing minke whale responses to the Lofitech 'seal scarer' ADD showed minke whales within 500m and 1,000m of the source (4.6kHz tone with a source level of 198dB re 1  $\mu$ Pa at 1m (rms)) exhibiting responses of increased swim speeds and movement away from the source (McGarry *et al.*, 2017). Marine mammal monitoring showed that fine-scale temporal occurrence of minke whales was reduced by the presence of construction related activity (which did not include piling but did assess vessel presence as a proxy for other activities, including seismic surveys and multi-beam surveys) in Broadhaven Bay, north-west (NW) Ireland (Culloch *et al.*, 2016).
- 11.9.7.21 While information on the behavioural responses of minke whales to underwater noise is limited, it is anticipated that minke whales, as seasonal migrants to Scottish waters, will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage.
- 11.9.7.22 Based on the above, minke whales are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of minke whale to disturbance from increased underwater noise during installation is considered to be **low**.

#### *Humpback whale*

- 11.9.7.23 There is limited information on the behavioural responses of humpback whales to underwater noise, particularly piling noise. Studies conducted on humpback whales during their southward migration off eastern Australia observed no abnormal behaviour to suggest signs of stress when seismic airguns were fired (Dunlop *et al.*, 2015; 2016; 2017). However, displacement when airguns were active occurred, with some deviations in migration course being recorded and a reduction in net southward migratory speed. Humpback whales were found to be more likely to avoid airguns when they were within 3km of the source, and when received levels were over 140dB re. 1  $\mu$ Pa<sup>2</sup>s (Dunlop *et al.*, 2017), suggesting both the proximity and the received level were important factors in causing disturbance. Exposure to airguns was found to reduce dive time and increase respiration (blow) rate when compared to the baseline group in which no airguns or vessels were present. However, these changes were also observed in the control treatment where vessels towing inactive airguns were present. Therefore, these behavioural changes may be in response to vessel presence

rather than exposure to airguns. Despite this, behavioural changes were mild and were still within their normal behavioural repertoire.

- 11.9.7.24 Based on the above, and considering that humpback whales are LF cetaceans and migratory and so will have a similar sensitivity to minke whales, humpback whales are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of humpback whale to disturbance from increased underwater noise during installation is considered to be **low**.

### Harbour and grey seal (PCW)

#### Harbour seal

- 11.9.7.25 Behavioural disturbance of harbour seals as a result of underwater noise during piling could have an effect on survival, if it results in the separation of a pup from its mother, and reproduction via body condition, if it results in the animal spending less time feeding or conserving energy by resting (Booth *et al.*, 2019).
- 11.9.7.26 A study of telemetry tagged harbour seals in the Wash, southeast England, showed displacement during piling with a 19 to 83% reduction in abundance compared to during piling breaks (Russell *et al.*, 2016). The study shows that abundance was significantly reduced up to 25km from the piling activity (Russell *et al.*, 2016). However, seals within the area returned to usage levels similar to non-piling periods within two hours of cessation of the piling activity, suggesting that the duration of displacement was short-term.
- 11.9.7.27 It is possible that displacement of harbour seals could result in an increased energetic cost if they are required to travel greater distances to compensate for missed foraging opportunities. However, during an expert elicitation workshop in 2018, the specialists considered it unlikely that an individual would repeatedly return to an area where it had been previously displaced, and therefore unlikely to result in reduced foraging opportunities over a number of days that would be required to reduce body condition or fertility and so affect vital rates (Booth *et al.*, 2019).
- 11.9.7.28 During the expert elicitation workshop in 2018, specialists also agreed that harbour seals have a reasonable ability to compensate for missed foraging opportunities from disturbance (from exposure to LF broadband pulsed noise such as piling driving) due to their generalist diet, adequate fat stores, mobility, and life-history traits (Booth *et al.*, 2019). For example, they have a thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods. Therefore, they are likely to have the capacity to tolerate short-term displacement from foraging grounds during piling activity. Foraging ranges of up to 273km from a haul-out have been reported for harbour seals, based on analysis of telemetry data (Carter *et al.*, 2022). However, typically, harbour seals normally forage within 50km of their haul-out site and show high site fidelity (Carter *et al.*, 2022).
- 11.9.7.29 Based on the above, harbour seals are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of harbour seal to disturbance from increased underwater noise during installation is considered to be **low**.

#### Grey seal

- 11.9.7.30 There is some information on the behavioural responses of grey seals to underwater noise during piling. Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the construction of the Luchterduinen wind farm and from 16 grey seals in 2015 during the construction of the Gemini wind farm (Aarts *et al.*, 2018). The most common

response was a change in behaviour from foraging to horizontal movement, although various other responses were recorded including altered surfacing and diving behaviour, changes in swim direction, and no response (Aarts *et al.*, 2018). Data from this study also showed that seals returned to the wind farm area on subsequent trips, despite receiving multiple exposures.

- 11.9.7.31 During an expert elicitation workshop in 2018, it was concluded that grey seals were considered to have a reasonable ability to compensate for missed foraging opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al.*, 2019; Smout *et al.*, 2014; Stansbury *et al.*, 2015). In general, experts agreed that grey seals would be more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet and more adaptable in their foraging strategies (Booth *et al.*, 2019). Experts also agreed that moderate-high levels of repeated disturbance would be required for any effect on grey seal fertility rates (Booth *et al.*, 2019).
- 11.9.7.32 Grey seals are highly adaptable to a changing environment. They are also able to tolerate periods of fasting as part of their life history because of their large body size and thick layer of blubber (*i.e.*, more energy reserve; Pomeroy *et al.*, 1999). Foraging ranges of up to 448km from a haul-out have been reported for grey seals, and 100km on average distances based on the analysis of telemetry data (Carter *et al.*, 2022); however, this range reduces to 20km during the breeding season.
- 11.9.7.33 Based on the above, grey seals are considered to be of high adaptability, reasonable to high tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of grey seal to disturbance from increased underwater noise during installation is considered to be **low**.

### Magnitude of impact

- 11.9.7.34 The number of each marine mammal species predicted to experience behavioural disturbance as a result of piling for the worst-case scenario, two driven piles per 24-hour period, is modelled at the modelling locations presented in **Table 11.32**. Each receptor has been assessed as the proportion of the respective reference populations (as presented in **Table 11.7**). Across all species, disturbance is anticipated to be intermittent, temporary, and recoverable, occurring with moderate frequency during the construction stage.

### Harbour porpoise (VHF cetaceans)

- 11.9.7.35 The maximum number of harbour porpoise predicted to be disturbed by piling is 14,787 animals at the offshore substation N location using the derived from SCANS-IV surface densities, equivalent to 4.27% of the NS MU (**Table 11.32; Volume 2, Figure 11.5: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on the harbour porpoise density surface from Gilles *et al.*, (2025)**). Site-specific DAS data provided a more refined population estimate of disturbance for 1,711 individuals (0.49% NS MU) under the dose-response model.
- 11.9.7.36 To evaluate whether the predicted level of disturbance from construction activities could lead to population-level impacts on harbour porpoise, iPCoD modelling was undertaken (**Volume 3, Appendix 11.2**). This modelling focused on a single piling scenario, representing a worst-case assessment. The scenario assumed the installation of 1,856 driven pin piles (3m diameter) over a four-year period, resulting in 1,082 piling days between 2030 and 2041. On each piling day, an estimated 14,787 harbour porpoise could be exposed to disturbance. This represents the maximum number of disturbance days and individuals potentially affected.

- 11.9.7.37 The results of the iPCoD modelling indicate that this level of disturbance is not sufficient to cause any significant change at the population level. The model predicts that the impacted population will continue to grow along a stable trajectory, closely mirroring that of an unimpacted population. Specifically, the size of the impacted population is projected to remain between 98.06% and 98.30% of the unimpacted population from 1 to 18 years following the end of piling activities (**Volume 3, Appendix 11.2**). These findings demonstrate that the consequences of disturbance are low, with no anticipated deviation in long-term population trends. Although a small proportion of the population may be temporarily affected during construction, the modelling confirms that this will not alter the overall population trajectory. Therefore, the impact of disturbance from piling on harbour porpoise is assessed as being of **low** magnitude, with no significant population-level effects expected.

### *Dolphin species (HF cetaceans)*

- 11.9.7.38 Due to the absence of species-specific dose-response data for all dolphin species assessed, behavioural disturbance from piling was modelled using the dose-response curve developed for harbour porpoises (Graham *et al.*, 2017b). This approach is considered precautionary and likely overestimates the number of individuals affected. To provide a comparative measure, disturbance was also calculated using the Level B harassment threshold, which consistently produced lower estimates across all species.

### *Bottlenose dolphin*

- 11.9.7.39 For bottlenose dolphins, the maximum number predicted to be disturbed by piling was 60 individuals (26.55% of the CES MU) and 586 individuals (28.98% of the GNS MU) using the dose-response method (**Table 11.32; Volume 2, Figure 11.6: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on the bottlenose dolphin density surface from Gilles et al. (2025)**). In contrast, the Level B disturbance threshold predicted disturbance to 18 individuals (8.12% of the CES MU) and 123 individuals (6.04% of the GNS MU; **Table 11.33; Volume 2, Figure 11.6**). Bottlenose dolphins are generally considered less sensitive to acoustic disturbance than harbour porpoises, further supporting the conservative nature of the dose-response estimates.
- 11.9.7.40 To evaluate whether the predicted level of disturbance from construction activities could lead to population-level impacts on bottlenose dolphins, iPCoD modelling was undertaken (**Volume 3, Appendix 11.2**). This modelling focused on a single piling scenario, representing a worst-case assessment. The scenario assumed the installation of 1,856 pin piles over a four-year period, resulting in 1,082 piling days between 2030 and 2041. On each piling day, an estimated 31 bottlenose dolphins in the CES MU, and an estimated 20 bottlenose dolphins in the GNS MU could be exposed to disturbance. This represents the maximum number of disturbance days and individuals potentially affected.
- 11.9.7.41 The results of the iPCoD modelling indicate that this level of disturbance is not sufficient to cause any significant change at the CES MU population level. **Volume 3, Appendix 11.2** outlines that the parameters used in the modelling represent a precautionary approach. As a result, the number of disturbed animals in real-life is expected to be lower than the values presented. This precautionary stance is reflected in several conservative assumptions, including: no restrictions on piling activity across all months during the assumed piling years; a conservative estimate of the number of piles, distributed over a higher number of piling days than the maximum design scenario (over 100 additional days; see **Section 11.7.1**); use of the highest number of disturbed animals calculated for the offshore substation North scenario, rather than lower estimates from other areas within the OAA; and incorporation of precautionary elements inherent to the iPCoD modelling framework. Considering this, the

model predicted that the impacted population will continue to maintain a stable growth trajectory, comparable to that of an unimpacted population. Specifically, the size of the impacted population is projected to remain between 89.51% and 91.51% of the unimpacted population from 1 to 18 years following the end of piling activities (**Volume 3, Appendix 11.2**). By 2057, 18 years after piling concludes, the impacted population is projected to reach 511 individuals, compared with 560 in the unimpacted scenario. Both 511 and 560 represent a substantial increase from the pre-piling 2028 estimate of 228 individuals. The impact is expected to be temporary, recoverable and the modelling confirms that this will not alter the overall population trajectory, but due to the higher (medium) proportion of the population affected, the magnitude of impact is assessed as **medium**.

- 11.9.7.42 As for the results of the iPCoD modelling indicate that this level of disturbance is not sufficient to cause any measurable change at the GNS MU population level. The model predicts that the impacted population will continue along a stable trajectory, closely mirroring that of an unimpacted population. Specifically, the size of the impacted population is projected to remain between 99.26% and 99.35% of the unimpacted population from 1 to 18 years following the end of piling activities (**Volume 3, Appendix 11.2**). These findings demonstrate that the consequences of disturbance are low, with no anticipated deviation in long-term population trends. The impact is expected to be temporary, recoverable and the modelling confirms that this will not alter the overall population trajectory, but due to the higher (medium) proportion of the population affected, the magnitude of impact is assessed as **medium**.

#### *Risso's dolphin*

- 11.9.7.43 For Risso's dolphins, the maximum number predicted to be disturbed by piling was 1,381 individuals (11.23% of the CGNS MU; **Table 11.32; Volume 2, Figure 11.9: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location for Risso's dolphin overlain the SCANS-IV block densities**) under the dose-response model and 288 individuals (2.34% of the CGNS MU; **Table 11.33; Volume 2, Figure 11.9**) under the Level B disturbance threshold. Site-specific DAS data provided a more refined population estimate of disturbance for 40 individuals (0.33% CGNS MU) under the dose-response model. The impact is expected to be temporary and recoverable, but due to the higher (medium) proportion of the population affected, the magnitude of impact is assessed a medium.

#### *Atlantic white-sided dolphin*

- 11.9.7.44 For Atlantic white-sided dolphins, the dose-response method predicted disturbance to 288 individuals (1.59% of the CGNS MU; **Table 11.32; Volume 2, Figure 11.10: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location for Atlantic white-sided dolphin overlain on the SCANS-IV block densities**), while the Level B disturbance threshold estimated 60 individuals (0.33% of the CGNS MU; **Table 11.33; Volume 2, Figure 11.10**). These effects are expected to be intermittent and short-lived, impacting only a small proportion of the population, with dolphins likely to return to the area shortly after piling concludes. The magnitude of impact is assessed as **low**.

#### *White-beaked dolphin*

- 11.9.7.45 White-beaked dolphins had the highest predicted disturbance levels among dolphins. Up to 8,181 individuals (18.61% of the CGNS MU; **Table 11.32; Volume 2, Figure 11.8: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on white-beaked dolphin density surface from**

**Gilles et al. (2025)**) may be affected under the dose-response model, and 1,706 individuals (3.88% of the CGNS MU; **Table 11.33; Volume 2, Figure 11.8**) under the Level B disturbance threshold. Site-specific DAS data provided a more refined population estimate of disturbance for 453 individuals (1.03% GNS MU) under the dose-response model.

- 11.9.7.46 Although movement patterns of white-beaked dolphin in UK waters are not well understood, their wide-ranging distribution suggests limited exposure to the effects of piling for the Project. The impact is expected to be temporary and recoverable, but due to the higher (medium) proportion of the population affected, the magnitude of impact is assessed a **medium**.

#### *Short-beaked common dolphin*

- 11.9.7.47 For short-beaked common dolphins, the dose-response method predicted a maximum of 335 individuals disturbed (0.33% of the CGNS MU; **Table 11.32; Volume 2, Figure 11.7: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on the short-beaked common dolphin density surface from Gilles et al. (2025)**), while the Level B disturbance threshold estimated 70 individuals (0.07% of the CGNS MU; **Table 11.33; Volume 2, Figure 11.7**). These effects are expected to be intermittent and short-lived, impacting only a small proportion of the population, with dolphins likely to return to the area shortly after piling concludes. The magnitude of impact is assessed as **low**.

#### *Minke and humpback whale (LF cetaceans)*

- 11.9.7.48 In the absence of species-specific behavioural response data, the number and proportion of minke whales predicted to be disturbed by piling were estimated using the dose-response curve developed for harbour porpoises (Graham et al., 2017b), consistent with the approach applied to dolphin species. This method predicted a maximum of 984 individuals (4.89% of the CGNS MU; **Table 11.32; Volume 2, Figure 11.11: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on the minke whale density surface from Gilles et al. (2025)**) potentially disturbed at the offshore substation N location. In contrast, the Level B harassment threshold produced a significantly lower estimate of 205 individuals (1.02% of the CGNS MU; **Table 11.33; Volume 2, Figure 11.11**).
- 11.9.7.49 To evaluate whether the predicted level of disturbance from construction activities could lead to population-level impacts on minke whale, iPCoD modelling was undertaken (**Volume 3, Appendix 11.2**). This modelling focused on a single piling scenario, representing a worst-case assessment. The scenario assumed the installation of 1,856 pin piles over a four-year period, resulting in 1,082 piling days between 2030 and 2041. On each piling day, an estimated 984 minke whale could be exposed to disturbance. This represents the maximum number of disturbance days and individuals potentially affected.
- 11.9.7.50 The results of the iPCoD modelling indicate that this level of disturbance is not sufficient to cause any significant change at the population level. The model predicts that the impacted population will continue to mildly decline along a stable trajectory, closely mirroring that of an unimpacted population. Specifically, the size of the impacted population is projected to remain between 99.91% and 99.97% of the unimpacted population from 1 to 18 years following the end of piling activities (**Volume 3, Appendix 11.2**). These findings demonstrate that the consequences of disturbance are low, with no anticipated deviation in long-term population trends. Although a small proportion of the population may be temporarily affected during construction, the modelling confirms that this will not alter the overall population trajectory. Therefore, the impact of disturbance from piling on minke whale within the CGNS MU is assessed as being of low magnitude, with no significant population-level effects expected. Given that humpback whales are also low-frequency

cetaceans and occur in low densities in the Project area on a seasonal basis only, they are conservatively assigned the same impact magnitude of **low**.

### Harbour and grey seal (PCW)

#### Harbour seal

- 11.9.7.51 Using the dose-response function, the maximum number of harbour seals predicted to be disturbed by piling is 17 animals (4.41% of the ES SMA reference population) at the RCP S location in the ES SMA; however, as piling is only estimated to occur across two days at this location, it is more realistic to consider the number of individuals disturbed within pile installation within the OAA. A maximum of two animals (<0.47% of the ES SMA) are estimated to be disturbed by piling within the OAA. In the North Coast and Orkney SMA, a maximum of one animal (<0.01% of the North Coast and Orkney SMA) is predicted to be disturbed at all modelling locations. In the Moray Firth SMA, the maximum number of harbour seals predicted to be disturbed by piling is three animals (0.19% of the Moray Firth SMA) at the RCP S location (**Table 11.32; Volume 2, Figure 11.13: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on harbour seal at-sea density Carter et al. (2022)**).
- 11.9.7.52 To evaluate whether the predicted level of disturbance from construction activities could lead to population-level impacts on harbour seal, iPCoD modelling was undertaken (**Volume 3, Appendix 11.2**). This modelling focused on a single piling scenario, representing a worst-case assessment. The scenario assumed the installation of 1,856 pin piles over a four-year period, resulting in 1,082 piling days between 2030 and 2041. On each piling day, an estimated one harbour seal could be exposed to disturbance. This represents the maximum number of disturbance days and individuals potentially affected.
- 11.9.7.53 The results of the iPCoD modelling indicate that this level of disturbance is not sufficient to cause any significant change at the population level. The model predicts that the impacted population will continue to decline, at exactly the same rate and size as the unimpacted population. Specifically, the size of the impacted population is projected to remain 100% of the unimpacted population from 1 to 18 years following the end of piling activities (**Volume 3, Appendix 11.2**). These findings demonstrate that the consequences of disturbance are low, with no anticipated deviation in long-term population trends. Therefore, the impact of disturbance from piling on harbour seal within the East Scotland and North Coast and Orkney SMAs is assessed as being of low magnitude, with no significant population-level effects expected.

#### Grey seal

- 11.9.7.54 Using the dose-response function, the maximum number of grey seals predicted to be disturbed by piling is 455 animals (7.23% of the ES SMA) at the RCP S location in the ES SMA; however, as piling is only estimated to occur across two days at this location, it is more realistic to consider the number of individuals disturbed within pile installation within the OAA. A maximum of 216 animals (3.43% of the ES SMA) are estimated to be disturbed by piling within the OAA. In the North Coast and Orkney SMA, a maximum of 115 animals (0.34% North Coast and Orkney SMA) are predicted to be disturbed at the offshore substation N location. In the Moray Firth SMA the maximum number of grey seals predicted to be disturbed by piling is 81 animals (1.50% of the Moray Firth SMA) at the RCP S location (**Table 11.32; Volume 2, Figure 11.12: Noise contours (SEL<sub>ss</sub>) and Level B disturbance contour for piling at the offshore substation north location overlain on grey Seal at-sea density Carter et al. (2025)**).

- 11.9.7.55 To evaluate whether the predicted level of disturbance from construction activities could lead to population-level impacts on grey seal, iPCoD modelling was undertaken (**Volume 3, Appendix 11.2**). This modelling focused on a single piling scenario, representing a worst-case assessment. The scenario assumed the installation of 1,856 pin piles over a four-year period, resulting in 1,082 piling days between 2030 and 2041. On each piling day, an estimated 183 grey seals could be exposed to disturbance. This represents the maximum number of disturbance days and individuals potentially affected.
- 11.9.7.56 The results of the iPCoD modelling indicate that this level of disturbance is not sufficient to cause any significant change at the population level. The model predicts that the impacted population will continue to grow along a stable trajectory, at exactly the same size as the unimpacted population. Specifically, the size of the impacted population is projected to remain 100% of the unimpacted population from 1 to 18 years following the end of piling activities (**Volume 3, Appendix 11.2**). These findings demonstrate that the consequences of disturbance are low, with no anticipated deviation in long-term population trends. Therefore, the impact of disturbance from piling on grey seal within the East Scotland and North Coast and Orkney SMAs is assessed as being of low magnitude, with no significant population-level effects expected.

**Table 11.32 Predicted impact of disturbance to marine mammals from piling using dose-response curves; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	13,914	14,787	12,959	13,250	9,977	14,048
		% NS MU	4.01	4.27	3.74	3.82	2.88	4.05
		% UK MU	8.46	9.01	7.99	8.17	6.23	8.57
	0.5985 (Gilles <i>et al.</i> , 2023)	#	11,074	11,769	10,314	10,545	7,941	11,181
		% NS MU	3.20	3.40	2.98	3.04	2.29	3.23
		% UK MU	6.73	7.17	6.36	6.50	4.96	6.82
	0.087 (site-specific DAS)	#	1,610	1,711	1,500	1,533	1,155	1,626
		% NS MU	0.46	0.49	0.43	0.44	0.33	0.47
		% UK MU	0.98	1.04	0.92	0.95	0.72	0.99
	0.416	#	7,697	8,181	7,169	7,330	5,520	7,771

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
White-beaked dolphin	(Gilles <i>et al.</i> , 2025)	% CGNS MU	17.51	18.61	16.31	16.68	12.56	17.68
		% UK MU	21.95	23.37	20.73	21.21	16.17	22.25
	0.1775 (Gilles <i>et al.</i> , 2023)	#	3,285	3,491	3,059	3,128	2,355	3,316
		% CGNS MU	7.47	7.94	6.96	7.12	5.36	7.54
		% UK MU	9.36	9.98	8.85	9.05	6.90	9.49
	0.023 (site-specific DAS)	#	426	453	397	406	306	430
		% CGNS MU	0.97	1.03	0.90	0.92	0.70	0.98
		% UK MU	1.21	1.29	1.15	1.17	0.90	1.23
	Bottlenose dolphin	0.116 (within 2km of the coast) and 0.0298 (beyond)	#	20	31	19	29	60
% CES MU			8.85	13.72	8.41	12.83	26.55	7.96
0.001 (Gilles <i>et al.</i> , 2025)		#	19	20	18	18	14	19
		% GNS MU	0.94	0.99	0.89	0.89	0.69	0.94

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
	0.0298 (Hammond <i>et al.</i> , 2021)	% UK MU	0.95	1.06	0.90	0.95	0.74	1.01
		#	552	586	514	526	396	557
		% GNS MU	27.30	28.98	25.42	26.01	19.58	27.55
		% UK MU	28.38	30.24	26.84	27.43	20.90	28.81
Short-beaked common dolphin	0.017 (Gilles <i>et al.</i> , 2025)	#	315	335	293	300	226	318
		% CGNS MU	0.31	0.33	0.29	0.29	0.22	0.31
		% UK MU	0.53	0.57	0.50	0.51	0.39	0.54
Risso's dolphin	0.0702 (Gilles <i>et al.</i> , 2023)	#	1,299	1,381	1,210	1,237	932	1,312
		% CGNS MU	10.57	11.23	9.84	10.06	7.58	10.67
		% UK MU	14.50	15.45	13.71	14.02	10.69	14.71
	0.002 (site-specific DAS)	#	38	40	35	36	27	38
		% CGNS MU	0.31	0.33	0.28	0.29	0.22	0.31

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
		% UK MU	0.41	0.45	0.39	0.40	0.31	0.43
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	271	288	252	258	194	273
		% CGNS MU	1.49	1.59	1.39	1.42	1.07	1.51
		% UK MU	2.14	2.28	2.02	2.07	1.58	2.16
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	926	984	862	881	664	935
		% CGNS MU	4.60	4.89	4.28	4.38	3.30	4.65
		% UK MU	8.73	9.29	8.24	8.44	6.43	8.85
	0.0419 (Gilles <i>et al.</i> , 2023)	#	776	824	723	739	556	783
		% CGNS MU	3.86	4.10	3.59	3.67	2.76	3.89
		% UK MU	7.32	7.79	6.91	7.07	5.38	7.42
Harbour seal	Carter <i>et al.</i> (2022) grid-specific densities	# ES SMA	1	<0.01	2	2	17	1
		% ES SMA	0.19	<0.01	0.47	0.33	4.41	0.05

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					Driven pile anchor N
			OSS SE	OSS N	OSS SW	OSS W	RCP S	
		# North Coast and Orkney SMA	1	1	1	1	1	1
		% North Coast and Orkney SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		# Moray Firth SMA	<0.01	<0.01	1	1	3	<0.01
		% Moray Firth SMA	<0.01	<0.01	<0.01	0.02	0.19	<0.01
Grey seal	Carter <i>et al.</i> (2025) grid-specific densities	# ES SMA	141	68	216	159	455	62
		% ES SMA	2.24	1.08	3.43	2.53	7.23	0.98
		# North Coast and Orkney SMA	41	115	63	53	3	106
		% North Coast and Orkney SMA	0.12	0.34	0.18	0.16	<0.01	0.31
		# Moray Firth SMA	0	1	7	17	81	0
		% Moray Firth SMA	0.00	0.02	0.13	0.32	1.50	0.00

**Table 11.33 Predicted impact of disturbance to marine mammals from piling using Level B harassment thresholds; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	1,664	1,706	1,581	1,581	1,332	1,540
		% CGNS MU	3.79	3.88	3.60	3.60	3.03	3.50
		% UK MU	4.89	5.01	4.64	4.64	3.91	4.52
	0.1775 (Gilles <i>et al.</i> , 2023)	#	710	728	675	675	568	657
		% CGNS MU	1.62	1.66	1.53	1.53	1.29	1.49
		% UK MU	2.09	2.14	1.98	1.98	1.67	1.93
	0.023 (site-specific DAS)	#	92	95	88	88	74	86
		% CGNS MU	0.21	0.21	0.20	0.20	0.17	0.19
		% UK MU	0.27	0.28	0.26	0.26	0.22	0.25
Bottlenose dolphin	0.116 (within 2km of the coast) and 0.0298 (beyond)	#	No overlap				18	No overlap
		% CES MU					8.12	

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
	0.001 (Gilles <i>et al.</i> , 2025)	#	4	5	4	4	4	4
		% GNS MU	0.20	0.20	0.19	0.19	0.16	0.18
		% UK MU	0.21	0.22	0.20	0.20	0.17	0.20
	0.0298 (Hammond <i>et al.</i> , 2021)	#	120	123	114	114	96	111
		% GNS MU	5.90	6.04	5.60	5.60	4.72	5.45
		% UK MU	6.32	6.48	6.01	6.01	5.06	5.85
Short-beaked common dolphin	0.017 (Gilles <i>et al.</i> , 2025)	#	68	70	65	65	55	63
		% CGNS MU	0.07	0.07	0.06	0.06	0.05	0.06
		% UK MU	0.12	0.12	0.11	0.11	0.09	0.11
Risso's dolphin	0.0702 (Gilles <i>et al.</i> , 2023)	#	281	288	267	267	225	260
		% CGNS MU	2.28	2.34	2.17	2.17	1.83	2.11
		% UK MU	3.23	3.31	3.07	3.07	2.59	2.99

Species	Density (individuals/km <sup>2</sup> )	Impact	Modelling location					
			OSS SE	OSS N	OSS SW	OSS W	RCP S	Driven pile anchor N
	0.002 (site-specific DAS)	#	8	9	8	8	7	8
		% CGNS MU	0.07	0.07	0.06	0.06	0.05	0.06
		% UK MU	0.09	0.09	0.09	0.09	0.07	0.09
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	59	60	56	56	47	55
		% CGNS MU	0.32	0.33	0.31	0.31	0.26	0.30
		% UK MU	0.48	0.49	0.45	0.45	0.38	0.44
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	200	205	190	190	160	185
		% CGNS MU	0.99	1.02	0.94	0.94	0.80	0.92
		% UK MU	1.94	1.99	1.85	1.85	1.56	1.80
	0.0419 (Gilles <i>et al.</i> , 2023)	#	168	172	160	160	135	156
		% CGNS MU	0.83	0.85	0.79	0.79	0.67	0.77
		% UK MU	1.63	1.67	1.55	1.55	1.30	1.51

### Significance of residual effect

- 11.9.7.57 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.34**.
- 11.9.7.58 The magnitude of disturbance from increased underwater noise during piling is deemed to be **medium** for bottlenose dolphin, Risso’s dolphin and white-beaked dolphin (**Table 11.34**). The sensitivity of these receptors is **low** for disturbance from underwater noise during installation. The effect will, therefore, be of **Minor (Not Significant)** in EIA terms.
- 11.9.7.59 The magnitude of disturbance from increased underwater noise during piling is deemed to be **low** for Atlantic white-sided dolphin and short-beaked common dolphin (**Table 11.34**). The sensitivity of these receptors is **low** for disturbance from underwater noise during installation. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.
- 11.9.7.60 The magnitude of disturbance from increased underwater noise during piling is also deemed to be **low** for the remaining marine mammal receptors (**Table 11.34**). The sensitivity of these receptors is **low** for disturbance from underwater noise during installation. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.34 Significance of C6: Disturbance from increased underwater noise during installation (for example, anchor piles).**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin (CES MU)	Medium	Low	Minor (Not Significant).
Bottlenose dolphin (GNS MU)	Medium	Low	Minor (Not Significant).
Risso’s dolphin	Medium	Low	Minor (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Medium	Low	Minor (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

## 11.9.8 Impact C7: Disturbance from increased underwater noise during other construction activities

### Overview

11.9.8.1 Although impact piling is expected to be the greatest overall noise source during construction, several other anthropogenic noise sources may be present during the construction stage. In general, there is little evidence on the disturbance effect to marine mammals from all other construction activities. Available studies focus primarily on disturbance from dredging, where behavioural responses by marine mammals have been observed. The likely sensitivity of each species based on the evidence from the available studies, and the likely impact magnitudes, are discussed in turn below.

### Sensitivity of receptor

11.9.8.2 Information regarding the sensitivity of marine mammals to other construction activities (such as cable plough, dredging, trenching, jetting, drilling, mechanical cutting and rock placement) is limited. Available studies focus primarily on the impact of disturbance from dredging. These studies have confirmed that underwater noise from construction activities can cause displacement and disturbance to marine mammals (Brandt *et al.*, 2011; Culloch *et al.*, 2016; Graham *et al.*, 2019; Pirodda *et al.*, 2014; Stone *et al.*, 2017). However, it is difficult to determine the sensitivity specifically to disturbance from other construction activities in isolation from the disturbance from vessel presence required for the activity (Todd *et al.*, 2015).

### Harbour porpoise (VHF cetaceans)

11.9.8.3 Harbour porpoises are particularly vulnerable to disturbance, with the main impact being loss of foraging opportunities (Nabe-Nielsen *et al.*, 2018). This is described in detail in **Section 11.9.7**.

11.9.8.4 Dredging activities have been shown to cause harbour porpoise displacement within a radius of 5km around the dredging location (Verboom, 2014). Diederichs *et al.* (2010) noted there was short term avoidance (~three hours post-cessation) at distances of up to 600m from a trailing suction hopper dredger, but no significant long-term impacts were recorded. Modelling potential impacts of dredging of a port expansion predicted a disturbance range of 400m (McQueen *et al.* 2020), with a more conservative approach, based on a practical spreading law for a source close to the sea surface in shallow water (Ainslie *et al.* 2014) predicting avoidance of harbour porpoise up to 5km (McQueen *et al.* 2020).

11.9.8.5 A review of potential effects of various cable types and installation methods including burial ploughs, machines, ROVs and sleds and the burial methods themselves including jetting, rock ripping, and dredging, used in the offshore wind farm industry concluded that it would be “*highly unlikely that cable installation would produce noise at a level that would cause a behavioural reaction in marine mammals*” (BERR and Defra, 2008). Additionally, underwater noise modelling conducted as part of the Greenlink Interconnector project for disturbance from cable laying installation, concluded that all marine mammals could experience disturbance from underwater noise, but the impact zone is in general small (*i.e.*, 130m from activities; Greenlink, 2019).

11.9.8.6 The occurrence of harbour porpoise was found to decrease in the vicinity of the Beatrice and Moray East Offshore Wind Farms during non-piling construction periods (Benhemma-Le Gall *et al.*, 2021). During these non-piling construction periods, harbour porpoise detections decreased by 17% with an increase in SPLs from vessels from 102dB re 1  $\mu$ Pa to 159dB re 1  $\mu$ Pa. (it is important to note that vessel activity did not only include wind farm

construction related vessels). Similarly, the probability of detecting buzzes decreased by 41.5% as SPLs from vessels increased from 104dB re 1  $\mu$ Pa to 155dB re 1  $\mu$ Pa. Despite this, harbour porpoise continued to be present across both sites throughout the three-year construction period. Displacement of harbour porpoise from the vicinity occurred at a local scale, with buzzing increasing once the individual was away from the noise source. This suggests that displaced individuals resumed foraging, potentially compensating for lost foraging opportunities or increased energy expenditure as a result of fleeing. Therefore, any impacts to harbour porpoise as a result of disturbance from other construction activities are likely to be localised and short-term, with harbour porpoise expected to be able to compensate for any displacement, with no impact to vital rates.

- 11.9.8.7 The presence of vessels has been shown to deter and disturb harbour porpoise out of the area before any non-piling construction activities start (Brandt *et al.*, 2018). Therefore, it is highly unlikely that harbour porpoise will be present in the immediate vicinity at the start of any other construction activity. Further information on vessel disturbance is covered in **Section 11.9.10**.
- 11.9.8.8 Based on the above, harbour porpoises are considered to be of reasonable adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of the harbour porpoise to disturbance from other construction activities is considered to be **low**.

#### *Dolphin species (HF cetaceans)*

- 11.9.8.9 For dolphin species, disturbance responses to non-piling construction activity appears to vary. One study observed a decrease in bottlenose dolphin presence in foraging areas of Aberdeen harbour with an increase in intensity of dredging activity, with bottlenose dolphins absent from the vicinity for five weeks during the initial dredge operations (Pirota *et al.*, 2013). The presence of shipping activity in Aberdeen harbour is high year-round, with dolphins in the region considered to be habituated to high levels of vessel presence as a result. Therefore, in this instance, it was concluded that displacement was a direct result of dredging. Another study determined that response varied depending on the site, with dolphins either remaining or being absent (Marley *et al.*, 2017a), which suggests that the response may be context specific (i.e., some sites being ecologically more important than others).
- 11.9.8.10 A monitoring study in northwest Ireland investigating the effects of construction-related activity (including but not limited to seismic surveys, MBES surveys, ROV surveys, dredging, back filling, rock trenching, rock placement, rock breaking, pipe laying and umbilical laying) during the construction of a gas pipeline found no changes in common dolphin occurrence as a result of these construction related activities in the area (Culloch *et al.*, 2016).
- 11.9.8.11 There is potential for behavioural disturbance due to underwater noise to result in disruption in foraging and resting activities and an increase in travel and energetic costs (Marley *et al.*, 2017a; Pirota *et al.*, 2015), although evidence suggests that this will occur on a small spatial and temporal scale. Furthermore, New *et al.* (2013) showed that individuals are able to compensate for immediate behavioural responses to disturbances caused by vessel activity. This suggests that they have some capability to adapt their behaviour and tolerate certain levels of temporary disturbance. Papale *et al.* (2015) also recorded evidence to suggest that common dolphins are able to adjust their whistle characteristics to account for masking as a result of anthropogenic noise, suggesting some tolerance and adaptability.
- 11.9.8.12 Based on the above, dolphin species are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of dolphin species to disturbance from other construction activities is considered to be **low**.

### *Minke and humpback whales (LF cetaceans)*

- 11.9.8.13 There is limited information on the response of minke and humpback whales to non-impulsive underwater noise, such as that related to other construction activities. A monitoring study in northwest Ireland investigating the effects of construction-related activity during the construction of a gas pipeline found a reduction in minke whale occurrence as a result of these construction related activities in the area (Culloch *et al.*, 2016).
- 11.9.8.14 A study of migrating humpback whales off Sydney, Australia, found that whales exhibited no observable response to underwater construction activities, such as dredging and drilling (Pirodda, 2017). In this study, whales exhibited similar behaviours (directionality, dive duration and swim speed) on days with and without construction (Pirodda, 2017). Behaviour of migrating humpback whales was assessed again five years post-construction. Analyses showed no change in behaviours, except for increased dive durations (Pirodda, 2017).
- 11.9.8.15 Studies of other baleen whale species have reported varying responses to dredging activities (Bryant *et al.*, 1984; Richardson *et al.*, 1995). In one study, bowhead whales did not show any response to suction dredging but avoided dredged areas during another investigation (Richardson *et al.*, 1995). Gray whales have also been reported to cease use of a particular breeding lagoon following an increase in industrial activities (Bryant *et al.*, 1984). However, in this study it was not clear whether this was due to an increase in underwater noise levels or vessel presence.
- 11.9.8.16 While information on the behavioural responses of minke and humpback whales to non-impulsive underwater noise is limited, it is anticipated that these species will be able to tolerate temporary displacement from foraging areas due to their large size and capacity for energy storage.
- 11.9.8.17 Based on the above, minke and humpback whales are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of minke and humpback whales to disturbance from other construction activities is considered to be **low**.

### *Grey and harbour seals (PCW)*

- 11.9.8.18 The source level of dredging activities has been described to vary between SPL 172 and 190dB re 1  $\mu$ Pa at 1m with a frequency range of 45Hz to 7kHz (Verboom, 2014). At these levels, disturbance may occur. One study used noise modelling to demonstrate that displacement to seals could occur between 400m and 5km from a dredging site (the frequency and sound pressure can vary considerably depending on the equipment; McQueen *et al.*, 2020).
- 11.9.8.19 Studies in the Netherlands collected telemetry data from 20 grey seals in 2014 during the construction of the Luchterduinen wind farm and from 16 grey seals in 2015 during the construction of the Gemini wind farm (Aarts *et al.*, 2018). The most common response suggested a change in behaviour from foraging to horizontal movement, although various other responses were recorded including, altered surfacing and diving behaviour, changes in swim direction, and no response (Aarts *et al.*, 2018). Data from this study also showed that seals returned to the area on subsequent trips, despite receiving multiple exposures. Construction activities during an offshore wind farm installation have a much greater risk of disturbance compared to cable installation due to the impulsive noise sources such as impact piling. Harbour seals in the Wash were studied during the construction stage of Lincs Offshore Wind Farm where Russell *et al.* (2016) observed significant displacement of harbour seals during piling, but not during construction as a whole.
- 11.9.8.20 During an expert elicitation workshop in 2018, it was concluded that both harbour seals and grey seals were considered to have reasonable ability to compensate for missed foraging

opportunities due to disturbance from underwater noise given their generalist diet, adequate fat stores, mobility, and life history (Booth *et al.*, 2019). In general, specialists agreed that grey seals are more robust to the effects of disturbance than harbour seals as they have larger energy store and are more generalist in their diet. Grey seals are also more adaptable in their foraging strategies, while harbour seals also have thick layer of blubber for energy storage that enables them to tolerate periods of fasting when hauled out between foraging trips or during breeding and moulting periods (Booth *et al.*, 2019).

- 11.9.8.21 Based on the above, grey and harbour seals are considered to be of high adaptability, reasonable to high tolerance, have high recoverability, and are of very high value. Taking these factors into account, the overall sensitivity of grey and harbour seals to disturbance from other construction activities is considered to be **low**.

### Magnitude of impact

- 11.9.8.22 This assessment has considered the TTS-onset thresholds as modelled within **Volume 3, Appendix 8.1** as a proxy for disturbance. The modelled TTS impact ranges for other construction activities are presented in **Table 11.35**, based on both a fleeing and stationary receptor. For a summary of estimated source levels included in the modelling parameters, refer to **Section 11.9.4**.

**Table 11.35 Summary of the TTS impact ranges for the different noise sources related to the construction of the Project using non-impulsive criteria from Southall *et al.* (2019) for marine mammals assuming a fleeing and stationary receptor**

Southall <i>et al.</i> (2019) SEL <sub>cum</sub>	TTS (non-impulsive; fleeing)				TTS (non-impulsive; stationary)			
	LF (199dB)	HF (198dB)	VHF (173dB)	PCW (201dB)	LF (199dB)	HF (198dB)	VHF (173dB)	PCW (201dB)
Cable laying	<100m	<100m	<100m	<100m	810m	<100m	2.3km	110m
Drag embedment anchors	<100m	<100m	<100m	<100m	<100m	<100m	<100m	<100m
Dredging (backhoe)	<100m	<100m	<100m	<100m	<100m	<100m	<100m	<100m
Dredging (suction)	<100m	<100m	270m	<100m	640m	390m	4.3km	420m
Drilling	<100m	<100m	<100m	<100m	<100m	<100m	<100m	<100m
Rock placement	<100m	<100m	1.2km	<100m	2.1km	410m	13km	460m
Suction bucket installation	<100m	<100m	780m	<100m	1.3km	770m	6.8km	830m
Trenching	<100m	<100m	<100m	<100m	830m	<100m	1.9km	120m
Vessel noise (large)	<100m	<100m	<100m	<100m	480m	<100m	140m	<100m
Vessel noise (medium)	<100m	<100m	<100m	<100m	<100m	<100m	<100m	<100m

- 11.9.8.23 When assuming a fleeing receptor, all species except harbour porpoise would show a strong disturbance or TTS from all other construction activities within 100m of the activity. Harbour porpoises were estimated to react within 100m for all activities except suction dredging, rock placement and suction bucket installation, where TTS-onset was reached within 270m, 1.2km, and 780m, respectively. The impact ranges are greater when considering a stationary receptor; however, given the high mobility of marine mammals and their instinct to flee from noise sources or structures which cause discomfort, the scenario of a stationary receptor within these ranges are highly unlikely. Therefore, TTS-onset impact ranges for stationary receptors are not discussed further in this assessment.
- 11.9.8.24 There is evidence that the extent of strong disturbance from underwater noise from other construction activities will be highly localised (<1.5km) for all marine mammal receptors. The impact may take place intermittently over the duration of the construction stage. Whilst it has been assumed that the activities will occur on a 24-hour basis, this is unlikely in practice, due to the transient and intermittent nature of the noise produced through these activities. Although animals in the vicinity of the construction works are likely to respond behaviourally to the underwater noise associated with dredging, rock dumping and other activities, they are likely to move away temporarily from the activity outside of the impact area. For all species the impact may have a noticeable disturbance effect on a small proportion of the population but is unlikely to lead to changes in population trajectory. Therefore, the magnitude is assessed as **low**.

### Significance of residual effect

- 11.9.8.25 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.36**.
- 11.9.8.26 The magnitude of impact of disturbance from other construction activities is deemed to be **low** for all marine mammal receptors. The sensitivity of receptors is **low** for all receptors. The effect of disturbance from other construction activities on all marine mammal species will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.36 Significance of C7:Disturbance from other construction activities**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).

Receptor	Magnitude	Sensitivity	Significance
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

### 11.9.9 Impact C8: Vessel collisions from increased vessel presence and traffic

#### Overview

- 11.9.9.1 The Project's Offshore Red Line Boundary lies within an area neighbouring key transport routes for vessels transiting to and from the Port of Aberdeen and Moray Firth (**Chapter 15: Shipping and Navigation**; MMO, 2019). During the construction stage (including pre-construction), there will be an increase in localised vessel activity within the offshore Project area and along routes to ports being used by the Project, compared with baseline levels. This may result in an increased risk of injury or mortality to marine mammals within these areas, through collision with vessels and/or propeller strikes. These injuries include blunt trauma to the body or injuries consistent with propeller strikes. The severity of injuries associated with collision can range from minor, whereby the animal can recover, to mortality (Vanderlaan and Taggart, 2007; Schoeman *et al.*, 2020). Collisions between cetaceans and vessels are not necessarily lethal on all occasions (Wells *et al.*, 2008; Luksenburg, 2014).
- 11.9.9.2 A peak of up to ten construction and support vessels are anticipated offshore, with up to 3,838 vessel movements anticipated for the offshore Project over the 12-year construction stage. A proportion of vessels would be stationary or slow moving for significant periods and would therefore pose a low collision risk. Nevertheless, the increase in vessels present may increase the number of interactions between marine mammals and vessels, thus increasing the risk of collision.
- 11.9.9.3 Further detail on vessel types, routes, and traffic density in the area surrounding the Project OAA and offshore export cable corridor is described in **Chapter 15: Shipping and Navigation** of the EIA Report.

#### Sensitivity of receptor

- 11.9.9.4 Although many species of marine mammal are able to detect and avoid vessels, it is unclear why some individuals do not always move out of the path of an approaching vessel (Schoeman *et al.*, 2020). It has been suggested that behaviours such as resting, foraging, nursing, and socialising could distract animals from detecting the risk posed by vessels (Dukas, 2002). It is also possible that animals do not hear vessels when they are near the surface.
- 11.9.9.5 There is currently a lack of information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality. Data from the UK Cetacean Strandings Investigation Programme (CSIP) indicate that vessel collisions are an infrequent cause of marine mammal mortality. In 2022, 291 harbour porpoise strandings were reported, with 32 examined post-mortem, none of which were confirmed as vessel strike, although two deaths were attributed to physical trauma of unknown origin (CSIP, 2023). For bottlenose dolphins,

three of nine strandings were examined, and for Risso's dolphins, one of seven; no cases of vessel strike were identified. A single white-beaked dolphin and one Atlantic white-sided dolphin were also examined, with no evidence of vessel strike. Of 11 minke whale strandings, two were investigated, again with no indication of vessel strike. No humpback whale strandings were reported. These findings are consistent with previous years (CSIP 2016–2022), which similarly report very few strandings attributable to vessel collisions.

- 11.9.9.6 In Scotland, the Scottish Marine Animal Stranding Scheme (SMASS) work alongside CSIP, to collate, analyse and report data of marine mammal strandings around the Scottish coast. The most recent SMASS report for 2023, recorded 444 cetacean strandings and 476 seal strandings. Of these, 78 cetaceans and 86 seals were necropsied (Brownlow *et al.*, 2024). Physical trauma as a result of vessel strike was not found to be the cause of death for any of the species included in this assessment. Physical trauma as a result of vessel strike was not identified as the cause of death for any strandings in SMASS reports in 2022 or 2021 (SMASS, 2023; 2022). However, in 2020, one harbour porpoise was identified as dying from physical trauma as a result of vessel strike (Davison and ten Doeschate, 2021).
- 11.9.9.7 Collision risk for seals is less understood than for cetaceans; however, trauma attributed to collisions with vessels has been identified in a small proportion of both live stranded (Goldstein *et al.*, 1999) and dead stranded seals in the US (Swails, 2005). In these cases; however, less than 2% of all dead necropsied seals had vessel collision attributed to cause of death. In 2022, CSIP took part in a one-year pilot study to assess the viability of a seal mortality monitoring and investigation scheme across England and Wales. During the study, 480 dead stranded seals were reported, of which 34 grey seals and one harbour seal were examined by post-mortem. Of the grey seals, two died from physical trauma of an unknown cause, which could have been vessel strike. A cause of death could not be identified for the harbour seal.
- 11.9.9.8 While there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post-mortem examinations. However, it is important to note that the strandings data are biased to those carcasses that wash ashore for collection and therefore may not be representative. Furthermore, post-mortems are not undertaken for many carcasses, further reducing the representativity of strandings data.
- 11.9.9.9 A study in the Moray Firth showed that seals use the same areas as vessels during trips between haul-outs and foraging sites but that seals tended to remain beyond 20m from vessels (only three instances over 2,241 days of seal activity resulted in passes at less than 20m; Onoufriou *et al.*, 2016), suggesting that the possibility of a risk of collision is very low.
- 11.9.9.10 Overall, marine mammals will predominantly avoid vessels and vessel collision is not considered to be a key source of mortality highlighted from post-mortem examinations of stranded animals. However, should a collision event occur, this is likely to kill or injure the animal. Should an animal be killed or injured, then there is no or very limited potential for the animal to adapt, tolerate, or recover from the impact. Therefore, the overall sensitivity of the marine mammal receptors to vessel collisions is considered to be **high**.

## Magnitude of impact

- 11.9.9.11 During the construction stage, it is estimated that approximately 3,838 individual vessels transits would be required during the construction of the Project. It is estimated that the installation of each floating unit will require up to three vessel transits of the installation vessel. (**Table 11.9**). Vessels that will be used during the construction stage include heavy lift vessel, support vessel, AHTS vessel, survey vessel, offshore construction vessel or larger AHTS vessel and rock dumping vessel (**Table 11.9**).

- 11.9.9.12 Vessel traffic associated with the Project has the potential to lead to an increase in vessel movements within the site-specific study area and surrounding transit routes. This increase in vessel movement could lead to an increase in interactions between marine mammals and vessels during offshore construction. Whilst a broad range of vessel types have been involved in collisions with marine mammals (Laist *et al.*, 2001), vessels travelling at higher speeds pose a higher risk because of the potential for a stronger strike impact for marine mammals (Schoeman *et al.*, 2020). For example, a study by Laist *et al.* (2001) found that in 89% of collisions in which a whale was killed or seriously injured, vessels were travelling at speeds of 14 knots (kn; 7m/s) or more, and the vessel exceeded a length of 80m. Therefore, larger vessels travelling at 7m/s or faster are those most likely to cause death or serious injury to marine mammals (Laist *et al.*, 2001). The majority of vessels used during the construction stage are likely to be large vessels that will either be travelling considerably slower than 7m/s or will be stationary for significant periods of time.
- 11.9.9.13 The actual increase in vessel traffic moving within the Project and to or from port will occur over short periods of the offshore construction activity. Smaller vessels involved in construction activities are able to move to avoid marine mammals (when detected), even when an animal is close and the vessel is going at high speed, due to better manoeuvrability compared to larger vessels (Schoeman *et al.*, 2020). In contrast, large vessels, have low manoeuvrability and may require larger distances to avoid an animal, but travel at slower speeds. In addition, the embedded measures (**Section 11.7.2, Table 11.10**) which include an Outline Vessel Management and Navigation Safety Plan (M-039), will advise that vessel traffic will move along predictable routes, which is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.*, 2001; Lusseau 2003; 2006). The Vessel Management and Navigation Safety Plan will also provide best practice guidance to minimise interactions with marine mammals and define how vessels should behave in the presence of them. In addition, adherence to the Scottish Marine Wildlife Watching Code will also minimise the risk of collision.
- 11.9.9.14 It is also likely that the noise emissions from vessels involved in the construction stage will be detectable by marine mammals and therefore will deter animals from the areas of potential impact (refer to **Section 11.9.10** for assessment of vessel disturbance). Whilst construction of the Project will lead to an uplift in vessel activity, vessel movements will be largely restricted to within the OAA or along the offshore export cable corridor and will follow existing shipping routes to and from ports. Due to the volume of vessel traffic around the site-specific study area, the introduction of additional vessels during the construction stage of the Project will not be a novel impact for marine mammals present in the area (see **Chapter 15: Shipping and Navigation**). Therefore, it is not expected that vessel activities during the construction stage would increase the risk of injury due to vessel collision.
- 11.9.9.15 The impact of injury to all marine mammal species from vessel activities is considered highly unlikely to occur, particularly given implementation of embedded environmental measures. If it did occur, it would affect a negligible or very small proportion of the population, occurring only once or infrequently throughout the construction stage, and would not affect the population size or trajectory. The magnitude is therefore **negligible**.

### Significance of residual effect

- 11.9.9.16 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.37**.
- 11.9.9.17 The magnitude of impact from vessel collisions from increased vessel presence and traffic is deemed to be **negligible** and the sensitivity of receptors is **high**. The effect of vessel collisions from increased vessel presence and traffic will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.37 Significance of C8: Vessel collisions from increased vessel presence and traffic**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	High	Negligible (Not Significant).
Bottlenose dolphin	Negligible	High	Negligible (Not Significant).
Risso's dolphin	Negligible	High	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	High	Negligible (Not Significant).
White-beaked dolphin	Negligible	High	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	High	Negligible (Not Significant).
Minke whale	Negligible	High	Negligible (Not Significant).
Humpback whale	Negligible	High	Negligible (Not Significant).
Harbour seal	Negligible	High	Negligible (Not Significant).
Grey seal	Negligible	High	Negligible(Not Significant).

### 11.9.10 Impact C9: Disturbance from increased vessel presence and traffic

#### Overview

11.9.10.1 The physical presence of vessels and associated underwater noise may result in an increase in disturbance to marine mammals, such as through avoidance and displacement as well as behavioural and vocalisation changes. Disturbance due to physical presence of and underwater noise generated by vessels are linked and occur simultaneously, unless the vessel is idle. There is insufficient evidence to support the assessment of physical presence separately, and vessel underwater noise studies are often subject to observer bias from the presence of the research vessel and cannot differentiate between the effects of vessel presence and vessel noise (Erbe *et al.*, 2019; Pirodda *et al.*, 2015). Additionally, the magnitude of impact from underwater noise and physical presence of vessels will both increase with vessel size and number of vessels. Therefore, this impact assessment considers the underwater noise and physical presence of vessels as a single pressure.

## Sensitivity of receptor

### Harbour porpoise (VHF cetaceans)

- 11.9.10.2 Harbour porpoises have a HF generalised hearing range (275Hz–160kHz) with a peak hearing sensitivity between 100-125kHz (Morell *et al.*, 2021). Vessels generally emit LF noise, where large vessels typically emit noise up to 10kHz and small vessels typically emit noise up to 40kHz (Duarte *et al.*, 2021). These frequencies overlap with the hearing frequencies of harbour porpoise but are not within the species' peak hearing sensitivity. Roberts *et al.* (2019) observed that harbour porpoise presence, resting and feeding behaviour reduced in response to increasing vessel frequencies. Frequent, lower-level noise exposures can cause masking and behavioural disruption that may be hard to detect but can have cumulative long-term effects on populations (Tougaard *et al.*, 2015).
- 11.9.10.3 Harbour porpoises are particularly sensitive to anthropogenic noise, with the species having been documented to actively avoid vessels (for example, Culloch *et al.*, 2016; Benhemma-Le Gall *et al.*, 2021). Harbour porpoises were observed being displaced up to 4km from construction vessels during the construction of the Beatrice and Moray East Offshore Wind Farm in the Moray Firth, with increased vessel activity leading to a significant decrease in the acoustic detections and activity (Benhemma-Le Gall *et al.*, 2021). Gradient analyses from this study showed that the probability of detecting harbour porpoises within the site decreased by up to 35.2% with increased vessel intensity and a decrease in distance to the nearest vessel. Similar impacts were also observed in a large-scale study of harbour porpoise density across UK waters (Heinänen and Skov, 2015). Using statistical analysis of multiple datasets, Heinänen and Skov (2015) found that increased vessel presence was associated with lower harbour porpoise densities.
- 11.9.10.4 Vessel disturbance has also been found to impact foraging activity in harbour porpoise. Wisniewska *et al.* (2018) collected telemetry data to study the change in foraging rates of harbour porpoise in response to vessel noise in coastal waters in the inner Danish waters and Belt seas. The results suggest that foraging may be disrupted at greater distances of up to 7km as a result of vessel disturbance. In addition, disturbance from vessels may also lead to displacement from important foraging grounds, resulting in loss of foraging opportunities (Nabe-Nielsen *et al.*, 2018). Harbour porpoise are small cetaceans which makes them susceptible to heat loss and as a result, requires them to forage frequently in order to maintain a high metabolic rate with little energy remaining for fat storage (Rojano-Doñate *et al.*, 2018; Wisniewska *et al.*, 2016). Therefore, overall fitness may be impacted if foraging activity is disrupted or they are displaced from high-quality foraging grounds and are unable to find alternative suitable foraging grounds that will provide sufficient food to meet their metabolic needs. Despite this, results from studies using tags suggest that harbour porpoises are able to respond to short-term reductions in food intake and therefore, may have some resilience to disturbance (Wisniewska *et al.*, 2016).
- 11.9.10.5 Wisniewska *et al.* (2018) also observed that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96dB re 1 µPa (16kHz third octave; Wisniewska *et al.*, 2018). Behavioural responses of harbour porpoise to vessel noise have also been observed under controlled conditions (Dyndo *et al.*, 2015).
- 11.9.10.6 Despite studies demonstrating that harbour porpoise display changes in behaviour and distribution as a result of vessel disturbance, harbour porpoises continue to be widespread and are frequently recorded across the North Sea (Evans *et al.*, 2003; Gilles *et al.*, 2023). As a result, it can be assumed that there are suitable foraging habitats across their range. The Project is also not located within an area of persistent high density of harbour porpoise or an SAC for the species. Therefore, whilst vessel use will occur frequently through the

Project construction, any effect will be short-term due to harbour porpoises' ability to adapt, tolerate and recover from the impact. The Project is unlikely to have any significant population-level effect on harbour porpoise as a result of vessel collision. Furthermore, harbour porpoise may also become habituated where construction vessel movements are regular and predictable (Wisniewska *et al.* 2018).

- 11.9.10.7 Based on the above, harbour porpoises are considered to be of reasonable adaptability and tolerance and have high recoverability. Taking these factors into account, the overall sensitivity of harbour porpoise to disturbance from increased vessel presence is considered to be **low**.

### *Dolphin species (HF cetaceans)*

#### *Bottlenose dolphin*

- 11.9.10.8 Studies on the interactions of bottlenose dolphins with vessels have shown varying responses. In the Moray Firth, a PAM study found that the presence of vessels resulted in a short-term reduction in foraging activity by 49% (Pirodda *et al.*, 2015). Animals resuming foraging after the vessel had travelled through the area and no relationship with noise level was observed, suggesting that disturbance was limited to the time the vessel was physically present (Pirodda *et al.*, 2015). The behavioural disturbance observed here was temporary, with foraging activities quickly resuming as vessels moved away from the area. As a result, this was the first study to conclusively show that the physical presence of vessels plays a large role in disturbance of bottlenose dolphins.
- 11.9.10.9 Studies have found behavioural effects as a result of vessel disturbance in bottlenose dolphins to include disruption of socialisation and resting behaviours and changes in vocalisation patterns (Koroza and Evans, 2022; Lusseau, 2003; Pellegrini *et al.*, 2021; Pirodda *et al.*, 2015; Marley *et al.*, 2017b; Piwetz, 2019), with effects often dependent on vessel size and speed. Bottlenose dolphins have been observed increasing their swim speeds in response to high levels of vessel activity (Marley *et al.*, 2017a; Piwetz, 2019). Activity changes were also seen, with bottlenose dolphins spending less time resting, socialising and foraging, in response to vessel presence (Marley *et al.*, 2017b; Piwetz, 2019). As a result, repeated disturbance may lead to an overall reduced energy intake in these individuals. Whistle structures of bottlenose dolphins have also been found to change in relation to vessel presence and the resulting underwater noise (Rako Gospic and Picculin, 2016; Marley *et al.*, 2017a; Pellegrini *et al.*, 2021).
- 11.9.10.10 In a modelling study by Lusseau *et al.* (2011), it was predicated that increased vessel movements associated with offshore wind development in the Moray Firth did not have a negative effect on the local population of bottlenose dolphins, although it did note that foraging may be disrupted by disturbance from vessels. Bottlenose dolphins can tolerate vessel disturbance, particularly in areas where vessel traffic has always been high (Pirodda *et al.*, 2013). During the construction works of an oil pipeline in Broadhaven Bay, northwest Ireland, the presence of bottlenose dolphin was positively correlated with overall vessel number (Anderwald *et al.*, 2013). However, it is unclear whether this correlation is as a result of the bottlenose dolphins being attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time (Anderwald *et al.*, 2013). In Cardigan Bay, UK, bottlenose dolphins showed neutral and even positive responses towards some vessels, depending on the vessel type and speed (Gregory and Rowden, 2001).
- 11.9.10.11 New *et al.* (2013) found that bottlenose dolphins are able to compensate for their immediate behavioural response to an increase in vessel traffic. The study modelled an increase in traffic from 70 to 470 vessels and found that this increase in vessel traffic alone would not result in a biologically significant increase in disturbance.

- 11.9.10.12 The studies presented above show the variety of responses that bottlenose dolphins have been observed to display in response to vessel disturbance. Behavioural responses include changes in foraging behaviour, swim speed, behavioural state, avoidance, and acoustic behaviour (Pirodda *et al.*, 2015; Koroza and Evans, 2022; Lusseau, 2003; Pellegrini *et al.*, 2021; Pirodda *et al.*, 2015; Marley *et al.*, 2017a; 2017b; Piwetz, 2019; Rako Gospic and Picculin, 2016). However, evidence suggests that bottlenose dolphins can tolerate and habituate to vessel traffic, and therefore certain levels of temporary increases in vessel disturbance is unlikely to lead to high levels of disturbance (Pirodda *et al.*, 2013; Anderwald *et al.*, 2013; Gregory and Rowden, 2001; New *et al.*, 2013). Where behavioural changes do occur, bottlenose dolphins have demonstrated their ability to adapt to and quickly recover from vessel disturbance. It is noted that the location of vessel movements associated with the Project will likely overlap an important area (Moray Firth SAC) for bottlenose dolphin, therefore they may be more sensitive to disturbance within or from this key habitat.
- 11.9.10.13 Based on the above, bottlenose dolphins are considered to be of high adaptability, reasonable tolerance, and have high recoverability. However, the impact may overlap an important area for bottlenose dolphin where they could be more sensitive. Taking these factors into account, the overall sensitivity of bottlenose dolphins to disturbance from increased vessel presence is considered to be **low**.

#### *Risso's dolphin*

- 11.9.10.14 There is limited information available on the behavioural response of Risso's dolphin to increased vessel disturbance. However, several studies have shown that vessel traffic can affect the behaviour, activity, energy budgets, habitat use, and reproductive success of dolphin species (Bejder *et al.*, 2006; Lusseau, 2003; Lusseau and Higham, 2004; Lusseau and Bejder, 2007).
- 11.9.10.15 A study of Risso's dolphin in the Azores, recorded Risso's displaying aversion behaviours in the presence of vessels and altering daily resting patterns in response to high vessel activity (Visser *et al.*, 2011). When more than five vessels were present in the vicinity, Risso's dolphins spent significantly less time resting and socialising. In turn, reduced resting and socialising rates may have negative impacts on the build-up of energy reserves and reproductive success (Visser *et al.*, 2011). In the Ionian Sea, a study on the impacts of cetacean watching vessels on behavioural activities of Risso's dolphins found that Risso's showed a neutral response to the presence of the vessel during 81.3% of sightings, a negative response in 17% of sightings and a positive response in 1% of sightings (Bellomo *et al.*, 2021). A study on the effects of anthropogenic noise on Risso's dolphin vocalisations in the North Ionian Sea found that click train and buzzes are particularly affected by the LF noise found from vessels (Carlucci *et al.*, 2024).
- 11.9.10.16 As limited information exists on the behavioural response of Risso's dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on Risso's dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are likely to be higher as they seek out marine mammals, which will not be the case for construction vessels.
- 11.9.10.17 Based on the above, Risso's dolphins are considered to be of reasonable adaptability and tolerance. The duration of the impact will likely be limited to when the vessel is present, though this will be frequently during the construction period, resulting in overall medium recoverability. Taking these factors into account, the overall sensitivity of Risso's dolphins to disturbance from increased vessel presence is considered to be **low**.

### *Atlantic white-sided dolphin / White-beaked dolphin*

- 11.9.10.18 There is currently no information on the behavioural effects as a result of vessel disturbance in Atlantic white-sided or white-beaked dolphins. Therefore, the information provided for bottlenose and Risso's dolphin has been used as a proxy for the assessment of vessel disturbance on Atlantic white-sided and white-beaked dolphins.
- 11.9.10.19 Based on the information for bottlenose and Risso's dolphin, Atlantic white-sided and white-beaked dolphins are considered to be of reasonable adaptability and tolerance. The duration of the impact will likely be limited to when the vessel is present, though this will be frequently during the construction period, resulting in overall medium recoverability. Taking these factors into account, the overall sensitivity of Atlantic white-sided and white-beaked dolphins to disturbance from increased vessel presence is considered to be **low**.

### *Short-beaked common dolphin*

- 11.9.10.20 There is limited information available on the behavioural response of common dolphin to increased vessel disturbance. Culloch *et al.* (2016) reported a strong, negative correlation in the occurrence of common dolphins with an increase in vessel numbers during the construction of a gas pipeline in Broadhaven Bay. Other studies have primarily focused on the impact of cetacean-watching vessels. These studies found that common dolphins altered their behaviours in the presence of vessels, with a reduction in feeding behaviour and an increase in travelling being observed (Olaya-Ponzone *et al.*, 2025; Meissner *et al.*, 2015; Stockin *et al.*, 2008). This, in turn, may result in reduced energy intake, which, in line with an increase in energy expenditure due to an increase in travelling behaviour, may affect individual fitness and potentially negative impacts at a population level (Olaya-Ponzone *et al.*, 2025; Meissner *et al.*, 2015; Stockin *et al.*, 2008). In contrast, Silva *et al.* (2024) reported an increase in feeding behaviours of common dolphins when in the presence of vessels.
- 11.9.10.21 As limited information exists on the behavioural response of common dolphins to construction-related vessels, studies on the impact of cetacean watching vessels on common dolphin behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are likely to be higher as they seek out marine mammals, which will not be the case for construction vessels.
- 11.9.10.22 Based on the above, common dolphins are considered to be of reasonable adaptability and tolerance. The duration of the impact will likely be limited to when the vessel is present, though this will be frequently during the construction period, resulting in overall medium recoverability. Taking these factors into account, the overall sensitivity of common dolphins to disturbance from increased vessel presence is considered to be **low**.

### *Minke and humpback whale (LF cetaceans)*

#### *Minke whale*

- 11.9.10.23 A study into the response of minke whales to construction-related vessel traffic in Broadhaven Bay, northwest Ireland found a significant negative correlation between minke whale presence and both the number of overall vessels and the number of utility vessels (those emitting lower frequency noise but moving around more than construction vessels; Anderwald *et al.*, 2013). This suggests that minke whales were displaced from the vicinity, most likely due to disturbance resulting from vessel presence.
- 11.9.10.24 Christiansen *et al.* (2013) found that minke whales change their diving patterns and behaviour in response to the presence of whale-watching vessels. Minke whales were recorded reducing dive times and increasing sinuous movements, which in turn, reduced

foraging activity with observed surface feeding evenings decreasing during vessel interactions. The study also found that this reduction in foraging activity could result in decreased energy availability, leading to reduced reproductive success. Behavioural changes in response to vessel presence were also observed by Christiansen and Lusseau (2015) who found that interactions with whale-watching vessels led to a 42.1% decrease in feeding activity and a 7.6% increase in non-feeding activity. This resulted in a 63.5% decrease in net energy intake. These bioenergetic effects were then examined in terms of their impacts on foetal growth. However, impacts were considered negligible, with there being no significant impact found on foetal growth, due to the very low number of interactions with vessels during the foraging season. It is important to note that noise levels were not measured in either study. Therefore, behavioural responses could only be correlated to vessel presence.

- 11.9.10.25 Despite minke whales displaying a clear behavioural response in relation to vessel presence, when considering the temporal and spatial rates of minke whale exposure to vessels across the whale-watching season, Christiansen *et al.* (2015) found no population-level effects. This is likely due to their large population size and migratory behaviour.
- 11.9.10.26 As limited information exists on the behavioural response of minke whales to construction-related vessels, studies on the impact of whale-watching vessels on minke whale behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are likely to be higher as they seek out marine mammals, which will not be the case for construction vessels.
- 11.9.10.27 Based on the above, minke whales are considered to be of reasonable adaptability and tolerance, as whilst there have been individual behavioural responses observed, these have not been shown to have an effect on vital rates or population-level effects. The duration of the impact will likely be limited to when the vessel is present, though this will be frequently during the construction period, resulting in overall medium recoverability. Taking these factors into account, the overall sensitivity of minke whales to disturbance from increased vessel presence is considered to be **low**.

#### *Humpback whale*

- 11.9.10.28 Sprogis *et al.* (2020) observed a decrease in resting rates by up to 30% and a doubling of respiration rates in humpback mother-calf pairs when vessels producing high level low-frequency noise were within 100m of the pair, when compared to control low level noise scenarios. Swim speeds were also found to increase by 37%. These behaviours are likely to be a result of avoidance strategies, in turn increasing energy expenditure in these individuals. A study by Villagra *et al.* (2021) looked into the energetic effects of whale-watching vessels on humpback whales at a breeding ground in northern Peru. Here, cost of transport was used as a proxy for energetic efficiency, calculated using estimated swim speeds and breath frequency. Results found that the mere presence of whale watching vessels did not lead to any significant behavioural changes; however, an increase in swim speed and respiration frequency, and a decrease in cost of transport was observed as the number of vessels and duration of interactions with vessels increased. Behavioural responses of humpback whales to whale-watching vessels were also observed by Stamation *et al.* (2010). Whales were observed to increase dive times and the percentage of time spent submerged in the presence of vessels. Some surface behaviours also occurred less often when vessels were present. Pods containing calves also appear to be more sensitive to vessel disturbance than adult-only pods.
- 11.9.10.29 As limited information exists on the behavioural response of humpback whales to construction-related vessels, studies on the impact of whale-watching vessels on humpback whale behaviour have been presented as a proxy to inform this assessment. However, it is important to note that disturbance effects from cetacean watching vessels are likely to be

higher as they seek out marine mammals, which will not be the case for construction vessels. It is also noted that many studies have focused on the effects on pairs or groups with calves in them, which are likely to be more sensitive to disturbance; however humpback whale calves or breeding have not been recorded in the Project's Offshore Red Line Boundary.

- 11.9.10.30 Based on the above, humpback whales are considered to be of reasonable adaptability and tolerance. Whilst there have been individual behavioural responses observed, these are primarily associated with calves or breeding, which will not be present in the Project area. It is also noted that disturbance occurs in close proximity to vessels, however the embedded environmental measures (M-039) will ensure that vessels do not approach marine mammals, thereby reducing individual's sensitivity to the vessel. The duration of the impact will likely be limited to when the vessel is present, though this will be frequently during the construction period. However, humpback whales are present in the Project area on a seasonal basis and therefore, will not be exposed to this effect over extended periods of time, resulting in overall medium recoverability. Taking these factors into account, the overall sensitivity of humpback whales to disturbance from increased vessel presence is considered to be **low**.

#### Harbour and grey seal (PCW)

- 11.9.10.31 For seals, vessels may cause disturbance both in the water and while they are hauled out, with impacts ranging from avoidance and stress reactions to TTS (using Southall *et al.*, 2019; Anderwald *et al.*, 2013; Bishop *et al.*, 2015; Karpovich *et al.*, 2015; Jones *et al.*, 2017). However, there is limited information on the behavioural response of seals to increased vessel presence, particularly in relation to construction vessels. Seals are particularly sensitive to disturbance where vessel traffic overlaps with productive coastal waters, especially over their breeding and moulting periods (Robards *et al.*, 2016). Studies have shown that vessels may disturb seals hauled out (Back *et al.*, 2018; Cowling *et al.*, 2015; Ruiz-Mar *et al.*, 2022; Osinga *et al.*, 2012; Wilson, 2014). However, due to the distance between the Project and nearest established haul-out site (approximately 105km; **Table 11.8**), vessels associated with the Project are highly unlikely to cause disturbance to seal haul-out sites.
- 11.9.10.32 Seals have a broad hearing range of 50Hz – 86kHz and have reportedly responded to small (~2kHz) and large (~0.25kHz) vessels at approximately 400m (Southall *et al.*, 2019; Thomsen *et al.*, 2006). Avoidance and disturbance behaviour has been observed in seals at haul-out sites up to 100m for harbour seals and 400m for grey seals from vessel activity (Richardson *et al.*, 1995). However, a study of 37 telemetry tagged harbour seals at sea in Moray Firth, Scotland reported no apparent response by seals to close passing vessels (Onoufriou *et al.*, 2016) Another telemetry study of harbour seals in the UK found that despite shipping noise potentially causing TTS due to cumulative SELs exceeding the TTS-threshold, there was no evidence of reduced harbour seal presence due to vessel traffic (Jones *et al.*, 2017).
- 11.9.10.33 Anderwald *et al.* (2013) found that grey seal sightings were significantly negatively correlated with the overall number of vessels and the number of utility vessels (*i.e.*, those emitting lower frequency noise but moving around more than construction vessels) in the surrounding area, suggesting that grey seals were actively avoiding the area. However, it is important to note that this correlation was weaker than those with environmental variable such as sea state. Grey seals have also been found to alter their surfacing and diving behaviour in relation to vessel presence (Trigg, 2019), demonstrating disturbance occurring in this species while at sea as well as when hauled-out.
- 11.9.10.34 Vessel type also has an effect on disturbance responses in grey seals. Grey seals can become habituated to the presence of specific vessel types, particularly wildlife watching or

fishing vessels. However, vessels which are not regularly occurring in an area are known to cause displacement in grey seals from the vicinity (SCOS, 2023).

- 11.9.10.35 Based on the above, no disturbance effect is predicted at seal haul-out sites, however disturbance at-sea may occur from vessels associated with the Project construction. Harbour and grey seals are considered to be of reasonable adaptability and tolerance to disturbance at-sea. The duration of the impact will likely be limited to when the vessel is present, though this will be frequently during the construction period, resulting in overall medium recoverability. Taking these factors into account, the overall sensitivity of grey and harbour seals to disturbance from increased vessel presence is considered to be **low**.

### Magnitude of impact

- 11.9.10.36 During the construction stage, it is estimated that approximately 3,838 individual vessels transits would be required during the construction of the Project. It is estimated that the installation of each floating unit will require up to three vessel transits of the installation vessel. (**Table 11.9**). Vessels that will be used during the construction stage include heavy lift vessel, support vessel, AHTS vessel, survey vessel, offshore construction vessel or larger AHTS vessel and rock dumping vessel (**Table 11.9**).
- 11.9.10.37 Disturbance to marine mammals by vessels will be driven by a combination of underwater noise and the physical presence of the vessel itself (Pirootta *et al.*, 2015). It is not simple to identify individual drivers of vessel disturbance; therefore, it is assessed in general terms, covering both disturbance from vessel presence and underwater noise.
- 11.9.10.38 Noise levels from construction vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, cavitation and various rotating machinery (for example, power generation, pumps) in the vicinity of the Project. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed, and ambient noise levels (Wilson *et al.*, 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the construction exceeds the background ambient noise level.
- 11.9.10.39 Vessel noise levels are typically in the range of 10 to 100Hz (Erbe *et al.*, 2019) with an estimated source level of 168 SEL<sub>cum</sub> dB re 1 µPa at 1m (rms) for large construction vessels and 161 SEL<sub>cum</sub> dB re 1 µPa at 1m (rms) for medium construction vessels, travelling at a speed of 10 knots (see **Volume 3, Appendix 8.1**). In general, support and supply vessels (50-100m) are expected to have broadband source levels in the range 165-180dB re 1µPa, with the majority of energy below 1kHz (OSPAR, 2009). Large commercial vessels (>100m) produce relatively loud and predominately LF sounds, with the strongest energy concentrated below several hundred Hz (OSPAR, 2009).
- 11.9.10.40 The reported distance between marine mammals and vessels at which behavioural responses are observed varies. Thomsen *et al.* (2006) reported that harbour porpoise respond to both small (~2kHz, 1/3 octave SPL levels of ship noise) and large (~0.25kHz, 1/3 octave SPL levels of ship noise) vessels at approximately 400m. In addition, a study on the impacts of construction-related activities at Beatrice and Moray East offshore wind farms showed that harbour porpoises are displaced by offshore wind farm construction vessels. Hourly occurrence of porpoise detections declined within 2km of construction vessels, but no response was observed out to 4km, suggesting that responses declined within increasing distance to vessels (Benhemma-Le Gall *et al.*, 2021). Furthermore, Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 20,000 vessels/year (80 per day within an area of 5km<sup>2</sup>). Comparatively, vessel traffic in the OAA were recorded by the Project's vessel traffic surveys as 7 to 24 unique vessel transits per day (see **Chapter 15: Shipping and Navigation**).

- 11.9.10.41 For bottlenose dolphins, responses to different types of vessel traffic have been reported in a number of studies (Koroza and Evans, 2022; Lusseau, 2003; Pellegrini *et al.*, 2021; Pirodda *et al.*, 2015). Despite this, research on an increase of commercial vessels for the construction of an offshore wind farm found that bottlenose dolphin response to disturbance is not biologically significant in that health, vital rates and population dynamics remained unchanged (New *et al.*, 2013).
- 11.9.10.42 Jones *et al.* (2017) analysed the predicted co-occurrence of ships and seals at sea which demonstrated that there is a large degree of predicted co-occurrence UK-wide, particularly within 50km of the coast close to seal haul-outs. Despite this, there is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and seals (Jones *et al.*, 2017). Despite the documented co-occurrence of vessels and seals (Jones *et al.*, 2017), behavioural disturbance to vessels has been recorded in both harbour and grey seals. Thomsen *et al.* (2006) estimated that both harbour and grey seals will respond to both small and large vessels at approximately 400m. When exposed to shipping noise of 122dB re 1  $\mu$ Pa (received SPL), telemetry studies indicate an increased descent rate of benthic and shallow dives in adult grey seals (Trigg, 2019). These quick descent dives are often a response to a stressor, which could impact the animal's fitness, due to increased energy demands and reduced foraging opportunities if disturbance was persistent (Mikkelsen *et al.* 2019).
- 11.9.10.43 This assessment considered the TTS-onset thresholds for assessing vessel disturbance, as modelled within **Volume 3, Appendix 8.1**. For all marine mammal species, TTS-onset was modelled to occur for fleeing receptors at a distance of <100m. All cumulative noise sources were modelled being operational for the entirety of each 24-hour period, this is highly unlikely, due to the transient and intermittent nature of the noise produced through these activities.
- 11.9.10.44 While the presence of vessels in the area may cause displacement or changes in behaviour, marine mammal receptors are likely to return to the area quickly and resume pre-disturbance behaviours. Throughout the construction of the Project, the Vessel Management and Navigation Safety Plan (M-039) will ensure that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals. The proposed implementation of a Vessel Management and Navigation Safety Plan will reduce the risk of vessel disturbance by controlling the speed and movement of vessels, approach distances to marine mammals, and ensuring predictable routes which are less likely to cause disturbance. This is supported by vessel simulation modelling by Findlay *et al.* (2023) which predicted that, when animals were exposed to vessels at a given distance with both a 20% and a 50% reduction in speed, all potential noise impacts were reduced.
- 11.9.10.45 The area of disturbance as a result of increased vessel presence and traffic is considered to be small given the anticipated local spatial range of impact. Consequently, the impact of disturbance to marine mammals from vessel activities may result in a small proportion of the population being affected at any one time. The consequences of disturbance are expected to be short-term *i.e.* the disturbance effect is limited to the duration of vessel presence, though vessels will be used frequently during the Project construction stage. Overall, vessel disturbance is very unlikely to affect the population trajectory of any of the marine mammal receptor species, also considering the implementation of embedded commitments. Therefore, magnitude of impact of disturbance from increased vessel presence and traffic is therefore **low** for all marine mammal receptors.

### Significance of residual effect

- 11.9.10.46 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.38**.

11.9.10.47 The magnitude of impact of disturbance from other construction activities is deemed to be **low** and the sensitivity of receptors is **low**. The effect of disturbance from increased vessel presence and traffic will therefore be of **Negligible (Not Significant)** in EIA terms.

**Table 11.38 Significance of C9: Disturbance from increased vessel presence and traffic**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

### 11.9.11 Impact C10: Auditory injury from unexploded ordnance clearance

#### Overview

11.9.11.1 UXO clearance may be required prior to construction of the offshore Project. The underwater explosions associated with UXO clearance generate a broadband acoustic pulse of very high peak pressure, which can result in auditory injury (PTS). Auditory injury can affect feeding, mating, breeding, and resting activities of marine mammal receptors (Ketten, 2004; Richardson *et al.*, 1995; von Benda-Beckmann *et al.*, 2015). The generated noise levels from UXO clearance have been assumed to be proportional to the total size of explosive material being detonated, which is indicated by the charge weight, given lack of information on the nature or locations of the UXOs at the time of writing.

11.9.11.2 While avoidance, removal, or relocation of identified UXO is preferred, underwater clearance in-situ may be necessary where removal is deemed unsafe. The method for UXO removal will be determined based on a risk assessment after the detection and initial investigation of the UXO. It is expected that if any UXO clearance is required, it would be

undertaken using low order clearance and all efforts will be made to avoid high order clearance where possible. However, the potential impact associated with high order detonation is given here to provide a worst case assessment, in line with advice from Department for Environment, Food and Rural Affairs (DEFRA *et al.*, 2021) and advice received from NatureScot on 15<sup>th</sup> of April 2023.

- 11.9.11.3 The potential for PTS-onset from UXO clearance has been assessed for several scenarios (refer to **Volume 3, Appendix 8.1** for further detail):
- High order clearance: this method aims to completely detonate all explosive material in the UXO. The worst case high order detonation of a large 907kg UXO has been assessed, in addition to smaller potential charge weights of 25, 55, 120, 240, 525, 698 and 750kg plus a 0.5kg donor charge, which is used to initiate the detonation.
  - Low order deflagration: clearance of any size of UXO using a small specialist donor charge (up to 250g) which causes a very high temperature rapid burning event to vaporise the explosive material in the UXO without an explosion (called deflagration). Noise levels are proportional to the donor charge only (Robinson *et al.*, 2020).
- 11.9.11.4 It should be noted that when attempting to undertake a low order clearance, including deflagration and burning, there is a potential risk (albeit low) that a high order event will be initiated.
- 11.9.11.5 The number of UXO items requiring clearance and the duration of clearance operations are currently unknown. Therefore, the assessments presented in this Chapter are illustrative and based on a range of charge weights. The maximum estimated charge weight within the Project OAA is 907kg. This Section summarises the assessment for injury to marine mammals from UXO clearance, utilising the underwater noise modelling results presented in **Volume 3, Appendix 8.1**.

### Sensitivity of receptor

- 11.9.11.6 The primary acoustic energy produced by an explosive detonation is below the region of greatest sensitivity for harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW; Southall *et al.*, 2019). Most of the acoustic energy is produced below a few hundred hertz, and decreases by around 10dB SEL per decade above 100Hz (von Benda-Beckmann *et al.*, 2015; Salomons *et al.*, 2021). There is also a pronounced reduction in energy levels above 5-10kHz (von Benda-Beckmann *et al.*, 2015; Salomons *et al.*, 2021). Therefore, if PTS (a permanent effect) were to occur as a result of UXO clearance, the location of the PTS in the hearing range of marine mammals is unlikely to result in impact to vital rates in harbour porpoise, dolphin and seal species. These species would be able to adapt or tolerate any PTS that would occur in this range. Therefore, dolphins, porpoise and seal receptors, are assessed to be of **low** sensitivity to auditory injury from UXO clearance.
- 11.9.11.7 In contrast, the frequencies of the peak acoustic energy produced during UXO clearance may fall within the peak hearing range of minke and humpback whales (LF cetaceans), resulting in them having greater sensitivity to a PTS in this range. These species are considered to be of limited adaptability and tolerance to a PTS effect, noting this is a permanent effect that is not recoverable. Taking these factors into account, the overall sensitivity of minke and humpback whale to auditory injury from UXO is considered to be **medium**.

### Magnitude of impact

- 11.9.11.8 This Section presents the quantitative assessment of permanent auditory injury (PTS-onset) in marine mammals resulting from UXO clearance. Each UXO detonation is treated as a

single acoustic pulse. Accordingly, both weighted single pulse SEL and unweighted  $SPL_{peak}$  thresholds from Southall *et al.* (2019) are used (**Table 11.16**). Source levels for each charge weight are provided in **Table 11.17**. Fleeing behaviour is not factored into these estimates. Predicted impact ranges for PTS-onset are shown in **Table 11.39**, and estimated numbers of affected individuals are presented in **Table 11.40** and **Table 11.41**.

- 11.9.11.9 PTS-onset impact ranges increase with charge size across all FHGs. For harbour porpoise, the maximum impact range is 15km (based on the  $SPL_{peak}$  criterion), equating to up to 532 individuals affected (0.15% of the NS MU population). This worst case assessment is based on a high-order detonation of the largest charge (907kg plus donor) and SCANS-IV density estimates (**Table 11.40**).
- 11.9.11.10 Dolphin species show the smallest predicted impact range, with a maximum of 880m (based on the  $SPL_{peak}$  criterion). For bottlenose dolphin, Risso's dolphin, short-beaked common dolphin and Atlantic white-sided dolphin, this corresponds to one or fewer than one individual affected under worst case scenario (**Table 11.40**). For white-beaked dolphin, this corresponds to two individuals. This comprises <0.01% of the reference population for all dolphin species except for bottlenose dolphin in the CES MU, for which it comprised 0.12%.
- 11.9.11.11 For minke and humpback whale, the maximum PTS-onset range is 12km (based on the SEL criterion). This corresponds to up to 23 minke whales potentially affected (0.11% of the CGNS MU) (**Table 11.41**). Humpback whales have not been quantitatively assessed due to the absence of reliable density estimates and defined MUs. Given their expected low density and seasonal occurrence in the Project area, the number of individuals affected is expected to be substantially smaller than for minke whales.
- 11.9.11.12 For seals, the maximum PTS-onset range is 3km (based on the  $SPL_{peak}$  criterion). This corresponds to one grey seal (<0.01% of the ES SMA) and fewer than one harbour seal (<0.01% of the ES SMA) predicted to be affected under the worst-case scenario (**Table 11.40**).
- 11.9.11.13 Low order detonations (based on a 250g charge) result in significantly smaller impact ranges than the high order clearances. The maximum predicted PTS-onset range is 990m, across all FHGs (**Table 11.39**). This is based on the  $SPL_{peak}$  criterion for harbour porpoise.
- 11.9.11.14 Overall, the number of marine mammals predicted to experience PTS-onset is very low relative to reference populations (maximum of 0.15% of a reference population). While PTS represents a permanent change to the individual receptor, the magnitude of impact is considered to be **low** for harbour porpoise, white-beaked dolphin, bottlenose dolphin, Risso's dolphin, minke whale, humpback whale and grey seal, where one or more individuals could be exposed. For common dolphin, Atlantic white-sided dolphin, and harbour seal, where less than one individual is predicted to be affected, the magnitude of impact is considered to be **negligible**.

**Table 11.39 Summary of auditory injury (PTS-onset) impact ranges for UXO clearance using impulsive noise criteria from Southall *et al.* (2019) for marine mammals**

Charge weight (kg)	PTS-onset (unweighted SPL <sub>peak</sub> )				PTS-onset (weighted SEL)			
	LF	HF	VHF	PCW	LF	HF	VHF	PCW
<b>Low order (0.25 kg)</b>	170m	60m	990m	190m	230m	<50m	80m	<50m
<b>25 kg (+donor)</b>	820m	260m	4.6km	910m	2.2km	<50m	570m	390m
<b>55 kg (+donor)</b>	1.0km	340m	6.0km	1.1km	3.2km	<50m	740m	570m
<b>120 kg (+donor)</b>	1.3km	450m	7.8km	1.5km	4.7km	<50m	950m	830m
<b>240 kg (+donor)</b>	1.7km	560m	9.8km	1.9km	6.5km	<50m	1.1km	1.1km
<b>525 kg (+donor)</b>	2.2km	730m	12.0km	2.5km	9.5km	50m	1.4km	1.6km
<b>698 kg (+donor)</b>	2.4km	810m	13.0km	2.7km	10.0km	60m	1.5km	1.9km
<b>750 kg (+donor)</b>	2.5km	830m	14.0km	2.8km	11.0km	60m	1.5km	2.0km
<b>907 kg (+donor)</b>	2.7km	880m	15.0km	3km	12.0km	70m	1.6km	2.2km

**Table 11.40 Predicted impact of PTS-onset (unweighted SPL<sub>peak</sub>) for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	3	50	86	144	227	341	400	464	532
		% NS MU	<0.01	0.01	0.02	0.04	0.07	0.10	0.12	0.13	0.15
		% UK MU	<0.01	0.03	0.05	0.09	0.14	0.21	0.25	0.29	0.33
	0.5985 (Gilles <i>et al.</i> , 2023)	#	2	40	68	115	181	271	318	369	424
		% NS MU	<0.01	0.01	0.02	0.03	0.05	0.08	0.09	0.11	0.12
		% UK MU	<0.01	0.02	0.04	0.07	0.11	0.17	0.20	0.23	0.27
	0.087 (site-specific DAS)	#	1	6	10	17	27	40	47	54	62
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.02
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	0.02	0.03	0.03	0.04
	0.416	#	<1	1	1	1	1	1	1	1	2

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (unweighted SPL <sub>peak</sub> )									
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor	
White-beaked dolphin	(Gilles <i>et al.</i> , 2025)	% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	0.1775 (Gilles <i>et al.</i> , 2023)	#	<1	<1	1	1	1	1	1	1	1	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	0.023 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	Bottlenose Dolphin	0.116 (within 2km of the coast; Cheney <i>et al.</i> , 2024) and 0.0298 (beyond; Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	1	1	1	1	1	1
% CES MU			<0.01	0.01	0.02	0.03	0.05	0.09	0.11	0.11	0.12	
0.001		#	<1	<1	<1	<1	<1	<1	<1	<1	<1	

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
	(Gilles <i>et al.</i> , 2025)	% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0298 (Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	<1	<1	1	1	1	1
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<b>Short-beaked common dolphin</b>	0.017 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
<b>Risso's dolphin</b>	0.0702 (Gilles <i>et al.</i> , 2023)	#	<1	1	1	1	1	1	1	1	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
	0.002 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	<1	1	1	1	1	1	1	1	2
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
	0.0419 (Gilles <i>et al.</i> , 2023)	#	<1	1	1	1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Harbour Seal	0.0000011 (Carter <i>et al.</i> , 2022)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Grey seal	0.01 (Carter <i>et al.</i> , 2025)	#	<1	<1	<1	1	1	1	1	1	1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0021 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	1	1	1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

**Table 11.41 Predicted impact of PTS-onset (weighted SEL) for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (weighted SEL)								
			LO (0.25 kg)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	698 kg + donor	750 kg + donor	907 kg + donor
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	<1	1	2	3	3	5	6	6	7
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.5985 (Gilles <i>et al.</i> , 2023)	#	<1	1	2	2	3	4	5	5	5
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.087 (site-specific DAS)	#	<1	<1	1	1	1	1	1	1	1
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (weighted SEL)									
			LO (0.25 kg)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	698 kg + donor	750 kg + donor	907 kg + donor	
	0.1775 (Gilles <i>et al.</i> , 2023)	% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		#	<1	<1	<1	<1	<1	<1	<1	<1	<1	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	0.023 (site-specific DAS)	% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
		#	<1	<1	<1	<1	<1	<1	<1	<1	<1	
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	
	<b>Bottlenose dolphin</b>	0.116 (within 2km of the coast; Cheney <i>et al.</i> , 2024) and 0.0298 (beyond; Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
			% CES MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		0.001 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
% GNS MU			<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (weighted SEL)								
			LO (0.25 kg)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	698 kg + donor	750 kg + donor	907 kg + donor
	0.0298 (Hammond <i>et al.</i> , 2021)	% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Short-beaked common dolphin	0.017 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Risso's dolphin	0.0702 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.002 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (weighted SEL)								
			LO (0.25 kg)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	698 kg + donor	750 kg + donor	907 kg + donor
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	<1	1	2	4	7	15	16	20	23
		% CGNS MU	<0.01	<0.01	<0.01	0.02	0.03	0.07	0.08	0.09	0.11
		% UK MU	<0.01	<0.01	0.02	0.03	0.06	0.14	0.15	0.18	0.22
	0.0419 (Gilles <i>et al.</i> , 2023)	#	<1	1	2	3	6	12	14	16	19
		% CGNS MU	<0.01	<0.01	<0.01	0.01	0.03	0.06	0.07	0.08	0.09
		% UK MU	<0.01	<0.01	0.01	0.03	0.05	0.12	0.13	0.15	0.18
Harbour seal	0.0000011 (Carter <i>et al.</i> , 2022)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	PTS-onset (weighted SEL)								
			LO (0.25 kg)	25 kg + donor	55 kg + donor	120 kg + donor	240 kg + donor	525 kg + donor	698 kg + donor	750 kg + donor	907 kg + donor
Grey seal	0.01 (Carter <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	1	1	1	1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0021 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

### Significance of residual effect

11.9.11.15 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.42**.

11.9.11.16 The magnitude of the auditory injury from underwater noise from UXO clearance is deemed to be **low** for harbour porpoise, bottlenose dolphin, Risso’s dolphin, white-beaked dolphin, minke whale, humpback whale and grey seal, and **negligible** for common and Atlantic white-sided dolphin, and harbour seals (**Table 11.42**). The sensitivity of most marine mammal receptors is **low**, with the exception of minke and humpback whale which have **medium** sensitivity. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms for all species with the exception of minke whale and humpback whale which have **Minor (Not Significant)** in EIA terms.

**Table 11.42 Significance of Impact C10: Auditory injury from underwater noise from UXO clearance**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso’s dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Low	Medium	Minor (Not Significant).
Humpback whale	Low	Medium	Minor (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

## 11.9.12 Impact C11: Disturbance from unexploded ordnance clearance

### Overview

- 11.9.12.1 This Section provides the quantitative assessment for behavioural disturbance during UXO clearance. Similarly to **Section 11.9.11**, the potential for TTS-onset (as a proxy for disturbance) from UXO clearance has been assessed for several scenarios (refer to **Volume 3, Appendix 8.1** for further detail):
- High order clearance: this method aims to completely detonate of all explosive material in the UXO. The worst case high order detonation of a large 907kg UXO has been assessed, in addition to smaller potential charge weights of 25, 55, 120, 240, 525, 698 and 750kg plus a 5kg donor charge which is used to initiate the detonation.
  - Low order deflagration: clearance of any size of UXO using a small specialist donor charge (up to 250g) which causes a very high temperature rapid burning event to vaporise the explosive material in the UXO without an explosion (called deflagration). Noise levels are proportional to the donor charge only and is typically 85% less than high-order clearance.
  - Low order burning: the UXO case is penetrated by an Explosively Formed Magnesium Projectile (or similar) which aims to immediately burn-out its main high explosive charge, requiring significantly less explosive to initiate the shape charge (typically up to 90% less) than that for higher-order clearance.
- 11.9.12.2 However, it should be noted that when attempting to undertake a low order clearance, including deflagration and burning, there is a potential risk (albeit low) that a high order event will be initiated.
- 11.9.12.3 The number of UXO items requiring clearance and the duration of clearance operations are currently unknown. Therefore, the assessments presented in this Chapter are illustrative and based on a range of charge weights, as outlined in **Section 11.8.4** The maximum estimated charge weight within the Project OAA is 907kg. This Section summarises the assessment for disturbance to marine mammals from UXO clearance, utilising the underwater noise modelling results presented in **Volume 3, Appendix 8.1**.

### Sensitivity of receptor

- 11.9.12.4 JNCC (2020) guidance states that '*a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement*'. Each detonation will comprise an instantaneous pulse of noise; therefore, it is not expected that behavioural disturbance from a single UXO detonation would result in any changes to the vital rates of individuals.
- 11.9.12.5 Based on the above, all marine mammal receptors within this assessment are considered to be of high adaptability, reasonable tolerance, and have high recoverability. Taking these factors into account, the overall sensitivity of the marine mammal receptors to disturbance from UXO clearance is considered to be **low**.

### Magnitude of impact

- 11.9.12.6 The predicted impact ranges for UXO clearance using TTS as a proxy for disturbance considering the different charge weights and impact criteria are presented in **Table 11.43**. The number of animals predicted to experience TTS-onset from UXO clearance, including the proportion of the reference population, are presented in **Table 11.44** and **Table 11.45**.

- 11.9.12.7 The worst case scenario arose when modelling high order UXO clearances, using a maximum charge of 907kg. Under this scenario, the furthest distances at which disturbance effects may occur vary by species group: 120km for LF cetaceans and 24km for pinnipeds (using the SEL criterion), 28km for VHF cetaceans and 1.6km for HF cetaceans (using the SPL<sub>peak</sub> criterion) (**Table 11.43**). However, the projected 120km impact radius for minke whales is likely a considerable overestimate. Research by Matei *et al.* (2024) suggests that noise levels above 180dB are not exceeded beyond 20km from the detonation location in real-world UXO events. As explained earlier, these models assume no degradation of the UXO and no smoothing of the pulse over distance, which is very precautionary and unrealistic in a real-life scenario.
- 11.9.12.8 Minke whales were predicted to experience the greatest disturbance, with an estimated 2,262 individuals potentially disturbed, equivalent to 11.24% of the CGNS MU (**Table 11.45**). An estimate of 1,853 harbour porpoises are expected to be disturbed, equivalent to 0.53% of the NS MU (**Table 11.44**). In addition, 19 grey seals were predicted to be impacted, representing 0.04% of the ES SMA population (**Table 11.44**). Whilst a maximum of one bottlenose dolphin from the CES MU was predicted to be disturbed, this comprised 0.41% of the CES MU population. All other marine mammal species have four or fewer individuals predicted to experience disturbance, representing less than 0.01% of their respective MUs.
- 11.9.12.9 Low order detonations (based on a 250g charge) result in predicted disturbance ranges of up to 3.2km for LF cetaceans, 1.80km for VHF cetaceans, 0.57km for pinnipeds and 0.1km for HF cetaceans (**Table 11.43**). A maximum of two minke whales, eight harbour porpoise, or less than one of all other marine mammal species are predicted to experience disturbance, equivalent to <0.01% of their respective reference populations (**Table 11.44** and **Table 11.45**).
- 11.9.12.10 Humpback whales have not been quantitatively assessed due to the absence of reliable density estimates and defined MUs. Given their expected low density and seasonal occurrence in the Project area, the number of individuals affected is expected to be substantially smaller than for minke whales.
- 11.9.12.11 While high order detonation represents the realistic worst-case scenario, in practice, low order clearance methods such as deflagration are expected to be used as a priority for UXO clearance. These approaches are substantially less disruptive and lead to much smaller predicted disturbance impact ranges. Furthermore, Southall *et al.* (2007) noted that using TTS-onset levels as a proxy for behavioural disturbance is likely a highly conservative assumption. TTS-onset typically does not persist for an entire diel cycle and is unlikely to lead to lasting biological effects. Therefore, estimates based on TTS thresholds potentially overstate the actual behavioural impact on marine mammals.
- 11.9.12.12 The detonation of UXOs is anticipated to trigger a startle response in nearby marine mammals, possibly followed by brief and temporary behavioural changes. However, these effects are unlikely to result in sustained displacement. For most marine mammal species, the proportion of their respective MUs predicted to be impacted is very small. The behavioural responses are expected to be short-lived and intermittent with temporary behavioural effects that are unlikely to alter the population trajectory.
- 11.9.12.13 As such, TTS impacts related to high-order UXO clearance are considered **negligible** for bottlenose dolphins, white-beaked dolphins, Risso's dolphins, short-beaked common dolphin and harbour seal, each with one or fewer individuals expected to be disturbed. For harbour porpoise, Atlantic white-sided dolphin, humpback whale and grey seal, the impacts are characterised as **low**, given the limited scale and transient nature of the disturbance. For minke whales, whilst the predicted numbers are considered precautionary, they suggest a higher proportion of the population could be temporarily disturbed. Nevertheless, the impacts remain short-term and are not expected to change long-term population trends.

Given this, TTS effects from high-order UXO clearance on minke whales are assessed as **medium** due to the relatively higher scale of potential disturbance.

- 11.9.12.14 As for TTS impacts related to low-order UXO clearance the magnitudes are considered **negligible** for all dolphin and seal species, each with one or fewer individuals expected to be disturbed. For harbour porpoise, minke and humpback whale, the impacts are characterised as **low**, given the limited scale and transient nature of the disturbance.

**Table 11.43 Summary of TTS-onset impact ranges used as a proxy for disturbance for UXO detonation using the impulsive (both SPL<sub>peak</sub> and SEL (single pulse)) noise criteria from Southall *et al.* (2019) for marine mammals**

Charge weight (kg)	TTS (unweighted SPL <sub>peak</sub> )				TTS (weighted SEL)			
	LF	HF	VHF	PCW	LF	HF	VHF	PCW
Low order (0.25kg)	320m	100m	1.8km	360m	3.2km	<50m	750m	570m
25kg (+donor)	1.5km	490m	8.5km	1.6km	29km	150m	2.4km	5.2km
55kg (+donor)	1.9km	640m	11km	2.1km	41km	210m	2.8km	7.5km
120kg (+donor)	2.5km	830m	14km	2.8km	57km	300m	3.2km	10km
240kg (+donor)	3.2km	1.0km	18km	3.5km	76km	390m	3.5km	14km
525kg (+donor)	4.1km	1.3km	23km	4.6km	100km	530m	4km	19km
698kg (+donor)	4.5km	1.4km	25km	5.0km	110km	590m	4.1km	22km
750kg (+donor)	4.6km	1.5km	26km	5.1km	110km	600m	4.2km	22km
907kg (+donor)	4.9km	1.6km	28km	5.5km	120km	650m	4.3km	24km

**Table 11.44 Predicted impact of TTS-onset (unweighted SPL<sub>peak</sub>) for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	8	171	286	464	766	1,250	1,477	1,598	1,853
		% NS MU	<0.01	0.05	0.08	0.13	0.22	0.36	0.43	0.46	0.53
		% UK MU	<0.01	0.11	0.18	0.29	0.48	0.78	0.92	1	1.16
	0.5985 (Gilles <i>et al.</i> , 2023)	#	7	136	228	369	610	995	1,176	1,272	1,475
		% NS MU	<0.01	0.04	0.07	0.11	0.18	0.29	0.34	0.37	0.43
		% UK MU	<0.01	0.09	0.14	0.23	0.38	0.62	0.74	0.8	0.92
	0.087 (site-specific DAS)	#	1	20	34	54	89	145	171	185	215
		% NS MU	<0.01	<0.01	0.01	0.02	0.03	0.04	0.05	0.05	0.06
		% UK MU	<0.01	0.01	0.02	0.03	0.06	0.09	0.11	0.12	0.13

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	<1	1	1	1	2	3	3	3	4
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.1775 (Gilles <i>et al.</i> , 2023)	#	<1	1	1	1	1	1	2	2	2
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.023 (site-specific DAS)	#	<1	<1	<1	<1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bottlenose Dolphin	0.116 (within 2km of the coast; Cheney <i>et al.</i> , 2024) and 0.0298 (beyond; Hammond <i>et al.</i> , 2021)	#	<1	1	1	1	1	1	1	1	1
		% CES MU	<0.01	0.04	0.07	0.11	0.16	0.27	0.32	0.36	0.41

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
	0.001 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0298 (Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	1	1	1	1	1	1
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
Short-beaked common dolphin	0.017 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Risso's dolphin	0.0702 (Gilles <i>et al.</i> , 2023)	#	<1	1	1	1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (unweighted SPL <sub>peak</sub> )									
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor	
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.002 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	<1	1	1	1	2	3	4	4	4	4
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.02	0.02	0.02
		% UK MU	<0.01	<0.01	<0.01	<0.01	0.02	0.03	0.03	0.03	0.03	0.04
	0.0419	#	<1	1	1	1	2	3	3	3	3	4

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (unweighted SPL <sub>peak</sub> )								
			LO (0.25 kg)	25 kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
	(Gilles <i>et al.</i> , 2023)	% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.02
		% UK MU	<0.01	<0.01	<0.01	<0.01	0.01	0.02	0.03	0.03	0.03
Harbour seal	0.0000011 (Carter <i>et al.</i> , 2022)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Grey seal	0.01 (Carter <i>et al.</i> , 2025)	#	<1	1	1	1	1	1	1	1	1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0021 (site-specific DAS)	#	<1	<1	<1	1	1	1	1	1	1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

**Table 11.45 Predicted impact of TTS-onset (weighted SEL) for marine mammals from UXO clearance; # = number of animals disturbed; % = the percentage of the reference population**

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (weighted SEL)								
			LO (0.25 kg)	25kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
Harbour porpoise	0.752 (Gilles <i>et al.</i> , 2025)	#	2	14	19	25	29	38	40	42	44
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01	0.01	0.01
		% UK MU	<0.01	<0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.03
	0.5985 (Gilles <i>et al.</i> , 2023)	#	2	11	15	20	24	31	32	34	35
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
		% UK MU	<0.01	<0.01	<0.01	0.01	0.01	0.02	0.02	0.02	0.02
	0.087 (site-specific DAS)	#	1	2	3	3	4	5	5	5	6
		% NS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (weighted SEL)								
			LO (0.25 kg)	25kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
White-beaked dolphin	0.416 (Gilles <i>et al.</i> , 2025)	#	<1	<1	1	1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.1775 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	1	1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.023 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Bottlenose dolphin	0.116 (within 2km of the coast; Cheney <i>et al.</i> , 2024) and 0.0298 (beyond; Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	<1	1	1	1	1	1
		% CES MU	<0.01	<0.01	<0.01	0.01	0.02	0.05	0.06	0.06	0.07

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (weighted SEL)								
			LO (0.25 kg)	25kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
	0.001 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
	0.0298 (Hammond <i>et al.</i> , 2021)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% GNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Short-beaked common dolphin	0.017 (Gilles <i>et al.</i> , 2025)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Risso's dolphin	0.0702 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	1	1	1	1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (weighted SEL)								
			LO (0.25 kg)	25kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
	0.002 (site-specific DAS)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Atlantic white-sided dolphin	0.0146 (Gilles <i>et al.</i> , 2023)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% CGNS MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
		% UK MU	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Minke whale	0.05 (Gilles <i>et al.</i> , 2025)	#	2	133	265	511	908	1,571	1,901	1,901	2,262
		% CGNS MU	<0.01	0.66	1.31	2.54	4.51	7.81	9.45	9.45	11.24
		% UK MU	0.02	1.28	2.57	4.96	8.82	15.27	18.47	18.47	21.99
	0.0419 (Gilles <i>et al.</i> , 2023)	#	2	111	222	428	761	1,317	1,593	1,593	1,896
		% CGNS MU	<0.01	0.55	1.1	2.13	3.78	6.54	7.92	7.92	9.42

Species	Density (individuals/km <sup>2</sup> )	Impact	TTS-onset (weighted SEL)								
			LO (0.25 kg)	25kg + donor	55kg + donor	120kg + donor	240kg + donor	525kg + donor	698kg + donor	750kg + donor	907kg + donor
		% UK MU	0.01	1.08	2.15	4.16	7.39	12.79	15.48	15.48	18.42
Harbour seal	0.0000011 (Carter <i>et al.</i> , 2022)	#	<1	<1	<1	<1	<1	<1	<1	<1	<1
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Grey seal	0.01 (Carter <i>et al.</i> , 2025)	#	<1	1	2	4	7	12	16	16	19
		% ES SMA	<0.01	<0.01	<0.01	<0.01	0.02	0.03	0.04	0.04	0.04
	0.0021 (site-specific DAS)	#	<1	1	1	1	2	3	4	4	4
		% ES SMA	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

### Significance of residual effect

- 11.9.12.15 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.46** and **Table 11.47**.
- 11.9.12.16 The magnitude of impact for disturbance from underwater noise from high order UXO clearance using TTS as a proxy is deemed to be **negligible** for all species, with the exception of harbour porpoise, Atlantic white-sided dolphin, humpback whale and grey seal which is **low**, and minke whale which is **medium** (**Table 11.46**). The sensitivity of all receptors is **low**. The effect will, therefore, be of **negligible** significance for all species, with the exception of minke whale which is **minor**. Both of these terms are not significant in EIA terms.
- 11.9.12.17 The magnitude of impact for disturbance from underwater noise from low order UXO clearance using TTS as a proxy is deemed to be **negligible** for all species, with the exception of harbour porpoise, minke whale and humpback whale which is **low** (**Table 11.47**). The sensitivity of all receptors is **low**. The effect will, therefore, be of **Negligible (Not Significant)** for all species, in EIA terms.

**Table 11.46 Significance of C11: Disturbance from underwater noise from high order UXO clearance**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Medium	Low	Minor (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

**Table 11.47 Significance of C11: Disturbance from underwater noise from low order UXO clearance**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

## 11.10 Assessment of effects: Operation and maintenance stage

### 11.10.1 Introduction

11.10.1.1 This Section provides an assessment of the effects for marine mammals from the O&M of the offshore elements of the Project. The assessment methodology set out in **Section 11.8** has been applied to assess effects to marine mammals from the Project.

### 11.10.2 Impact O1: Electromagnetic fields from cables

#### Overview

11.10.2.1 Natural magnetic and electric fields occur in the marine environment through the Earth's geomagnetic field, which influence the movement of tides and ocean currents (Gill *et al.*, 2014; Hutchison and Gill, 2025). The Earth's magnetic field ranges globally from 25 to 65 microtesla ( $\mu\text{T}$ ), and is currently approximately 50  $\mu\text{T}$  in the United Kingdom (NOAA, 2025), including in Scotland within the Project Red Line Boundary. Natural EMF cues are ecologically important to aquatic species and some species have evolved to be magneto-receptive, meaning that they have sensory capabilities to make use of these natural cues to aid with orientation or migration (Normandeau *et al.*, 2011).

- 11.10.2.2 The transmission of electrical current through subsea infrastructure, such as array cables and export cables within the Project, has the potential to emit a localised EMF. These fields could potentially influence magneto-receptive species such as cetaceans. Industry-standard cables designed to transfer electricity from offshore wind farm to the National Grid are designed to retain the electric field within the cable; however, there is a magnetic field that is emitted into the surrounding environment (Gill *et al.*, 2014; Hutchison and Gill, 2025). Hutchison and Gill (2025) provide a detailed description of how electric and magnetic fields impact the terrestrial and marine environments for further detail. Although this report mainly focusses on benthic and fish communities, it covers topics and ideas which can be transferred across to marine mammals.
- 11.10.2.3 The array cabling between WTGs will consist of dynamic high voltage alternating current (HVAC) cables, with a maximum total length at site of 680km. As for the export cable, up to five high voltage cables are proposed, with a maximum total offshore cable length of 140km per cable, so a total of 700km cable length. These cables will be installed in trenches with landfall either between Lunderton (Option 1) or Scotstown and Lunderton (North and/or South; Option 2). Additional cable parameters that have been used to underpin the modelling for EMF are described in **Volume 1, Chapter 9: Electromagnetic Fields**.
- 11.10.2.4 Factors that will influence the EMF encountered by individuals include the distance from the cable (which is influenced by both the burial depth and the animal's position in the water column), and the power level in the cable. Since the power level being transmitted in a cable is temporally variable, the encounter at a given point on a cable for an animal's constant position in the water column, is also variable. Cables are planned to be buried at a target depth of one to two metres, although buried cables will typically not have a consistent burial depth along the cable route, which will also alter the extent and intensity of the EMFs potentially encountered by fauna by varying distance from source. There will also be sections of surface-laid and dynamic cables in the water column connecting buried sections to the WTGs. Cable burial is an embedded measure (M-054, M-057 and M-206; **Table 11.10**) primarily to protect the cable; however, this also results in receptive species being at a greater distance from the cable and therefore reduces the magnitude of intensity of EMF exposure and the assumption is that reduced intensity reduces the level of potential impact.
- 11.10.2.5 It has not yet been demonstrated whether receptive species can distinguish between cable emissions and natural fields, and it is possible that they do not (Kimber *et al.*, 2011). Improving the research approaches used to assess the effects of EMFs on aquatic species is necessary to better understand its impact on response from receptive species. The likely sensitivities of each marine mammal species based on the evidence presented from the available studies, and the likely impact magnitudes, are discussed below.

### Sensitivity of receptor

- 11.10.2.6 Cetaceans are magneto-sensitive and use the Earth's magnetic field for navigation during migrations (Normandeau *et al.*, 2011). Cetaceans are therefore capable of detecting electromagnetic variations caused by EMFs in close proximity. EMF emissions from cables have the potential to cause short-term changes in swim direction, potentially leading to deviations from migratory routes and increased travel time (Gill *et al.*, 2005). However, there is currently no evidence that cable-related EMF emissions directly affect marine mammals (Normandeau *et al.*, 2011). Evidence indicates that the likelihood of significant effects is low, as the high mobility of cetaceans limits exposure duration. Accordingly, Normandeau *et al.* (2011) concluded that effects are possible but unlikely to be significant.
- 11.10.2.7 Based on the above, harbour porpoise, dolphin species and whale species are considered to be of high adaptability, tolerance and recoverability to any effect resulting from their

detection of EMF from cables. Taking these factors into account, the overall sensitivity of these marine mammal receptors to EMF from cables is considered to be **low**.

- 11.10.2.8 No magnetic sensitivity has been reported for seal species (Normandeau *et al.*, 2011). As such, there is no risk to seal species from EMF from cables. Therefore, the overall sensitivity of these marine mammal receptors to EMF from cables is considered to be **negligible**.

### Magnitude of impact

- 11.10.2.9 The EMF that is likely to be emitted by the Project's cables have been modelled, with the results presented in **Volume 1, Chapter 9: Electromagnetic Fields**. As described in **Table 11.9**, the EMF analysis has determined that the distance from the cables where EMF will have attenuated to 50µT (i.e. equal to background levels) is 0.8m from each array cable, and between 1.1m to 11m from the export cables (depending on cable type). The distances over which EMF above background levels may occur is therefore retained close to the cables and not attenuating over a significant distance into the marine environment.
- 11.10.2.10 Current evidence indicates that EMF emitted by offshore renewable energy export cables occur at levels too low to cause direct, significant impacts on marine mammals (Copping and Hemery, 2020). Field research, laboratory studies, and modelling consistently demonstrate that EMFs from subsea cables present only a minor risk, which can be further reduced through mitigation measures such as cable burial (Copping *et al.*, 2016). Further, there is no evidence to suggest that EMF from offshore wind farm components have any direct effect on marine mammal species (Copping, 2018). EMFs are only detectable in close proximity to export cables, making it highly unlikely that mobile species such as marine mammals would experience negative effects at either individual or population levels (Copping and Hemery, 2020).
- 11.10.2.11 This conclusion is supported by the physical attenuation of EMF in the marine environment. EMFs generated by subsea power cables are known to diminish rapidly with distance, following an inverse square relationship both vertically and horizontally from the cable source. Typically, magnetic field strength falls to negligible levels within approximately 10m from the cable (Normandeau *et al.*, 2011), which is supported by the EMF modelling outputs reported in **Chapter 9: Electromagnetic Fields**. While shallow burial or external cable protection does not influence the inherent strength of the EMF, it increases the distance between the cable and nearby receptors, effectively lowering their exposure.
- 11.10.2.12 To mitigate the potential effects a detailed CBRA (M-054 and M-057; **Table 11.10**) will be implemented as part of the embedded environmental measures. This plan will outline specific actions such as cable burial or protective measures to reduce EMF-related environmental impacts.
- 11.10.2.13 Given these considerations, it is anticipated that any EMF impacts on marine mammal receptors will be limited. Therefore, interactions are expected to be brief, sporadic, and reversible. Accordingly, the overall magnitude of EMF impacts during the O&M stage of the project is considered **low**.

### Significance of residual effect

- 11.10.2.14 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.48**.
- 11.10.2.15 The magnitude of impact of EMF from cables is deemed to be **low**. The sensitivity of harbour porpoise, dolphin species and whale species is **low**. For seal species, the sensitivity is **negligible**. The effect of EMF from cables will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.48 Significance of O1: EMF from cables**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Negligible	Negligible (Not Significant).
Grey seal	Low	Negligible	Negligible (Not Significant).

### 11.10.3 Impact O2: Vessel collisions from increased vessel presence and traffic

#### Overview

- 11.10.3.1 Increased vessel movement during the operations and maintenance stage of the Project has the potential to result in a range of impacts on marine mammals. These include injury or death due to collision with vessels due to increased vessel presence.
- 11.10.3.2 A peak of up to seven O&M vessels are anticipated offshore, with up to 640 round trips to port per year.
- 11.10.3.3 Further detail on vessel types, routes, and traffic density in the area surrounding the Project OAA and offshore export cable corridor is described in **Chapter 15: Shipping and Navigation** of the EIA Report.

#### Sensitivity of receptor

- 11.10.3.4 Marine mammal receptors sensitivity to vessel collision risk is described in **Section 11.9.9**. The sensitivity of the receptors is **high**.

## Magnitude of impact

- 11.10.3.5 During the O&M stage, a peak of seven O&M vessels will be present within the OAA at any one time, resulting in a maximum of 640 round trips to port per year (**Table 11.9**). Vessels that will be used during the O&M stage include guard vessels, service operation vessels and diving support vessels (**Table 11.9**).
- 11.10.3.6 As stated in **Section 11.9.9**, due to the volume of vessel traffic already present around the site-specific study area, the introduction of additional vessels during the construction stage of the Project will not be a novel impact for marine mammals present in the area (see **Chapter 15: Shipping and Navigation**). Nevertheless, vessel traffic associated with the Project has the potential to lead to an increase in vessel movements within the site-specific study area and surrounding transit routes.
- 11.10.3.7 Marine mammals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. The implementation of embedded measures (**Table 11.10**), including an Outline Vessel Management and Navigation Safety Plan (M-039) and adherence to the Scottish Marine Wildlife Watching Code, will ensure that vessels movements will follow predictable routes where possible and behave appropriately in the presence of marine mammals in order to minimise the potential impact. Furthermore, a proportion of the O&M vessels will be stationary or slow moving for significant periods of time, further reducing the likelihood of vessel collision.
- 11.10.3.8 The impact of injury to all marine mammal species from vessel activities is considered highly unlikely to occur, particularly given implementation of embedded measures. If it did occur, it would affect a negligible or very small proportion of the population, occurring only once or infrequently throughout the O&M stage, and would not affect the population size or trajectory. The magnitude is therefore **negligible**.

## Significance of residual effect

- 11.10.3.9 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.49**.
- 11.10.3.10 The magnitude of impact of vessel collisions from increased vessel presence and traffic is deemed to be **negligible** and the sensitivity of all receptors is **high**. The effect of vessel collisions from increased vessel presence and traffic will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.49 Significance of O2: Vessel collisions from increased vessel presence and traffic**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	High	Negligible (Not Significant).
Bottlenose dolphin	Negligible	High	Negligible (Not Significant).
Risso's dolphin	Negligible	High	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	High	Negligible (Not Significant).

Receptor	Magnitude	Sensitivity	Significance
White-beaked dolphin	Negligible	High	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	High	Negligible (Not Significant).
Minke whale	Negligible	High	Negligible (Not Significant).
Humpback whale	Negligible	High	Negligible (Not Significant).
Harbour seal	Negligible	High	Negligible (Not Significant).
Grey seal	Negligible	High	Negligible (Not Significant).

#### 11.10.4 Impact O3: Disturbance from increased vessel presence and traffic

##### Overview

- 11.10.4.1 Increased vessel movement during the O&M stage of the Project has the potential to result in a range of impacts on marine mammals. These include avoidance behaviour or displacement due to increased vessel presence, as well as masking of vocalisations or changes in vocalisation rate due to increased underwater noise.
- 11.10.4.2 Vessel disturbance may arise from a combination of underwater vessel noise and the physical presence of the vessel itself (Pirodda *et al.*, 2015). However, it is often difficult to attribute the cause of disturbance to one and/or the other definitively. Therefore, disturbance from vessels is to be assessed separately from the underwater noise assessment, covering disturbance driven by both underwater noise and vessel presence.

##### Sensitivity of receptor

- 11.10.4.3 Marine mammal receptors sensitivity to vessel disturbance is described in **Section 11.9.10**. The sensitivity of all marine mammal receptors to vessel disturbance is **low**.

##### Magnitude of impact

- 11.10.4.4 During the O&M stage, a peak of up to 7 O&M vessels are anticipated offshore, with up to 1,350 round trips to port per year (**Table 11.9**). Vessels that will be used during the operations and maintenance stage include guard vessels, service operation vessels and diving support vessels (**Table 11.9**).
- 11.10.4.5 Noise levels from O&M vessels will result in an increase in non-impulsive, continuous sounds primarily from propellers, thrusters, cavitation and various rotating machinery (for example, power generation, pumps) in the vicinity of the Project. The main drivers influencing the magnitude of potential impact with respect to noise disturbance from vessels are vessel type, speed, and ambient noise levels (Wilson *et al.*, 2007). Disturbance from vessel noise is likely to occur only when vessel noise associated with the O&M stage exceeds the background ambient noise level.

- 11.10.4.6 As stated in **Section 11.9.9**, due to the volume of vessel traffic already present around the site-specific study area, the introduction of additional vessels during the construction stage of the Project will not be a novel impact for marine mammals present in the area (see **Chapter 15: Shipping and Navigation**). **Section 11.9.9** presents the results from the available literature on the observed disturbance effect from vessels on marine mammals, particularly harbour porpoise, bottlenose dolphin and seals.
- 11.10.4.7 This assessment considered the TTS-onset thresholds for assessing vessel disturbance, as modelled within **Volume 3, Appendix 8.1**. For all marine mammal species, TTS-onset was modelled to occur for fleeing receptors at a distance of <100m. All cumulative noise sources were modelled being operational for the entirety of each 24-hour period, this is highly unlikely, due to the transient and intermittent nature of the noise produced through these activities.
- 11.10.4.8 The implementation of a VMP (M-039) will ensure that vessel movements follow predictable routes where possible and behave appropriately in the presence of marine mammals, in order to minimise the potential impact.
- 11.10.4.9 The area of disturbance as a result of increased vessel presence and traffic is considered to be small given the anticipated local spatial range of impact. Consequently, the impact of disturbance to marine mammals from vessel activities may result in a small proportion of the population being affected at any one time. The consequences of disturbance are expected to be short-term i.e. the disturbance effect is limited to the duration of vessel presence, though vessels will be used frequently during the Project O&M stage. Overall, vessel disturbance is very unlikely to affect the population trajectory of any of the marine mammal receptor species, also considering the implementation of embedded commitments. Therefore, magnitude of impact of disturbance from increased vessel presence and traffic is therefore **low** for all marine mammal receptors.

### Significance of residual effect

- 11.10.4.10 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.50**.
- 11.10.4.11 The magnitude of impact of disturbance from increased vessel presence and traffic is deemed to be **low** and the sensitivity of all receptors is **low**. The effect of disturbance from increased vessel presence and traffic will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.50 Significance of O3: Disturbance from increased vessel presence and traffic**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).

Receptor	Magnitude	Sensitivity	Significance
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

### 11.10.5 Impact O4: Long term displacement / habitat change / barrier effects due to offshore wind farm structures

#### Overview

- 11.10.5.1 The physical presence of the offshore wind farm array infrastructure has the potential to displace marine mammals via creation of a barrier effect, whereby the regular movements of a species are impacted by the presence of the wind farm (Onoufriou *et al.*, 2021). Barrier effects can also be present in the form of a reduction of access to areas which were once used by marine mammals. In this respect, the extent of the 'barrier' corresponds to the extent of the array infrastructure, as outlined in **Table 11.9**. The presence of infrastructure can also constitute a habitat change, when compared to the unconstructed baseline.
- 11.10.5.2 To date, no studies have reported any physical barrier effects from floating offshore wind farm structures on marine mammal species. However, due to the dynamic nature of floating offshore wind farms and presence of additional infrastructure in the water column, they do have the potential to yield different and potentially greater barrier effects than fixed foundations. Wawrzynekowski *et al.* (2025) conducted a generalised impact assessment of the biological effects of floating offshore wind farms, based on a literature review. This assessment concluded that physical barrier effects from floating offshore wind farms would have a low impact on all marine mammal species.
- 11.10.5.3 As floating foundations for offshore wind farms are relatively novel, fixed foundations have been used as a proxy for the impacts of barrier effects, and the sensitivity of marine mammals to barrier effects in this assessment. Studies on tidal turbines are included to provide an insight into the implications of dynamic structures on marine mammal behaviour.

#### Sensitivity of receptor

- 11.10.5.4 A study by Palmer *et al.* (2021) using PAM, found significant avoidance of harbour porpoises to operational tidal turbines. The study demonstrated that harbour porpoises were able to detect and avoid turbines, with avoidance behaviour increasing with the number of tidal turbines. However, while operational tidal turbines did lead to a significant reduction in harbour porpoise presence, both harbour porpoise and dolphin species were still detected in the vicinity suggesting these species were not avoiding the area entirely. Sparling *et al.*

(2017) observed the movements of harbour seals around a single operational tidal turbine in Strangford Narrows, Northern Ireland. They found that while there was some degree of avoidance of the turbine, it did not prevent transit of the seals through the channel and therefore did not result in a barrier effect.

- 11.10.5.5 Studies of marine mammal activity around fixed marine infrastructures, such as fixed foundation offshore wind farms, reported regular sightings and acoustic detections of dolphins, porpoises and pinnipeds (Scheidat *et al.*, 2011; Todd *et al.*, 2016; Vallejo *et al.*, 2017; Clausen *et al.*, 2021; Russell *et al.*, 2016). This suggests that barrier effects are not an issue for these marine mammal species, with both Russell *et al.* (2016) and Vallejo *et al.* (2017) observing no displacement of harbour seals and harbour porpoise during the operation of several offshore wind farms within the UK.
- 11.10.5.6 Therefore, with regards to the Project, a barrier effect is not expected for all individuals within these species. Instead, the effect may comprise localised avoidance behaviour by some individuals, with others still transiting through the Project area.
- 11.10.5.7 Barrier effects may have a greater impact on migratory species, such as humpback whales and minke whales. While there are currently very limited data available as to how anthropogenic infrastructures may alter migration routes, an increase in the total distance of a migratory route due to displacement resulting from the presence of marine infrastructure may increase energetic costs (Braithwaite *et al.*, 2015). This, in turn, has been found to have negative implications on survival, reproduction and calf growth. As the annual movements and migration patterns of both humpback whales and minke whales in the UK is not yet fully understood, it is difficult to predict if or how the Project could cause these baleen whales to deviate from their optimum migration routes.
- 11.10.5.8 Displacement of marine mammal species due to offshore wind farm structures may also occur as a result of habitat loss or change. Habitat loss due to the physical presence of marine infrastructure will primarily impact benthic habitats (Wawryznkowski *et al.*, 2025; Horwath *et al.*, 2020) However, this loss can extend to pelagic habitat loss which is expected to have some impacts on marine mammals. Direct effects i.e. loss of marine mammal pelagic habitat is predicted to be negligible when compared to the spatial extent over which marine mammals move. Indirect effects from habitat loss can also through the loss or changes in the availability of prey species and as such, foraging opportunities. Nevertheless, these impacts are likely to be relatively small and result in minimal impacts to these receptor species. Marine mammal receptor sensitivity to changes in prey availability is described in detail in **Section 11.9.5**, and assessed separately for the O&M stage as a whole in **Section 11.10.8**.
- 11.10.5.9 Based on the above, all marine mammal receptors are considered to have reasonable ability to avoid the impact (i.e. not all individuals will experience a barrier effect). Should a marine mammal avoid the area (i.e. show a barrier effect), it is expected that they will have reasonable adaptability and tolerance to the effect, making use of the surrounding areas. The source of the barrier effect will be present on a long-term basis (i.e. the O&M stage of up to 35 years for each Project phase. No marine mammal species is expected to be sensitive to the scale of the habitat change in the context of their or their prey's distribution. Taking these factors into account, the overall sensitivity of the marine mammal receptors to long term displacement / habitat change / barrier effects due to offshore wind farm structures is considered to be **low**.

## Magnitude of impact

- 11.10.5.10 Marine mammal species such as harbour porpoise, grey seal and harbour seals have been observed in and around operational offshore wind farms (Hastie *et al.*, 2016; Fernandez-Betelu *et al.*, 2024; Iorio-Merlo *et al.*, 2023). However, whilst minke whales have been recorded near offshore oil and gas infrastructure in the central North Sea (Delefosse *et al.*, 2018), it is still unclear whether baleen whales can effectively navigate turbine arrays, or floating offshore wind farms where mooring lines and cables extend throughout the water column. If a barrier effect was to occur to whale species, then the spatial extent is anticipated to be limited to the spatial extent of the OAA of 684km<sup>2</sup>. The duration of the impact source would be equivalent to the duration of the 35 O&M stage for each Project phase. However, due to the migratory nature of whale species, their exposure to the potential barrier effect would be limited to their seasonal presence in the Project area.
- 11.10.5.11 Long-term monitoring of operational wind farms including the UK (for example, Beatrice Offshore Wind Farm in the Moray Firth), Denmark (for example, Horns Rev Offshore Wind Farm) and the Netherlands (for example, Nysted and Egmond aan Zee) has shown that harbour porpoise and seals continue to use these areas, with some studies even reporting increased harbour porpoise activity within the arrays (Scheidat *et al.*, 2011). Movement data from tagged seals have shown they often travel between turbines in a grid-like pattern, indicating foraging behaviour (Russell *et al.*, 2014). Multiple reviews have concluded that operational windfarms do not present a significant barrier to movement (Madsen *et al.*, 2006; Teilmann *et al.*, 2006; Brasseur *et al.*, 2012; Wawrzynkowski *et al.*, 2025).
- 11.10.5.12 The introduction of man-made structures, such as midwater and surface structures used in floating offshore wind farms, can create new habitats in a phenomenon often referred to as the 'reef effect' and may act as artificial reef structures, and in turn, fish aggregation devices (Wawrzynkowski *et al.*, 2025; Karlsson *et al.*, 2022; Bergström *et al.*, 2014; Degraer *et al.*, 2020; Clausen *et al.*, 2021). These habitats enhance habitat complexity, increasing diversity and abundance. In turn, this may have a positive impact on marine mammals through the attraction of prey species. Furthermore, the area surrounding the OAA does not represent unique or ecologically critical habitat for any of the marine mammal species assessed. The habitat types are characteristic of the wider regional marine environment and are not limited in their distribution to the vicinity of the development. As such, the environmental conditions and prey resources available within the OAA are expected to be replicated across broader areas within the relevant MUs for each species.
- 11.10.5.13 Given the known ability of certain marine mammal species to navigate around offshore anthropogenic structures, the possibility of long term displacement / habitat change / barrier effects due to the Project is not expected to adversely affect harbour porpoise, dolphin species or seal species. Accordingly, the long-term displacement / habitat change / barrier effects magnitude for these species is assessed as **low**. However, due to the uncertainties around the responses of baleen whales to floating offshore wind farms, a **medium** magnitude of impact is assigned for minke whales and humpback whales.

## Significance of residual effect

- 11.10.5.14 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.50**.
- 11.10.5.15 The magnitude of impact of disturbance from long term displacement / habitat change / barrier effects is deemed to be **low** for harbour porpoise, dolphin and seal species and **medium** for baleen whales. The sensitivity of all receptors is **low**. The effect of long-term displacement / habitat change / barrier effects due to offshore wind farm structures will, therefore, be of **Negligible (Not Significant)** in EIA terms for harbour porpoise, dolphin and seal species and **Minor (Not Significant)** in EIA terms for baleen whales.

**Table 11.51 Significance of O4: Long term displacement / habitat change / barrier effects due to offshore wind farm structures**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Medium	Low	Minor (Not Significant).
Humpback whale	Medium	Low	Minor (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

### 11.10.6 Impact O5: Entanglement in lines and cables for example mooring lines and array cables

#### Overview

11.10.6.1 Floating offshore wind farms and other marine renewable energy devices are held in place and attached to the seabed by mooring lines and anchors to ensure they maintain a fixed position on or within the water column (Garavelli, 2020, Copping *et al.*, 2020). Furthermore, the array cables (also known as dynamic cables) for floating offshore wind have floating components that allow them to move with the tidal current and floating turbine (Taninoki *et al.*, 2017). Moorings and dynamic cables associated with the operation of floating wind turbines have the potential to entangle marine mammals within the Project. Primary entanglement is unlikely due to the large diameter and weight of mooring lines which prevents them from looping and entangling marine life (Maxwell *et al.*, 2022). However, secondary entanglement has the potential to cause risk to marine mammals whereby they are by-caught in drift nets and/or lost or discarded fishing gear snagged on moorings and dynamic cables (Benjamins *et al.*, 2014). Derelict fishing gear and nets wrapped around the offshore wind structures could potentially increase spatial impact ranges (considering derelict nets could be tens of metres in width) and impact a variety of species, including marine mammals, leading to a localised higher by-catch risk.

- 11.10.6.2 The entanglement risk of marine mammals with marine renewable energy devices depends on the physical parameters of the mooring systems and array cables (Harnois *et al.*, 2015, Copping *et al.*, 2020). Taut mooring lines are likely to have the lowest relative risk of entanglement, with higher risk being catenary moorings due to greater tension in the mooring line (Harnois *et al.*, 2015).
- 11.10.6.3 The Project comprises a maximum of 1,800 mooring lines across all WTGs, comprising up to eight mooring lines per turbine. Mooring line layouts may include catenary, semi-taut, or taut designs, with chain, synthetic rope, and buoyancy elements, or clump weights, depending on the configuration. The maximum mooring line footprint is approximately 2.011km<sup>2</sup>, with an individual mooring line radius of up to 800m. Additionally, array cables will be installed, with approximately 20% (136km) potentially unburied and exposed on the seabed.

### Sensitivity of receptor

- 11.10.6.4 Marine mammals can suffer from injury, and in some cases, mortality as a result of entanglement (Northridge *et al.*, 2010; Cassoff *et al.*, 2011; Benjamins *et al.*, 2014; Ryan *et al.*, 2016; MacLennan *et al.*, 2021). If the entanglement event is not lethal, the sub-lethal effects can threaten survival and negatively impact energy consumption. The resulting physiological stress and disturbance may also reduce reproductive success, potentially leading to long-term population declines and serious conservation concerns (Musick, 1997; van der Hoop *et al.*, 2017).
- 11.10.6.5 Baleen whales (such as minke whale and humpback whale) are particularly susceptible to entanglement due to their large size and feeding behaviours (Northridge *et al.*, 2010; Cassoff *et al.*, 2011; Benjamins *et al.*, 2014; Ryan *et al.*, 2016; Basran *et al.*, 2019; MacLennan *et al.*, 2021; Robinson *et al.*, 2023). However, evidence has found that harbour porpoise, dolphin species and seal species are also susceptible to entanglement, indicating that all marine mammal species face some level of risk (Allen *et al.*, 2012; Benjamins *et al.*, 2014).
- 11.10.6.6 There is currently a lack of information on the frequency of occurrence of entanglement as a source of marine mammal mortality. Furthermore, even less is known about the occurrence of marine mammals becoming entangled in moorings or cables of any kind, including secondary entanglement, with the majority of recorded cases being entanglement in fishing gear only (Benjamins *et al.*, 2014).
- 11.10.6.7 In 2020, three minke whale strandings were investigated and attributed to entanglement, while two grey seals were reported as entangled or as having lesions suggestive of previous entanglement (SMASS, 2021). In 2021, a total of eight entanglement cases were recorded, including two indeterminate baleen species, two humpback whales, one minke whale and two Risso's dolphins (SMASS, 2022). Six cases of entanglement were reported within the 2022 SMASS report, comprising four minke whales and two grey seals (SMASS, 2023). The most recent SMASS report for 2023 had an increase in reported entanglement cases, with 15 cetacean cases and two seal cases (Brownlow *et al.*, 2024). Cases included one harbour porpoise, two humpback whales, eight minke whales, two Risso's dolphins, one harbour seal, one grey seal and two undetermined dolphin species. To note, the SMASS reports do not differentiate between entanglement in active fishing gear (bycatch) and entanglement by other causes such as in rope or discarded fishing gear/marine litter.
- 11.10.6.8 According to the most recent CSIP report, one incident on marine debris entanglement was recorded in 2022 (CSIP, 2023). However, the species was identified as a Sowerby's beaked whale, which is not included within this assessment. No incidents of marine debris entanglement were reported on 2021 (CSIP, 2022). Between 2018 and 2020, one incident of marine debris entanglement was recorded per year. Minke whales were recorded in two

of the cases, while the other was identified as a Sowerby's beaked whale (CSIP, 2019; 2020; 2021).

- 11.10.6.9 While there is evidence that mortality from entanglement can and does occur, it is not considered to be a key source of mortality in marine mammals highlighted from post-mortem examinations. However, strandings data are limited to those carcasses that wash ashore for collection, and not all carcasses are examined, therefore the level of entanglement occurrence in the strandings data may not be representative of the true scale of the impact. Despite a low reported number of strandings due to entanglement across Scotland each year (SMASS Reports 2005-2019 as cited by MacLennan *et al.*, 2021; Davison and ten Doeschate, 2021; SMASS, 2022; 2023), entanglement is now the largest identified cause of anthropogenic mortality in baleen whales in Scottish waters (Davison *et al.*, 2020), with minke whales and humpback whales being the cetacean species most reported entangled since 1992. Based on the above and given the fact that entanglement can potentially result in death, and has been recorded for most marine mammal species in the baseline, the sensitivity of all marine mammal receptors to entanglement is considered to be **high**.

### Magnitude of impact

- 11.10.6.10 A study conducted by Benjamins *et al.* (2014) on the relative risk assessment of entanglement from offshore wind developments found that the likelihood of an encounter between marine animals and marine renewable energy mooring systems and subsea cables is dependent on the animal's size and behaviour. It concluded that entanglement with moorings and dynamic cables associated with offshore wind is estimated to be a low risk to cetaceans and pinnipeds, with baleen whales considered to be at greater risk due to their migratory patterns, size and feeding behaviours.
- 11.10.6.11 Most research focuses on injury and mortality caused by entanglement with fishing gear or submarine telecommunications cables, which contrary to marine renewable energy mooring lines and cables, have a loose end or loop that could entangle an animal (Copping *et al.*, 2020). The main risk is likely to be animal entanglement in derelict fishing gear (secondary entanglement) which becomes attached to marine renewable energy moorings and poses an entanglement risk for a wide range of species (Benjamins *et al.*, 2014; Garavelli, 2020).
- 11.10.6.12 In addition to mooring configurations, entanglement risks associated with offshore wind development also vary substantially based on factors such as WTG spacing, array layout and diameters of mooring lines and/or dynamic cables (FERC, 2010; Benjamins *et al.*, 2014; Harnois *et al.*, 2015). Regardless of the mooring line designs, any mooring or dynamic cable structures for the Project are unlikely to have any loops that could entangle marine mammals.
- 11.10.6.13 Little is known about the distribution and abundance of derelict fishing gear in Scottish waters, and the likelihood or extent of it being snagged and retained in mooring or cabling associated with offshore wind development. Therefore, the relative risk and likelihood of secondary entanglement of marine mammals under such conditions is largely unknown. Given the slow rate at which the snagged fishing gear (for example, nets and lines) might decay, the secondary impact could be substantial, although further studies are required to quantify the level of risk.
- 11.10.6.14 The diameter of mooring lines is not yet known but the risk of entanglement is considered low as they are of a large enough diameter to preclude entanglement and marine mammals are likely to be able to detect them either through vibration detected through vibrissae (pinnipeds) or acoustic detection (*i.e.*, echolocation; Maxwell *et al.* 2022, Benjamins *et al.* 2014). This further contributes to the assertion that primary entanglement, between the mooring lines and the animals directly, is highly unlikely.

- 11.10.6.15 The area over which there may be an increased entanglement risk will have a localised spatial extent (within the Project OAA only). The risk will be present for a moderate duration (for example, 43 years across three phases with operational lifespans of 35 years in each stage). If entanglement does occur, it is more likely to be from secondary than primary entanglement. Knowledge of the scale of entanglement is unknown, however it is considered likely that it would only affect a very small proportion of the population, and is not likely to affect the population trajectory.
- 11.10.6.16 The magnitude of primary entanglement to marine mammals is considered during the O&M stage of the Project is assessed as **negligible** when considering the mooring configuration resulting in the maximum design scenario.
- 11.10.6.17 The magnitude of secondary entanglement to marine mammals is considered during the O&M stage of the Project is assessed as **low** when considering the mooring configuration resulting in the maximum design scenario.

### Significance of residual effect

- 11.10.6.18 For primary entanglement, a summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.52**.
- 11.10.6.19 The magnitude of impact of primary entanglement is deemed to be **negligible**, with the sensitivity of all receptors being **high**. The effect of primary entanglement in lines and cable will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.52 Significance of O5: Primary entanglement in lines and cables for example mooring lines and array cables**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	High	Negligible (Not Significant).
Bottlenose dolphin	Negligible	High	Negligible (Not Significant).
Risso's dolphin	Negligible	High	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	High	Negligible (Not Significant).
White-beaked dolphin	Negligible	High	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	High	Negligible (Not Significant).
Minke whale	Negligible	High	Negligible (Not Significant).
Humpback whale	Negligible	High	Negligible (Not Significant).
Harbour seal	Negligible	High	Negligible (Not Significant).
Grey seal	Negligible	High	Negligible (Not Significant).

- 11.10.6.20 For secondary entanglement, a summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.53**.
- 11.10.6.21 The magnitude of impact of secondary entanglement is deemed to be **low** and the sensitivity of all receptors is **high**. The effect of secondary entanglement in lines and cable will, therefore, be of **Minor (Not Significant)** in EIA terms.

**Table 11.53 Significance of O5: Secondary entanglement in lines and cables for example mooring lines and array cables**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	High	Minor (Not Significant).
Bottlenose dolphin	Low	High	Minor (Not Significant).
Risso’s dolphin	Low	High	Minor (Not Significant).
Atlantic white-sided dolphin	Low	High	Minor (Not Significant)
White-beaked dolphin	Low	High	Minor (Not Significant).
Short-beaked common dolphin	Low	High	Minor (Not Significant).
Minke whale	Low	High	Minor (Not Significant).
Humpback whale	Low	High	Minor (Not Significant).
Harbour seal	Low	High	Minor (Not Significant).
Grey seal	Low	High	Minor (Not Significant).

### 11.10.7 Impact O6: Increased underwater noise for example operational noise and mooring noise

#### Overview

- 11.10.7.1 Operational noise from floating WTGs is primarily generated by mechanical vibrations transmitted through the tower and radiated from submerged components. Due to the smaller submerged radiating area compared to fixed foundations, floating WTGs are expected to produce lower underwater noise levels and a smaller extent of potential impact (Tougaard *et al.*, 2020; Risch *et al.*, 2023). In response to NatureScot’s request on 19<sup>th</sup> of January 2024, this Section includes a literature review on the underwater noise produced by mooring lines associated with floating offshore wind farms. This addresses the data gap that was identified at the time of scoping, due to floating offshore wind farms being a novel concept at the time.

- 11.10.7.2 In addition to turbine-generated noise, floating offshore wind farms may produce underwater noise from mooring and cable systems. Observations from the Hywind demonstrator project (Martin *et al.*, 2011) and Hywind Scotland (Burns *et al.*, 2022) identified occasional transient noises such as “snaps,” “rattles,” and “creaks,” associated with strain and friction in mooring lines. These sounds were short-lived (typically <1 second), non-impulsive, and occurred infrequently, at less than once per hour on average. The source levels of these noises are typically low.
- 11.10.7.3 Importantly, the mooring systems used in floating wind farms are designed to remain under constant tension, minimising slack-line movement and reducing the risk of impulsive noise generation (Statoil, 2015). The findings from Hywind Scotland suggest that such transient noises are not a consistent feature and may be site-specific, depending on mooring design, water depth, and environmental conditions (Burns *et al.*, 2022).
- 11.10.7.4 It is expected that the underwater noise due to operational floating turbines and mooring and cable systems are below the PTS-onset ranges for marine mammals, based on Southall *et al.* (2019). As such this Section focuses on the risk of disturbance to marine mammals. Further detail on underwater noise during the operational stage can be found within **Volume 3, Appendix 8.1**.

### Sensitivity of receptor

- 11.10.7.5 Risch *et al.* (2023) showed that operational noise of floating WTGs was primarily concentrated below 200Hz. This LF noise is outside of the peak sensitivity ranges of harbour porpoise (VHF cetaceans), dolphin (HF cetaceans) and seal species (PCW; Southall *et al.*, 2019), with hearing sensitivity of these receptors being relatively poor below 1kHz (Southall *et al.*, 2007). It is expected that marine mammals will be less sensitive to noise at these frequencies, hence they are less likely to cause disturbance and would result in little impact to behavioural changes or vital rates. In addition, turbine noise is thought to have no significant masking effects on harbour porpoise, with any potential masking being limited to a very small range (Lucke *et al.*, 2007). This is likely to be similar for dolphin species. There is an overlap between the frequency range of this operational noise and the vocalisations of seal species; however, seal vocalisations are more broadband, and therefore the effect of masking is expected to be minor (Madsen *et al.*, 2006).
- 11.10.7.6 Risch *et al.* (2023) observed some disturbance in harbour porpoise at the two studied locations (Kincardine and Hywind Scotland) surrounding a floating offshore wind farm. The recording sites nearest to the turbine (600m and 300m, respectively) detected fewer harbour porpoise vocalisations compared to the site further away (1,500m and 2,400m, respectively). This potentially indicates displacement or reduced vocalisations as a result of the operational turbines.
- 11.10.7.7 As floating technology concepts for offshore wind farms are relatively novel, limited information is currently available on the noise-related impacts associated with turbines based on floating units. The findings presented by Risch *et al.* (2023) suggest that the operational noise produced by floating offshore wind farms is similar to that from fixed offshore wind farms. Therefore, operational noise from turbines with fixed foundations can be used as a proxy within this assessment.
- 11.10.7.8 Studies on fixed foundation offshore wind farms have observed that odontocetes and seal species are likely to show initial avoidance to the offshore wind farm area, followed by habituation of the operational noise and possibly attraction to offshore wind farms as feeding grounds (Vella *et al.*, 2001). For example, long-term monitoring at the Horns Rev and Nysted offshore wind farms in Denmark showed that both harbour porpoise and harbour seals were sighted regularly within the operational offshore wind farm, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.*, 2008). This supports the prediction made by Risch *et al.* (2023) that

occurrence patterns of harbour porpoise may change as the Kincardine and Hywind Scotland floating offshore wind farms mature.

- 11.10.7.9 The LF noise produced by operational offshore wind farms is more likely to overlap with the hearing range of LF cetaceans such as minke whales and humpback whales. While knowledge about the hearing range of baleen whales is not fully understood, it is assumed that the hearing frequency ranges of cetaceans are similar to the sounds they produce. Communication signals between minke whales have been found to be below 2kHz (Edds-Walton, 2000; Mellinger *et al.*, 2000; Gedamke *et al.*, 2001; Risch *et al.*, 2013; 2014). Tubelli *et al.* (2012) estimated the hearing frequency range in minke whales to be approximately between 30Hz and 7.5kHz or between 100Hz and 25kHz depending on the stimulation location. The estimated hearing frequency range in humpback whales has been estimated as approximately between 15Hz and 3kHz or between 200Hz and 9kHz depending on simulation location (Tubelli *et al.*, 2018).
- 11.10.7.10 There are a limited number of studies on disturbance of LF cetaceans (for example, minke whales) as a result of LF noise (for example, wind turbine operational noise). A modelling study by Thomsen *et al.* (2023) assessed TTS on LF cetaceans over a 24-hour period from a 10MW and 20MW turbine. Although this study did not address disturbance, the likelihood of cumulative TTS was considered negligible for the 10MW turbine, and for the 20MW turbine impact ranges extended up to approximately 700m for LF cetaceans. Therefore, for cumulative TTS onset to occur, the individual would have to be within 700m of the turbine for 24-hours, which is unlikely as the minke whale is a highly mobile species. Although behavioural disturbance is likely to occur at distances greater than TTS onset, individual variation in behavioural responses to underwater noise is expected to occur. Individual variation in behavioural responses is likely attributed to a host of contextual factors such as behavioural and reproductive state of the receptor, as discussed by Ellison *et al.* (2012) and Southall *et al.* (2019), and is better reflected in the threshold parameters updated by Southall *et al.* (2021).
- 11.10.7.11 Due to the overlap of hearing frequency between baleen whales and operational noise, there may be a potential for masking effects. However, the effects of underwater noise from operational offshore wind farms are very small relative to other anthropogenic and natural noise sources within the environment, and there is little evidence to suggest significant impacts on baleen whales (Madsen *et al.*, 2006).
- 11.10.7.12 Based on the above, harbour porpoises, dolphin and seal species are as unlikely to experience disturbance effects as a result of operational noise and mooring noise, given their lack of sensitivity to the frequencies emitted. The potential area over which the effect could occur would be limited to the immediate area around the WTGs or moorings, though this infrastructure will be present for the operational lifetime of the Project. These species are considered to be of high adaptability, tolerance, and recoverability to any potential effect. Taking these factors into account, the overall sensitivity of these marine mammal receptors to increased underwater noise during operation is considered to be **negligible**.
- 11.10.7.13 Minke whales and humpback whales have greater sensitivity to LF noise such as that produced by operational noise and mooring noise. Hence they are assessed as having reasonable adaptability and tolerance, and have high recoverability from any potential effect. Taking these factors into account, the overall sensitivity of these marine mammal receptors to increased underwater noise during operation is considered to be **low**.

## Magnitude of impact

### Floating wind turbine generators

- 11.10.7.14 Empirical data on operational noise from floating WTGs remain limited. A study by Risch *et al.* (2023) compared the operational noise produced by two floating offshore wind farms in Scottish waters, Kincardine and Hywind Scotland. Data were collected at Kincardine floating wind farm from November 2021 to January 2022 based on five 9.5MW WTGs, geared, semi-submersible foundations. Additionally, data were collected at the Hywind Scotland Offshore Wind Farm from May to June 2022, based on six 6MW WTGs, direct-drive, spar-buoy foundations. At both wind farms, F-POD autonomous echolocation click detectors were used to monitor the presence of harbour porpoise.
- 11.10.7.15 Source levels for both operational turbines increased with wind speeds. At a wind speed of 15m/s, operational noise levels were about 3dB higher at Kincardine (148.8dB re 1 $\mu$ Pa) compared to Hywind Scotland (145.4dB re 1  $\mu$ Pa), potentially due to differences in power, technologies (gearbox vs. direct drive), and mooring structures. At this wind speed, turbine noise was predicted to exceed North Sea ambient noise levels up to 4km at Kincardine and up to 3.7km at Hywind Scotland. Both wind farms emitted continuous noise below 200Hz. Median one-third octave band levels below 200Hz ranged between 95 and 100dB re 1 $\mu$ Pa at approximately 600m from the nearest turbine, comparable to levels from fixed offshore wind turbines at similar distances (Tougaard *et al.*, 2020, Stöber and Thomsen, 2021, Risch *et al.*, 2023).
- 11.10.7.16 Due to the location of the Project in the North Sea, it is expected that the ambient noise levels are comparable to those assessed in which underwater noise generation was assessed as part of the Kincardine and Hywind projects, which utilised a 100dB contour to approximate median ambient noise levels (Risch *et al.*, 2023). A study by Merchant *et al.* (2016) measured underwater ambient noise levels in different locations in the North Sea with values ranging from 80 to 120dB re 1 $\mu$ Pa, while Robinson *et al.* (2022) reporting 100 – 110dB re 1 $\mu$ Pa in the Moray Firth.
- 11.10.7.17 To account for the larger floating WTGs for the Project (14-25MW), extrapolated estimates using the Tougaard *et al.* (2020) calculator suggest operational noise levels of 131–134dB re 1 $\mu$ Pa (SPL<sub>peak</sub>) at 150m (see **Volume 3, Appendix 8.1** for full details).

### Mooring and cable lines

- 11.10.7.18 Floating offshore wind farms are kept in position by mooring lines designed to remain under continuous tension. However, these lines must also tolerate motion caused by tide and waves, which can introduce temporary slack. When the slack is suddenly taken up again, typically during strong surface movements, sharp impulsive noises may occur. The sound energy generated via the rapid reapplication of tension in mooring lines is commonly referred to as ‘cable snapping’ (Liu, 1973).
- 11.10.7.19 Research on operational floating offshore wind farms, Kincardine and Hywind Scotland, found no clear evidence of intensive, impulsive ‘snapping’ noises (Burns *et al.*, 2022; Risch *et al.*, 2023), which were identified previously in the Hywind DEMO prototype mooring system (Martin *et al.*, 2011). Instead, acoustic data from Hywind Scotland floating offshore wind farm revealed significant amounts of transient mooring noise. This acoustic environment was characterised by brief, non-impulsive transient noises, including sounds described as “rattles,” “bangs,” and “creaks” (Burns *et al.*, 2022). These momentary events typically lasted about one second and had a frequency range from 10-48kHz but were often produced in sequences lasting for several minutes (Risch *et al.*, 2023). Transient noise levels appeared to be positively correlated with both wave height and wind speed, suggesting that stronger winds and larger waves both influence the dynamic response of

the mooring system, thus increasing the resultant noise produced (Burns *et al.*, 2022; Risch *et al.*, 2023). WTG floating unit type also appeared to influence the occurrence of transient noise, with noise being generally higher at semi-submersible platforms compared to spar-buoy platforms.

### Combined noise of devices and mooring lines

- 11.10.7.20 Burns *et al.* (2022) used back-propagation of statistically derived received levels to calculate the source levels for a single system, which combines both turbine and mooring transient noise. Calculations found that levels ranged from 156.7dB re 1  $\mu\text{Pa}^2\text{m}^2$  (5<sup>th</sup> percentile) in 10kn wind speeds to 172.0dB re 1  $\mu\text{Pa}^2\text{m}^2$  (95<sup>th</sup> percentile) in 25kn of wind.
- 11.10.7.21 Following guidance from NMFS (2018), Burns *et al.* (2022) applied non-impulsive noise thresholds when evaluating the potential for TTS-onset. Using these thresholds, they were able to determine potential effect ranges for various auditory groups. The greatest level of impact was found for VHF species (harbour porpoise), where TTS-onset threshold would be reached if an individual remained within 50m of the turbine during for a full 24-hour period assuming 15kn wind speeds. Risch *et al.* (2023) further determined these transient sounds could not be considered as impulsive, and thus the appropriate threshold for marine mammals would be non-impulsive frequency weighted noise threshold values in order to determine auditory impact risk.

### Summary of magnitude

- 11.10.7.22 During the operational stage of the Project, the impact of noise associated with floating foundations are expected to be confined to the OAA. The spatial reach of the impact is limited, and it is unlikely to cause widespread avoidance behaviour among marine mammals. As a result, any disturbance would likely involve only a small proportion of the local population, with no anticipated consequences for overall population trends or long-term viability. This corresponds to a **low** magnitude of impact. However, while the area affected remains small, the possibility of the noise to be regular and persistent means that marine mammals could experience intermittent disturbance throughout the operational lifespan of the wind farm, which is estimated to be up to 35 years for each of the Project's phases. Taking into account the extended duration and recurring nature of the sound exposure, a precautionary approach has been adopted. Consequently, the overall magnitude of impact has been assessed as **medium**, to reflect these longer-term considerations.

### Significance of residual effect

- 11.10.7.23 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.54**.
- 11.10.7.24 The magnitude of impact of increased underwater noise for example operational noise and mooring noise is deemed to be **medium**. The sensitivity is **negligible** for harbour porpoises, dolphin and seal species and **low** for minke and humpback whales. The effect of increased underwater noise during the O&M phase from sources such as operational noise and mooring noise will, therefore, be of **Negligible (Not Significant)** to **Minor (Not Significant)** in EIA terms.

**Table 11.54 Significance of O6: Disturbance from increased underwater noise for example operational noise and mooring noise**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Medium	Negligible	Negligible (Not Significant).
Bottlenose dolphin	Medium	Negligible	Negligible (Not Significant).
Risso's dolphin	Medium	Negligible	Negligible (Not Significant).
Atlantic white-sided dolphin	Medium	Negligible	Negligible (Not Significant).
White-beaked dolphin	Medium	Negligible	Negligible (Not Significant).
Short-beaked common dolphin	Medium	Negligible	Negligible (Not Significant).
Minke whale	Medium	Low	Minor (Not Significant).
Humpback whale	Medium	Low	Minor (Not Significant).
Harbour seal	Medium	Negligible	Negligible (Not Significant).
Grey seal	Medium	Negligible	Negligible (Not Significant).

### 11.10.8 Impact O7: Indirect impacts on marine mammals via changes in prey availability

#### Overview

- 11.10.8.1 Marine mammals are dependent on prey for survival. As a result, there is the potential for indirect effects on marine mammals to occur as a result of impacts on their prey species or the habitats that support them. The key prey species for the receptors within this assessment are presented in **Table 11.28**.
- 11.10.8.2 Potential pressures on prey species during the O&M stage have been assessed in detail within the EIA Report, specifically in **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** and **Chapter 13: Fish Ecology**. Relevant impacts include:
- habitat disturbance and loss, both temporary and long-term, due to the presence of infrastructure such as offshore substations, scour protection, and cable protection;
  - changes to sediment dynamics, including increases in SSC, deposition, and the release of sediment-bound contaminants from seabed disturbance;
  - alteration of benthic habitats, through colonisation of hard substrates and potential introduction or spread of marine INNS;

- underwater noise, vibration, and particle motion, which may cause behavioural changes or displacement in fish and shellfish prey species;
- EMF and heat emissions from array and export cables, which may influence sensitive species; and
- changes in water quality and potential contamination, as well as indirect effects from reduced fishing activity within the Project OAA; and collision or entanglement risk, particularly for larger or less mobile prey species.

11.10.8.3 The severity and likelihood of these pressures vary depending on species mobility, life stage, and behavioural state at the time of exposure. These factors influence the ability of prey species to avoid or recover from disturbance and are considered in the EIA Report's impact evaluations. Most effects are expected to be temporary and spatially limited, with no predicted population-level consequences on prey species relevant to marine mammal receptors.

### Sensitivity of receptor

11.10.8.4 Marine mammal receptors sensitivity to changes in prey availability is described in **Section 11.9.5**. The sensitivity of the receptors is **low**.

### Magnitude of impact

11.10.8.5 As described in **Section 11.10.5**, the presence of the offshore wind farm array infrastructure as well as the occurrence of O&M activities have the potential to lead to habitat changes and associated changes in prey availability for marine mammals.

11.10.8.6 **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** of the EIA Report has concluded that there will be no likely significant effects arising on the benthic, epibenthic and intertidal species, which includes some prey species of marine mammals, during the O&M stage. For each of the above impacts assessed within **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**, the magnitude of impact was assessed as negligible to medium (depending on the impact), and the sensitivity of the receptor was assessed as very low to medium (depending on the impact). As such, the significance of all impacts were assessed as negligible to minor, which is not significant in EIA terms.

11.10.8.7 **Chapter 13: Fish Ecology** of the EIA Report has concluded that there will be no likely significant effects arising on the fish species, which includes some prey species of marine mammals, during the O&M stage. For each of the above impacts assessed within **Chapter 13: Fish Ecology**, the magnitude of impact was assessed as negligible to low (depending on the impact and receptor), and the sensitivity of all receptors were assessed as negligible to high (depending on the impact and receptor). As such, the significance of all impacts were assessed as negligible to minor, which is not significant in EIA terms.

11.10.8.8 The impact to all marine mammal receptors from changes to prey species is considered as unlikely to occur as there is expected to be no significant impacts on fish species. Given the absence of significant impacts on fish species, and the high likelihood that any effects on prey availability would lead to only minimal or imperceptible changes for marine mammal receptors, the potential magnitude of indirect impacts on marine mammal prey is assessed as **negligible**.

### Significance of residual effect

11.10.8.9 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.55**.

11.10.8.10 The magnitude of indirect impacts on marine mammals via changes in prey availability. is deemed to be **negligible** and the sensitivity of all receptors is **low**. The effect of disturbance from increased vessel presence and traffic will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.55 Significance of O7: Indirect impacts on marine mammals via changes in prey availability**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant)
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Negligible	Low	Negligible (Not Significant)
Humpback whale	Negligible	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

## 11.11 Assessment of effects: Decommissioning stage

### 11.11.1 Introduction

11.11.1.1 The approach to decommissioning of the offshore infrastructure will be completed in line with relevant guidance and legislation at the time of decommissioning. A Decommissioning Programme will be developed post consent but prior to construction. It is however expected that all infrastructure above the seabed will be removed. Any infrastructure below the seabed will be assessed to determine if it is less impactful to remove or leave in position.

11.11.1.2 Decommissioning activities will be largely a reversal of the construction process, involving the decommissioning and removal of the WTGs, floating units, array cables, offshore substations, RCP and export cables. In the absence of detailed information regarding decommissioning works, the impacts during the decommissioning of the offshore Project are considered analogous with, or likely less than, those of the construction stage (including

pre-construction). Therefore, the worst case parameters defined during the construction stage (including pre-construction) also apply to the decommissioning stage.

### 11.11.2 Impact D1: Auditory injury from increased underwater noise

#### Overview

- 11.11.2.1 While the specific activities that will be employed during decommissioning are not yet known, it is anticipated that the increase in underwater noise will be similar to or less than during construction, due to activities largely being a reversal of the installation process. It is not yet determined if infrastructure will be left in-situ or removed entirely. The approach will be reviewed throughout the lifetime of the Project, and good practice guidance at time of decommissioning will be followed.
- 11.11.2.2 This Section considers the worst case scenario to include the entire removal of the infrastructure, including the array cables, WTG mooring driven pile anchor, and foundations for offshore substations and RCP, as these activities will produce the greatest scenario of noise emission.
- 11.11.2.3 The sequence for removal of the cables is anticipated to be:
- To retrieve the cable, a grapnel or similar will be used to locate and lift it from either the water column or the seabed. If needed, an ROV may be deployed to cut the cable or attach a lifting device to enable safe retrieval to the vessel.
  - If necessary, seabed material will be cleared to access static cables on the seabed, typically using a water jetting tool.
  - For dynamic cable removal, the buoyancy modules will be detached as the cable is brought up onto the deck.
  - The recovery vessel will then move along the cable route while winching the cable onto a carousel or reel.
- 11.11.2.4 The sequence for removal of driven pile anchor or driven piles for offshore substations or RCP is anticipated to be:
- A heavy lift vessel would remove the topside before work to decommission the foundation could commence.
  - Driven piles will be cut at seabed level and left in situ, depending on seabed mobility, to minimise further disruption of the seabed. To cut the driven piles, decommissioning engineers typically use either diamond wire cutting or water jetting.
- 11.11.2.5 As piling will not be included in decommissioning, this impact is not considered for this stage. These decommissioning activities are similar to those included in **Section 11.9.4**.

#### Sensitivity of receptor

- 11.11.2.6 The effects of auditory injury from underwater noise on marine mammals during decommissioning is considered to be the same or less than those described for the construction stage. The conservative approach assumes that the sensitivity of marine mammal receptors to auditory injury from increased underwater noise during decommissioning is the same as the sensitivity during other construction activities, as described in **Section 11.9.4**.
- 11.11.2.7 The removal of driven piles from the seabed requires either diamond wire cutting or water jetting. Whilst these methods have been used for offshore decommissioning around the

world, measurement data of the underwater sound generated by these methods are limited (Pangerc *et al.*, 2016). However, manufacturer and technical specifications commonly describe them as having 'low-noise' emissions (Knecht, 2010; Robore Cuts, 2016 as referenced in Pangerc *et al.*, 2016) and being a technique that is generally considered safe for the environment (Twachtman *et al.*, 2004).

- 11.11.2.8 The primary sources of sound radiation from diamond wire cutting can be expected to include the wire (friction), the pulleys and the power mechanism. Furthermore, the support activities such as the presence of an ROV and surface vessel would also contribute to the overall noise, and depending on the actual activity may be noisier, overall, than the cutting process. A study conducted by Pangerc *et al.* (2016) described the underwater noise characteristics of an underwater diamond wire cutting operation of a 0.76m diameter conductor at an oil and gas platform. The conductor was cut around 10m from the seabed, in a water depth of 80m. This study noted difficulty in discerning the noise emitted as a result of the cutting over the ambient noise where multiple vessels were present; however, they did record an increase in the spectral level for the one-third octave bands at frequencies above 5kHz with the largest changes with time at the one-third octave band centred at 40kHz. During cutting, changes of between around 4dB and 15dB re 1  $\mu\text{Pa}^2$  were detectable in the one-third octave band spectral levels. Noise from diamond wire cutting was described as continuous in nature. Due to the similarity in noise characteristics to operational vessels, they will be used as a proxy to determine impacts to marine mammals.
- 11.11.2.9 PTS is a permanent effect which cannot be recovered from. With respect to harbour porpoise, dolphin and seal species' sensitivity to LF noise, these species are considered to be of reasonable adaptability, high tolerance, and have no recoverability. Taking these factors into account, the overall sensitivity of these marine mammal receptors to increased underwater noise during decommissioning is considered to be **low**.
- 11.11.2.10 With respect to minke and humpback whale's sensitivity to LF noise, the species are considered to be of reasonable adaptability, reasonable tolerance, and have no recoverability. Taking these factors into account, the overall sensitivity of these marine mammal receptors to changes in prey availability is considered to be **medium**.

### Magnitude of impact

- 11.11.2.11 At present, the specific activities that will be employed during decommissioning are unknown and will be determined in line with best practice guidance available at the time of decommissioning. However, it is anticipated that increased underwater noise during the decommissioning stage will be similar in nature, but of lower magnitude, to the construction stage (**Table 11.9**).
- 11.11.2.12 Due to the lack of information currently available, taking the precautionary approach, the worst case assumption is that auditory injury due to increased underwater noise from decommissioning activities would be similar to the construction stage, as described in **Section 11.9.4**. Therefore, the magnitude of auditory injury from increased underwater noise is assessed as **negligible** for all receptors.

### Significance of residual effect

- 11.11.2.13 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.56**. The magnitude of impact is deemed to be **negligible**, and the sensitivity of the receptor are deemed to be **low** for all marine mammals, except for minke and humpback whale which are assessed as **medium** sensitivity. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.56 Significance of D1: Auditory injury from increased underwater noise**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (Not Significant).
Bottlenose dolphin (CES MU)	Negligible	Low	Negligible (Not Significant).
Bottlenose dolphin (GNS MU)	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Negligible	Medium	Negligible (Not Significant).
Humpback whale	Negligible	Medium	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

### 11.11.3 Impact D2: Disturbance from increased underwater noise during decommissioning activities

#### Overview

11.11.3.1 While the specific activities that will be employed during decommissioning are not yet known, it is anticipated that disturbance from decommissioning activities will be similar or less than during construction, due to activities largely being a reversal of the installation process. As covered in **Section 11.11.2**, it is assumed that decommissioning activities will be similar to those included in **Section 11.9.8**.

#### Sensitivity of receptor

11.11.3.2 Disturbance from decommissioning activities is considered to be the same or less than those described for construction activities. Therefore, the conservative approach assumes that the sensitivity of marine mammal receptors disturbance from decommission activities is the same as the sensitivity during construction, as described in **Section 11.9.8**. The sensitivity of harbour porpoise is **medium**. For all other marine mammal receptors, sensitivity is **low**.

#### Magnitude of impact

11.11.3.3 At present, the specific activities that will be employed during decommissioning are unknown and will be determined in line with best practice guidance available at the time of decommissioning. However, it is anticipated that disturbance during the decommissioning

stage will be similar in nature, but of lower magnitude, to the construction stage (Table 11.9).

- 11.11.3.4 Due to the lack of information currently available, taking the precautionary approach, the worst-case assumption is that disturbance from decommissioning activities would be similar to the construction stage. The impact for marine mammals is therefore predicted to be of local spatial extent, short term duration and intermittent, and unlikely to affect the population trajectory. Therefore, the magnitude of disturbance from other construction activities is assessed as **low** for all receptors.

### Significance of residual effect

- 11.11.3.5 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in Table 11.57.
- 11.11.3.6 The magnitude of impact of disturbance from other construction activities is deemed to be **low**. The sensitivity of receptors is **low** for all receptor species. The effect of disturbance from other construction activities will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.57 Significance of D2: Disturbance from increased underwater noise during decommissioning activities**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

### 11.11.4 Impact D3: Vessel collisions from increased vessel presence and traffic

#### Overview

- 11.11.4.1 Increased vessel movement during the decommissioning stage of the Project has the potential to result in a range of impacts on marine mammals. These include injury or death due to collision with vessels due to increased vessel presence. At the time of writing this EIA Report, the number of vessel movements required during decommissioning was unknown; however, it is anticipated to be fewer than during the construction stage.
- 11.11.4.2 Further detail on vessel types, routes, and traffic density in the area surrounding the Project OAA and offshore export cable corridor is described in **Chapter 15: Shipping and Navigation** of the EIA Report.

#### Sensitivity of receptor

- 11.11.4.3 Marine mammal receptors sensitivity to vessel collision risk is described in **Section 11.9.9**. The sensitivity of the receptors is **high**.

#### Magnitude of impact

- 11.11.4.4 Vessel traffic during the decommissioning stage is anticipated to be similar or lower in nature than the construction stage (**Table 11.9**). The type of decommissioning vessels available at the time of decommissioning is unknown. Therefore, the worst-case assumption is that the same number of vessels present and trips as during the construction stage.
- 11.11.4.5 Due to the lack of information currently available, taking the precautionary approach, the worst case assumption is that vessel traffic would be similar to the construction stage, as described in **paragraph 11.9.9.15**. The magnitude is therefore **negligible**.

#### Significance of residual effect

- 11.11.4.6 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors are presented in **Table 11.58**.
- 11.11.4.7 The magnitude of impact of vessel collisions from increased vessel presence and traffic is deemed to be **negligible** and the sensitivity of all receptors is **high**. The effect of vessel collisions from increased vessel presence and traffic will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.58 Significance of D3: Vessel collisions from increased vessel presence and traffic**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	High	Negligible (Not Significant).
Bottlenose dolphin	Negligible	High	Negligible (Not Significant).
Risso's dolphin	Negligible	High	Negligible (Not Significant).

Receptor	Magnitude	Sensitivity	Significance
Atlantic white-sided dolphin	Negligible	High	Negligible (Not Significant).
White-beaked dolphin	Negligible	High	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	High	Negligible (Not Significant).
Minke whale	Negligible	High	Negligible (Not Significant).
Humpback whale	Negligible	High	Negligible (Not Significant).

### 11.11.5 Impact D4: Disturbance from increased vessel presence and traffic

#### Overview

- 11.11.5.1 Increased vessel movement during the decommissioning stage of the Project has the potential to result in a range of impacts on marine mammals. These include avoidance behaviour or displacement due to increased vessel presence, as well as masking of vocalisations or changes in vocalisation rate due to increased underwater noise.
- 11.11.5.2 The physical presence of vessels and associated underwater noise may result in an increase in disturbance to marine mammals, such as through avoidance and displacement as well as behavioural and vocalisation changes. Disturbance due to physical presence of and underwater noise generated by vessels are linked and occur simultaneously, unless the vessel is idle. There is insufficient evidence to support the assessment of physical presence separately, and vessel underwater noise studies are often subject to observer bias from the presence of the research vessel and cannot differentiate between the effects of vessel presence and vessel noise (Erbe et al., 2019; Pirotta et al., 2015). Additionally, the magnitude of impact from underwater noise and physical presence of vessels will both increase with vessel size and number of vessels. Therefore, this impact assessment considers the underwater noise and physical presence of vessels as a single effect.

#### Sensitivity of receptor

- 11.11.5.3 Marine mammal sensitivity to disturbance from increased vessel presence and traffic risk is described in **Section 11.9.10**. The sensitivity of the receptors is **low**.

#### Magnitude of impact

- 11.11.5.4 Vessel traffic during the decommissioning stage is anticipated to be similar or lower in nature to the construction stage (**Table 11.9**). The type of decommissioning vessels available at the time of decommissioning is unknown. Therefore, the worst-case assumption is that the same number of vessels present, and trips are required for decommissioning, as during the construction stage.

11.11.5.5 As summarised in **Section 11.9.10**, the impact of disturbance to marine mammals from increased vessel presence and traffic is therefore predicted to be of local spatial extent, short term duration and intermittent. The magnitude is therefore **low**.

### Significance of residual effect

11.11.5.6 The magnitude of impact of disturbance from increased vessel presence and traffic is deemed to be **low** and the sensitivity of all receptors is **low**. The effect of disturbance from increased vessel presence and traffic will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.59 Significance of D4: Disturbance from increased vessel presence and traffic.**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Low	Low	Negligible (Not Significant).
Bottlenose dolphin	Low	Low	Negligible (Not Significant).
Risso's dolphin	Low	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Low	Low	Negligible (Not Significant).
White-beaked dolphin	Low	Low	Negligible (Not Significant).
Short-beaked common dolphin	Low	Low	Negligible (Not Significant).
Minke whale	Low	Low	Negligible (Not Significant).
Humpback whale	Low	Low	Negligible (Not Significant).
Harbour seal	Low	Low	Negligible (Not Significant).
Grey seal	Low	Low	Negligible (Not Significant).

### 11.11.6 Impact D5: Indirect effects on marine mammals via changes in prey availability

#### Overview

11.11.6.1 Marine mammals are dependent on prey for survival. After decommissioning, the artificial hard substrate (scour protection, WTG anchors, offshore substations and RCP foundations) will no longer be present in the water column or will remain partially present. Therefore, the epifauna community, which will colonize the substrate in its 35-year lifespan per Project

phase, will also be (partially) removed. Additionally, the function of the artificial hard substrate as foraging, hiding or spawning habitat for associated species like certain fish and mobile macrobenthos will be removed. As a result, there is the potential for indirect effects on marine mammals to occur as a result of impacts on their prey species or the habitats that support them. The key prey species for the receptors within this assessment are presented in **Table 11.28**.

- 11.11.6.2 During the decommissioning stage, potential pressures on prey species have been assessed in detail with the EIA Report, specifically in **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** and **Chapter 13: Fish Ecology**. Potential impacts include:
- temporary habitat loss/disturbance, and increases in SSC and smothering;
  - mortality, injury, and behavioural changes from underwater noise, vibration, and particle motion (for example, UXO clearance);
  - potential indirect effects on prey dynamics;
  - release of sediment-bound contaminants, changes in water quality, and collision or entanglement risk; and
  - increased risk of introduction or spread of marine INNS.
- 11.11.6.3 The severity and likelihood of these impacts vary depending on species mobility, life stage, and behavioural state at the time of exposure. These factors influence the ability of prey species to avoid or recover from disturbance and are considered in the EIA Report's impact evaluations. Most effects are expected to be temporary and spatially limited, with no predicted population-level consequences on prey species relevant to marine mammal receptors.

### Sensitivity of receptor

- 11.11.6.4 Marine mammal receptors sensitivity to changes in prey availability is described in **Section 11.9.5**. The sensitivity of the receptors is **low**.

### Magnitude of impact

- 11.11.6.5 Indirect effects on marine mammal prey species during the decommissioning stage is anticipated to be similar in nature, but of lower magnitude, to the construction stage (**Table 11.9**).
- 11.11.6.6 **Chapter 10: Benthic, Epibenthic and Intertidal Ecology** of the EIA Report has concluded that there will be no likely significant effects arising on the on the prey species of marine mammals during the decommissioning stage. For each of the above impacts assessed within **Chapter 10: Benthic, Epibenthic and Intertidal Ecology**, the magnitude of impact was assessed as negligible to medium (depending on the impact), and the sensitivity of the receptor was assessed as low to medium (depending on the impact). The significance of all impacts were assessed as negligible to minor, which is not significant in EIA terms.
- 11.11.6.7 **Chapter 13: Fish Ecology** of the EIA Report has concluded that there will be no likely significant effects arising on the prey species of marine mammals during the decommissioning stage. For each of the above impacts assessed within **Chapter 13: Fish Ecology**, the magnitude of impact was assessed as very low to low (depending on the impact and receptor), and the sensitivity of the receptor was assessed as negligible to high (depending on the impact and receptor). As such, the significance of all impacts were assessed as negligible to minor, which is not significant in EIA terms.

- 11.11.6.8 Most decommissioning stage impacts on marine mammal prey species are expected to be temporary but recurring over the medium term, with no significant changes to the distribution or quality of are expected. As a result, any indirect effects on prey availability are likely to be minimal or imperceptible for marine mammal receptors and are not expected to lead to population-level changes.
- 11.11.6.9 Given the absence of significant impacts on marine mammal prey species, and the high likelihood that any effects on prey availability would lead to only minimal or imperceptible changes for marine mammal receptors, the potential magnitude of indirect impacts on marine mammal prey is assessed as **negligible**.

### Significance of residual effect

- 11.1.1.1 A summary of the impact magnitude, receptor sensitivity and significance of effect for marine mammal receptors is presented in **Table 11.60**.
- 11.1.1.2 The magnitude of impact is deemed to be **negligible**, and the sensitivity of the receptor are deemed to be **low** for changes to prey for all species. The effect will, therefore, be of **Negligible (Not Significant)** in EIA terms.

**Table 11.60 Significance of D5: Indirect effects of underwater noise on marine mammal prey species**

Receptor	Magnitude	Sensitivity	Significance
Harbour porpoise	Negligible	Low	Negligible (Not Significant).
Bottlenose dolphin	Negligible	Low	Negligible (Not Significant).
Risso's dolphin	Negligible	Low	Negligible (Not Significant).
Atlantic white-sided dolphin	Negligible	Low	Negligible (Not Significant).
White-beaked dolphin	Negligible	Low	Negligible (Not Significant).
Short-beaked common dolphin	Negligible	Low	Negligible (Not Significant).
Minke whale	Negligible	Low	Negligible (Not Significant).
Humpback whale	Negligible	Low	Negligible (Not Significant).
Harbour seal	Negligible	Low	Negligible (Not Significant).
Grey seal	Negligible	Low	Negligible (Not Significant).

## 11.12 Summary of effects

- 11.12.1.1 A summary of effects arising from the construction, O&M and decommissioning stages of the Project in relation to marine mammals are summarised in **Table 11.61**.

**Table 11.61 Summary of effects on marine mammals**

Impact	Receptor	Sensitivity of receptor	Embedded environmental measures	Magnitude of impact	Effect significance
<b>Construction</b>					
<b>Impact C1: Auditory injury from increased underwater noise during pre-construction surveys</b>	All marine mammal receptors	<b>Low</b>	M-028 M-032 M-033 M-120 M-121	<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>Impact C2: Auditory injury (PTS) from increased underwater noise during installation of driven piles</b>	Harbour porpoise (VHF cetaceans); minke and humpback whale (LF cetaceans)	<b>Low</b>	M-028 M-032 M-033 M-105 M-120 M-121	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Dolphin species (HF cetaceans); harbour and grey seal (PCW)	<b>Low</b>		<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>Impact C3: Auditory injury from other construction activities</b>	Harbour porpoise (VHF cetaceans); dolphin species (HF cetaceans); harbour and grey seal (PCW)	<b>Low</b>	M-028 M-032 M-033 M-039 M-054 M-057 M-120 M-121 M-186 M-187	<b>Negligible</b>	<b>Negligible (Not Significant).</b>
	Minke and humpback whale (LF cetaceans)	<b>Medium</b>		<b>Negligible</b>	<b>Negligible (Not Significant).</b>

Impact	Receptor	Sensitivity of receptor	Embedded environmental measures	Magnitude of impact	Effect significance
<b>Impact C4: Indirect impacts on marine mammals via changes in prey availability</b>	All marine mammal receptors	<b>Low</b>	M-028 M-032 M-033 M-120 M-121	<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>Impact C5: Disturbance from increased underwater noise during pre-construction surveys</b>	Harbour porpoise (VHF cetaceans); dolphin species (HF cetaceans); minke and humpback whale (LF cetaceans); grey seal (PCW)	<b>Low</b>	M-028 M-032 M-033 M-039	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Harbour seal (PCW)	<b>Low</b>		<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>Impact C6: Disturbance from increased underwater noise during installation (for example anchor piles)</b>	Atlantic white-sided dolphin, short-beaked common dolphin (HF cetaceans); minke and humpback whale (LF cetaceans); seal species (PCW)	<b>Low</b>	M-028 M-032 M-033 M-105 M-120 M-121	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Bottlnose dolphin, Risso's and white-beaked dolphin (HF cetaceans)	<b>Low</b>		<b>Medium</b>	<b>Minor (Not Significant).</b>
<b>Impact C7: Disturbance from other construction activities</b>	All marine mammal receptors	<b>Low</b>	M-028 M-032 M-033 M-039	<b>Low</b>	<b>Negligible (Not Significant).</b>
<b>Impact C8: Vessel collisions from increased vessel presence and traffic</b>	All marine mammal receptors	<b>High</b>	M-028 M-032 M-033	<b>Negligible</b>	<b>Negligible (Not Significant).</b>

Impact	Receptor	Sensitivity of receptor	Embedded environmental measures	Magnitude of impact	Effect significance
			M-039		
<b>Impact C9: Disturbance from increased vessel presence and traffic</b>	All marine mammal receptors	<b>Low</b>	M-028 M-032 M-033 M-039	<b>Low</b>	<b>Negligible (Not Significant).</b>
<b>Impact C10: Auditory injury from UXO</b>	Harbour porpoise (VHF cetaceans); bottlenose dolphin, Risso's dolphin, white-beaked dolphin (HF cetaceans); grey seal (PCW)	<b>Low</b>	M-028 M-032 M-033 M-114 M-115 M-120	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Atlantic white-sided dolphin, short-beaked common dolphin (HF cetaceans); harbour seal (PCW)	<b>Low</b>		<b>Negligible</b>	<b>Negligible (Not Significant).</b>
	Minke and humpback whale (LF cetaceans)	<b>Medium</b>		<b>Low</b>	<b>Minor (Not Significant).</b>
<b>Impact C11: Disturbance from UXO clearance (High order)</b>	Harbour porpoise (VHF cetaceans); Atlantic white-sided dolphin (HF cetacean); humpback whale (LF cetaceans); grey seal (PCW)	<b>Low</b>	M-028 M-032 M-033 M-114 M-115 M-120	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Minke whale (LF cetacean)	<b>Low</b>		<b>Medium</b>	<b>Minor (Not Significant).</b>
	Bottlenose dolphins, white-beaked dolphins, Risso's dolphins, short-beaked common dolphin (HF	<b>Low</b>		<b>Negligible</b>	<b>Negligible (Not Significant).</b>

Impact	Receptor	Sensitivity of receptor	Embedded environmental measures	Magnitude of impact	Effect significance
	cetaceans); harbour seal (PCW)				
<b>Impact C11: Disturbance from UXO clearance (Low order)</b>	Harbour porpoise (VHF cetaceans); minke whale, humpback whale (LF cetaceans)	<b>Low</b>	M-028 M-032 M-033 M-114 M-115	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Dolphin species (HF cetacean); seal species (PCW)	<b>Low</b>	M-120	<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>O&amp;M</b>					
<b>Impact O1: EMF from cables</b>	Harbour porpoise (VHF cetaceans); dolphin species (HF cetaceans); minke and humpback whale (LF cetaceans)	<b>Low</b>	M-032 M-054 M-121 M-122	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Harbour and grey seal (PCW)	<b>Negligible</b>		<b>Low</b>	<b>Negligible (Not Significant).</b>
<b>Impact O2: Vessel collisions from increased vessel presence and traffic</b>	All marine mammal receptors	<b>High</b>	M-028 M-032 M-033 M-039 M-121 M-122	<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>Impact O3: Disturbance from increased vessel presence and traffic</b>	All marine mammal receptors	<b>Low</b>	M-032 M-033 M-039 M-121	<b>Low</b>	<b>Negligible (Not Significant).</b>

Impact	Receptor	Sensitivity of receptor	Embedded environmental measures	Magnitude of impact	Effect significance
			M-122		
<b>Impact O4: Long term displacement / habitat change / barrier effects due to offshore wind farm structures</b>	Harbour porpoise (VHF cetaceans); dolphin species (HF cetaceans); harbour and grey seal (PCW)	<b>Low</b>	M-121 M-122	<b>Low</b>	<b>Negligible (Not Significant).</b>
	Minke and humpback whale (LF cetaceans)	<b>Low</b>		<b>Medium</b>	<b>Minor (Not Significant).</b>
<b>Impact O5: Entanglement in lines and cables for example mooring lines, array cables and export cables</b>	All marine mammal receptors	<b>High</b>	M-121 M-122	<b>Low</b>	<b>Minor (Not Significant).</b>
<b>Impact O6: Increased underwater noise for example operational noise and mooring noise</b>	Harbour porpoise (VHF cetaceans); dolphin species (HF cetaceans); harbour and grey seal (PCW)	<b>Negligible</b>	M-121 M-122	<b>Medium</b>	<b>Negligible (Not Significant).</b>
	Minke and humpback whale (LF cetaceans)	<b>Low</b>		<b>Medium</b>	<b>Negligible (Not Significant).</b>
<b>Impact O7: Indirect impacts on marine mammals via changes in prey availability</b>	All marine mammal receptors	<b>Low</b>	M-121 M-122	<b>Negligible</b>	<b>Negligible (Not Significant).</b>
<b>Decommissioning</b>					
<b>Impact D1: Auditory injury from increased underwater noise for example anchor piles</b>	Harbour porpoise (VHF cetaceans); dolphin species (HF cetaceans); harbour and grey seal (PCW)	<b>Low</b>	M-106	<b>Negligible</b>	<b>Negligible (Not Significant).</b>

Impact	Receptor	Sensitivity of receptor	Embedded environmental measures	Magnitude of impact	Effect significance
	Minke and humpback whale (LF cetaceans)	Medium		Negligible	Negligible (Not Significant).
<b>Impact D2: Disturbance from decommissioning activities</b>	Harbour porpoise (VHF cetaceans)	Medium	M-106	Low	Minor (Not Significant).
	Dolphin species (HF cetaceans); minke and humpback whale (LF cetaceans); harbour and grey seal (PCW)	Low		Low	Negligible (Not Significant).
<b>Impact D3: Vessel collisions from increased vessel presence and traffic</b>	All marine mammal receptors	High	M-106	Negligible	Negligible (Not Significant).
<b>Impact D4: Disturbance from increased vessel presence and traffic</b>	All marine mammal receptors	Low	M-106	Low	Negligible (Not Significant).
<b>Impact D5: Indirect impacts on marine mammals via changes in prey availability</b>	All marine mammal receptors	Low	M-106	Negligible	Negligible (Not Significant).

## 11.13 Transboundary effects

- 11.13.1.1 Transboundary effects arise when impacts from a development within one European Economic Area (EEA) State affects the environment of another EEA State(s). A screening of transboundary effects have been carried out and is presented in Appendix 4B of the Scoping Report (MarramWind Ltd., 2023).
- 11.13.1.2 Potential transboundary impacts associated with the Project may arise either independently or cumulatively with other plans or projects. This assessment considers the residual effects, those remaining after the implementation of mitigation measures.
- 11.13.1.3 During the construction stage, underwater noise has the potential to cause behavioural disturbance or displacement of marine mammals across broad spatial ranges. If such noise propagates beyond UK waters, particularly into neighbouring EEA States, transboundary effects could occur. Indirect impacts may also arise through changes in fish populations, which serve as key prey species for marine mammals. However, the Project is situated approximately 115km from the nearest EEA State (Norway), placing it beyond the modelled zone of influence for underwater noise. Underwater sound modelling has shown that during piling, typically the loudest activity during of construction, disturbance thresholds are unlikely to extend into transboundary waters. For example, the NMFS (2005) behavioural disturbance threshold of 160dB re 1  $\mu$ Pa (SPL<sub>rms</sub>) predicts a maximum range of ~38km from the OAA for all marine mammals. For harbour porpoise, the most acoustically sensitive species, the 140dB re 1 $\mu$ Pa<sup>2</sup>s SEL<sub>cum</sub> threshold for significant disturbance extends to 48km. These ranges fall significantly short of the nearest international boundary.
- 11.13.1.4 Furthermore, the modelling applied is highly precautionary, and it is considered unlikely that sound propagating tens of kilometres from the OAA would exceed ambient background levels. While marine mammals are highly mobile and may traverse international waters, the likelihood of piling activities resulting in significant transboundary effects is considered low.
- 11.13.1.5 Additional noise-producing activities, including UXO clearance, pre-construction surveys and vessel movements, have also been precautionarily assessed. The results indicate that none of the underwater noise impact distances intersect with the nearest EEA boundary, further supporting the conclusion that transboundary interactions are unlikely.
- 11.13.1.6 Based on the knowledge of the baseline environment, the nature of planned works and the evidence on the potential for impact from such projects more widely, there are not considered to be any transboundary effects on marine mammal receptors from the Project.

## 11.14 Inter-related effects

- 11.14.1.1 A description and assessment of the likely inter-related effects arising from the Project on marine mammals is provided in **Chapter 32: Inter-Related Effects**.

## 11.15 Assessment of cumulative effects

- 11.15.1.1 A description and assessment of the cumulative effects arising from the Project on marine mammals is provided in **Chapter 33: Cumulative Effects Assessment**.

## 11.16 Summary of residual likely significant effects

- 11.16.1.1 There are no residual likely significant effects on marine mammal receptors assessed in this Chapter have been identified.

## 11.17 References

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## 11.18 Glossary of terms and abbreviations

### 11.18.1 Abbreviations

Acronym	Definition
<b>ADD</b>	Acoustic Deterrent Devices
<b>AHTS</b>	Anchor Handling Tug Supply
<b>ASCOBANS</b>	Agreement on the Conservation of Small Cetaceans of the Baltic, North East Atlantic, Irish and North Seas
<b>BEIS</b>	Department of Business, Energy and Industrial Strategy
<b>blows/min</b>	blows per minute
<b>CBRA</b>	Cable Burial Risk Assessment
<b>CEF</b>	Cumulative Effects Framework
<b>Cefas</b>	Centre for Environment, Fisheries and Aquaculture
<b>CES</b>	Coastal East Scotland
<b>CGNS</b>	Celtic and Greater North Sea
<b>CITES</b>	Convention on International Trade in Endangered Species of Wild Fauna and Flora
<b>COT</b>	Cost of Transport
<b>CSIP</b>	Cetacean Strandings Investigation Programme
<b>DAS</b>	Digital Aerial Surveys
<b>DTAG</b>	Digital Acoustic Recording Tag
<b>ECC</b>	Export Cable Corridor
<b>ECOMMAS</b>	East Coast Scotland Marine Mammal Acoustic Array Surveys
<b>EDR</b>	Effective Deterrent Range
<b>EEA</b>	European Economic Area
<b>EIA</b>	Environmental Impact Assessment
<b>EMF</b>	Electromagnetic Fields
<b>EMP</b>	Environmental Management Plan
<b>EPS</b>	European Protected Species
<b>FHG</b>	Functional Hearing Group
<b>GNS</b>	Greater North Sea

<b>Acronym</b>	<b>Definition</b>
<b>HF</b>	High frequency
<b>HRA</b>	Habitats Regulations Appraisal
<b>HVAC</b>	High Voltage Alternating Current
<b>IALA</b>	Navigation and Lighthouse Authorities
<b>IAMMWG</b>	Inter Agency Marine Mammal Working Group
<b>IEEM</b>	Institute of Ecology and Environmental Management
<b>INNS</b>	Invasive Non-Native Species
<b>INSPIRE</b>	Impulse Noise Sound Propagation and Impact Range Estimator
<b>JNCC</b>	Joint Nature Conservation Committee
<b>LF</b>	Low frequency
<b>MARPOL</b>	International Convention for the Prevention of Pollution from Ships
<b>MBES</b>	Multibeam Echo Sounders
<b>MD-LOT</b>	Marine Directorate Licensing Operations Team
<b>MHWS</b>	Mean High Water Springs
<b>MMMP</b>	Marine Mammal Mitigation Protocol
<b>MPA</b>	Marine Protected Area
<b>MPCP</b>	Marine Pollution Contingency Plan
<b>MU</b>	Management Unit
<b>N</b>	North
<b>NERC</b>	Natural Environment Research Council
<b>NMFS</b>	National Marine Fisheries Service
<b>NOAA</b>	National Oceanic and Atmospheric Administration
<b>NS</b>	North Sea
<b>NW</b>	North-west
<b>O&amp;M</b>	Operation and maintenance
<b>OAA</b>	Option Area Agreement
<b>ORJIP</b>	Offshore Renewables Joint Industry Programme
<b>OSPAR</b>	Oslo and Paris Convention for the Protection of the Marine Environment

<b>Acronym</b>	<b>Definition</b>
<b>OSS</b>	Offshore Substation
<b>OWF</b>	Offshore Wind Farm
<b>PAM</b>	Passive Acoustic Monitoring
<b>PCW</b>	Phocid carnivores in water
<b>Photo-ID</b>	Photo-identification
<b>PTS</b>	Permanent Threshold Shift
<b>RCP</b>	Reactive Compensation Platform
<b>S</b>	South
<b>SAC</b>	Special Areas of Conservation
<b>SBP</b>	Sub-Bottom Profilers
<b>SCANS</b>	Small Cetaceans in European Atlantic Waters and North
<b>SCOS</b>	Special Committee on Seals
<b>SE</b>	South-east
<b>SEL</b>	Sound Exposure Level
<b>SEL<sub>cum</sub></b>	Cumulative Sound Exposure Level
<b>SEL<sub>ss</sub></b>	Single-strike Sound Exposure Level
<b>SMA</b>	Seal Management Areas
<b>SMASS</b>	Scottish Marine Animal Stranding Scheme
<b>SNH</b>	Scottish Natural Heritage
<b>SPA</b>	Special Protection Area
<b>SPAN</b>	Scottish Passive Acoustic Network
<b>SPL</b>	Sound Pressure Level
<b>SPL<sub>peak</sub></b>	Instantaneous Sound Pressure Level
<b>SSC</b>	Suspended Sediment Concentrations
<b>SSS</b>	Side-Scan Sonar
<b>SW</b>	South-west
<b>TNT</b>	Trinitrotoluene
<b>TTS</b>	Temporary Threshold Shift

Acronym	Definition
<b>UHRS</b>	Ultra-High Resolution Seismic
<b>UK</b>	United Kingdom
<b>US</b>	United States
<b>USBL</b>	Ultra-Short Baseline
<b>UXO</b>	Unexploded Ordnance
<b>VHF</b>	Very high frequency
<b>W</b>	West
<b>WTG</b>	Wind Turbine Generator

### 11.18.2 Glossary of terms

Term	Definition
<b>Annex II (of the Habitats Directive)</b>	Part of the Habitats Directive 92/43/EEC that identifies species that require conservation through the designation of SACs.
<b>Background sound level</b>	The underlying level of sound over a period, T, and is represented by LA90, T, the level exceeded for 90% of the measurement interval T.
<b>Collision</b>	Contact between two or more moving vessels.
<b>Decibels</b>	A unit used to measure the intensity of a sound or the power level of an electrical signal by comparing it with a given level on a logarithmic scale.
<b>Echolocation</b>	The location of objects by reflected sound.
<b>Ecological feature</b>	Ecological feature is the term used to refer to biodiversity receptors. This term is taken directly from Ecological Impact Assessment guidance from the Chartered Institute of Ecology and Environmental Management.
<b>European Protected Species</b>	Species of plants and animals (other than birds) protected by law throughout the European Union.
<b>Hertz</b>	The unit of measurement for frequency of a sound wave, measured as the number of sound waves oscillating per second.
<b>Joint Nature Conservation Committee</b>	The public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation.
<b>Long-term habitat loss</b>	Substantive change to a habitat such that it loses the integrity of its defining features for a period of time that bears significance to the species supported by the habitat (ie this may vary between habitats depending on the lifecycle of the dependent species in question) and their ability to successfully recolonise.

Term	Definition
<b>Marine Mammal Mitigation Protocol</b>	A programme of measures to minimise the risk of injury (in the form of a permanent change in hearing referred to as a permanent threshold shift, or PTS) in marine mammals.
<b>Root mean square</b>	Root Mean Square of a time varying quantity is obtained by squaring the amplitude at each instant, obtaining the average of the squared values over the interval of interest, and then taking the Square Root of this average.
<b>Small cetaceans in European Atlantic Waters and the North Sea</b>	The name of a scientific research endeavour that involved large-scale ship and aerial surveys of the distribution and abundance of cetaceans in European Atlantic waters. The survey was first undertaken in 1994, with similar surveys also conducted in 2005, 2007, 2016 and 2022.

MarramWind 