Morven South

Morven South Offshore Wind Array Project

Habitats Regulations Appraisal

Volume 2, Chapter 2: Report to Inform Appropriate Assessment Part 2: SAC Assessments

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1 Introduction

1.1 The purpose of this Report to Inform Appropriate Assessment

1.1.1.1 This Report to Inform Appropriate Assessment (RIAA) has been prepared by Tetra Tech RPS Energy Limited, on behalf of Morven Offshore Wind Limited (MvOWL) (hereafter referred to as the 'Applicant'). The purpose of this RIAA is to support the Habitats Regulations Appraisal (HRA) required under the Habitats Regulations[1] for the Morven South Offshore Wind Farm (hereafter referred to as 'Morven South').

1.1.1.2 The RIAA builds upon Volume, 1 Chapter 1: Morven Option Lease Agreement Site: HRA Stage 1 Screening Report (hereafter referred to as 'Morven Site HRA Screening Report') and the Likely Significant Effects (LSE[2]) re-screening exercise (see Volume 2, Chapter 1: RIAA Part 1: Introduction (hereafter 'RIAA Part 1')) to assess whether Morven South could have an adverse effect, either alone, or in-combination with other plans or projects, on the integrity of relevant European sites. It also incorporates the subsequent advice from stakeholders in response to the Morven Site HRA Screening Report (incorporated into the Morven Option Lease Agreement Site Scoping Opinion (hereafter 'Morven Site Scoping Opinion') from the Marine Directorate – Licensing Operations Team (MD-LOT, 2023)). This report will provide the Competent Authority with the information required to undertake an HRA Stage 2 Appropriate Assessment.

1.1.1.3 The scope of this Morven South RIAA covers all relevant European sites and designated features where the potential for LSE[2] have been identified due to the potential impacts arising from Morven South..

1.2 Structure of the Report to Inform Appropriate Assessment

1.2.1.1 The suite of HRA documents for Morven South that has been split into Chapters, of which the RIAA is one. This RIAA has been reported in three 'Parts', which are structured as follows:

- Volume 2, Chapter 1: Report to Inform Appropriate Assessment Part 1: Introduction;
- Volume 2, Chapter 2: Report to Inform Appropriate Assessment Part 2: Special Area of Conservation Assessments (this document, hereafter 'RIAA Part 2');
- Volume 2, Chapter 3: Report to Inform Appropriate Assessment Part 3: Special Protection Area and Ramsar site Assessments (hereafter 'RIAA Part 3').

1.3 Structure of this document

1.3.1.1 As stated in paragraph 1.2.1.1, this document constitutes the RIAA Part 2 and presents the assessment of the implications of Morven South on Special Areas of Conservation (SACs).

1.3.1.2 This document is structured as follows:

- Section 1: Introduction (this section), which details the purpose and structure of the RIAA;
- Section 2: Consultation, which provides a summary of relevant consultation undertaken to date, the responses provided and how these have been addressed within this RIAA Part 2;
- Section 3: Summary of HRA LSE[2] screening conclusions for SACs;
- Section 4: Information to inform the Appropriate Assessment, which includes the Maximum Design Scenario (MDS), information on designed-in measures, an outline of the approach taken to baseline data, conservation objectives, and the in-combination assessment;

[1] The 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 2017.

- Section 5: Assessment of Adverse Effects On Integrity (AEOI) on European sites designated for Annex II diadromous fish features, both alone and in-combination with other plans and projects;
- Section 6: Assessment of AEOI on European sites designated for Annex II marine mammal features, both alone and in-combination with other plans and projects;
- Section 7: Summary of this Part of the RIAA.

2 Consultation

2.1.1.1 Consultation has been undertaken with statutory and non-statutory stakeholders with regards to the relevant Annex I habitats and Annex II diadromous fish and marine mammal features of SACs. A summary of all relevant consultation undertaken to date is presented in Table 2.1.

Table 2.1: Summary of key consultation relevant to Part Two of the Report to Inform Appropriate Assessment

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
April 2023	Annex I habitats	NatureScot	Scoping Workshop	The Applicant presented proposed approach to screening of Annex I habitats and that no European sites with Annex I were to be screened in for LSE assessment.	No.	N/A
	Annex II diadromous fish			The Applicant presented proposed approach to screening of Annex II diadromous fish and the five European site to be screened in for LSE assessment.	No.	N/A
				Agreement on the use of Popper *et al.* (2014) for underwater sound modelling and the use of a 160dB threshold for behavioural disturbance (based on a number of literature sources).	No. The Popper *et al.* (2014) thresholds have been used in the underwater sound modelling (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report of the EIA Report).	Section 5.3

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
	Annex II marine mammals			Outlined proposed approach to screening of Annex II marine mammals and expected approach to marine mammal underwater sound assessment: both Sound Pressure Level (SPL_{pk}) and cumulative Sound Exposure Level over 24 hours (SEL_{24h}) should be used for assessment.	No A dual metric approach using both peak Sound Pressure Level (SPL) (PK) and SEL24h has been applied based on underwater sound assessment (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report of the EIA Report).	Section 6.3
May 2023	Annex I benthic habitats	NatureScot	Written advice following Scoping Workshop	NatureScot agreed that there are no sites designated for Annex I habitats are required to be taken forward for LSE[2] determination.	No	paragraph 3.2.1.2
	Annex II diadromous fish			NatureScot advised that diadromous fish species should be assessed through Environmental Impact Assessment (EIA) only and not through HRA. For diadromous fish species there is no available population data for any salmon or lamprey SAC on the data forms. This inability to understand connectivity to and within individual rivers to the development area currently prohibits an informed assessment of the impact on individual site integrity.	No. While the advice provided by NatureScot has been acknowledged by the Applicant, given that diadromous fish are a listed Annex II feature, they have been retained for inclusion within this RIAA Part 2.	A high-level assessment is provided in Section 5, taking account of the uncertainty in relation to connectivity between diadromous fish and natal rivers (Section 3.2.2).

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
	Annex II marine mammals			NatureScot advised that only the Moray Firth SAC should be screened in. The underwater sound assessment will provide information on connectivity to the Moray Firth SAC for bottlenose dolphin. NatureScot advised that no transboundary or cross border SACs need to be included in the LSE[2] screening (i.e. all 19 transboundary SACs listed and the Southern North Sea SAC can be screened out of the HRA assessment). For grey seals, NatureScot advised screening in sites for assessment if the project site/impact radius is within a 20km connectivity buffer of the SAC, as the conservation objectives for grey seal SACs are related to the protection of the breeding colony. NatureScot appreciate the use of telemetry data, however, they were content for grey seal SACs to be screened out if there is no evidence of hotspots or regular foraging areas within the project boundary. For harbour seals, NatureScot advise screening sites in for assessment if the project	No. NatureScot's advice has been acknowledged by the Applicant. However, to remain complaint with Natural England's requirements regarding screening for seal and harbour porpoise SACs all five SACs have been retained for inclusion within this RIAA Part 2 (i.e. Moray Firth SAC for bottlenose dolphin, Southern North Sea SAC for harbour porpoise, Berwickshire and North Northumberland Coast SAC and Isle of May SAC for grey seal and Firth of Tay and Eden Estuary SAC for harbour seal). The decision to retain the three seal SACs was also informed by Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the Environmental Impact Assessment (EIA) Report, which suggests connectivity between the	Section 3.2.3 and Section 6

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				site/impact radius is within a 50km connectivity buffer of the SAC. Harbour seals show greater site fidelity throughout the year, and, unlike grey seals, there is no seasonal difference. NatureScot appreciate the use of telemetry data, however, they were content for harbour seal SACs to be scoped out if there is no evidence of hotspots or regular foraging areas within the project boundary.	Morven South Boundary and all three SACs.	
				NatureScot would expect narrative on vessel movement and potential disturbance to be screened in to determine if it can be screened out. Otherwise, NatureScot agreed with the impacts screened in for further assessment within the RIAA.	No. Narrative on vessel movement and potential disturbance has been included within the impact from vessel use.	Section 6.3
August 2023	Annex I benthic habitats	NatureScot	Advice on Morven Site HRA Screening Report within the Morven Site Scoping Opinion	NatureScot agreed with the conclusion in the HRA Screening Report that no sites with Annex 1 habitat features need to be taken forward to assessment.	No	paragraph 3.2.1.2
	Annex II diadromous fish			NatureScot advised that diadromous fish species should be assessed through EIA only and not through HRA. NatureScot advised that offshore wind developers should be contributing to ScotMER research	No. While the advice provided by NatureScot has been acknowledged by the Applicant, given that diadromous fish are a listed Annex II feature, they have	Section 5 Uncertainty in relation to connectivity between diadromous fish and natal rivers is

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				as well as other initiatives such as the Wild Salmon Strategy Implementation Plan and any other strategies that are developed for diadromous fish interests.	been retained for inclusion within this RIAA Part 2.	discussed in Section 3.2.2
		Fisheries Management Scotland		Fisheries Management Scotland considered the following SACs relevant to the proposed development. River Spey SAC (salmon, sea lamprey and freshwater pearl mussel); River Dee SAC (salmon and freshwater pearl mussel); River South Esk SAC (salmon and freshwater pearl mussel); River Tay SAC (salmon, sea lamprey and river lamprey); River Teith SAC (salmon, sea lamprey and river lamprey); River Tweed SAC (salmon, sea lamprey and river lamprey).	No. The advice provided by Fisheries Management Scotland has been acknowledged and all sites identified by Fisheries Management Scotland, with the exception of the River Spey SAC, have been assessed in this RIAA. In light of the guidance from NatureScot to not assess diadromous fish SACs in the HRA, the RIAA Part 2 assessment is considered sufficiently precautionary with respect to the SACs screened in for assessment in this RIAA on the basis of potential for connectivity. There is considered to be no connectivity / pathway for impact for the River Spey SAC and so no potential for LSE as discussed in Section 3.2.2 (i.e. that there is no impact	Section 5 and Section 3.2.2

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
					pathway as prevalent migration routes are northwards for salmon from the River Spey SAC).	
	Annex II marine mammals	NatureScot		NatureScot agreed that, until underwater sound modelling is complete, the Moray Firth SAC should be screened in for further assessment, due to the potential connectivity of the coastal bottlenose dolphin population of the Moray Firth SAC.	No.	Section 6
				NatureScot advised that if vessels are travelling from ports either within the Moray Firth, or along the east coast, then the impact of vessel movements on the Moray Firth SAC bottlenose dolphin population should be assessed, although it was acknowledged this would be qualitative.	No. Narrative on vessel movement and potential disturbance has been included within the impact from vessel use.	Section 6.3
				NatureScot reiterated their advice that the Southern North Sea SAC can be screened out of the HRA assessment. This is because harbour porpoise are ubiquitous in Scottish Seas and in their view it is not possible to identify if they are from an SAC population. NatureScot defer to Natural	No. NatureScot's advice has been acknowledged by the Applicant. However, as this site is in English waters, and to remain complaint with Natural England's requirements regarding	Section 3.2.3 and Section 6

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				England as this site is in English waters.	seal and harbour porpoise SACs, the Southern North Sea SAC and three seal SACs have been retained for inclusion within this RIAA Part 2. The decision to retain the three seal SACs was also informed by Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report, which suggests connectivity between the Morven South Boundary and all three SACs.	
				NatureScot reiterated their previous advice that they are content for the three SACs designated for grey and harbour seals to be screened out.		
November 2023	Annex I benthic habitats	MD-LOT	Advice on Morven Site HRA Screening Report within the Morven Site Scoping Report	MD-LOT agreed with the conclusion of the HRA Screening Report that no sites with Annex 1 habitat features need to be taken forward for assessment.	No	paragraph 3.2.1.2
	Annex II diadromous fish			Scottish Ministers agree with NatureScot's view that migratory fish should currently be assessed through the EIA process and not through the HRA process. The Applicant should continue to engage with the Scottish Ministers and NatureScot regarding any change in how diadromous fish should be	No. While the advice provided by NatureScot has been acknowledged by the Applicant, given that diadromous fish are a listed Annex II feature, they have been retained for inclusion within this RIAA Part 2.	Section 5 Uncertainty in relation to connectivity between diadromous fish and natal rivers is discussed in Section 3.2.2.

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				assessed through EIA and HRA as a result of ongoing research in this area.		
	Annex II marine mammals			Scottish Ministers advised that potential impacts on the Moray Firth SAC bottlenose dolphin population from vessels travelling from ports within the Moray Firth or along the east coast should be given consideration. The Scottish Ministers directed the Applicant to the NatureScot representation on this point and advised that it must be fully implemented.	No. Narrative on vessel movement and potential disturbance has been included within the impact from vessel use.	Section 6.3
				MD-LOT advised that the Moray Firth SAC should remain screened into the assessment in respect of bottlenose dolphin until underwater sound modelling is completed.	No.	Section 6
				MD-LOT agreed with NatureScot, that the Berwickshire and North Northumberland Coast and Isle of May SACs for grey seals and the Firth of Tay and Eden Estuary SAC for harbour seals can be screened out for further assessment. The Southern North Sea SAC should remain screened in for further assessment in line with the	No. MD-LOT's advice has been acknowledged by the Applicant. However, to remain complaint with Natural England's expectations regarding seal SACs, the three seal SACs have been retained for inclusion within this	Section 3.2.3 and Section 6

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				representation from Natural England.	RIAA Part 2. The decision to retain the three seal SACs was also informed by Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report, which suggests connectivity between the Morven South Boundary and all three SACs. The Southern North Sea SAC has also been retained for harbour porpoise.	
November 2023	Annex II harbour porpoise	Natural England	Advice on Morven Site HRA Screening Report within the Morven Site Scoping Report	Natural England cannot agree with the advice provided by NatureScot with regard to scoping the Southern North Sea SAC out of the HRA for this proposed development. The Southern North Sea SAC lies wholly in English waters. It is Natural England's conclusion that a potential impact pathway exists between the proposed Morven Offshore Wind Farm (OWF) array area and the Southern North Sea SAC for harbour porpoise, as harbour porpoise are known to forage over wide ranges and as such have potential to travel	No. The Southern North Sea SAC has been retained for inclusion within this RIAA Part 2.	Section 6

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				between the Southern North Sea SAC and Morven OWF array area.		
July 2025	All	MD-LOT	Email correspondence	MD-LOT confirmed that approach to the whole project, Morven Programme and in-combination assessment, as set out within MvOWL's targeted consultation letter dated 13 March 2025, was likely to be acceptable, subject to NatureScot's agreement. MD-LOT confirmed the cut-off dates for the consideration of new or updated information for plans projects and activities within in-combination assessments should be six months prior to application submission for quantitative assessment and three months for qualitative in-combination assessment.	No	Sections 5.4 and 6.4
August 2025	All	NatureScot and MD-LOT	Consultation meeting with NatureScot titled 'Morven CEA discussion'	NatureScot and MD-LOT agreed to refinements to the whole project, Morven Programme and in-combination effects assessment approach set out set out within MvOWL's targeted consultation letter dated 13 March 2025. To allow each of the Morven North and Morven South consent applications to be considered	No	Section 4.6

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				independently, NatureScot advised that in-combination assessment should consider the potential effects of Morven North together with other projects, plans and activities (including other components of the Morven Programme alongside other tiered projects), rather than the consideration of Morven Programme impacts together with other projects, plans and activities. It was also agreed that the Morven Programme assessment would only be required for offshore ornithology and shipping and navigation receptors.		
October 2025	Annex II marine mammals	Natural England	Teams meeting to discuss Morven South approach to Cumulative Effects Assessment (CEA) for offshore ornithology held on 14 October 2025.	Natural England queried the general assessment approach (both project-alone and in-combination) intended for seals within the HRA.	No. The three seal SACs have been retained for inclusion within this RIAA Part 2, both in the alone assessment and in-combination assessment as relevant.	Section 6
October 2025	Annex II marine mammals	NatureScot, MD-LOT	Written advice in response to the underwater sound and marine mammal workshop held 23 October 2025.	Discussion of the following elements of the marine mammal assessment: • Underwater sound modelling approach and results;	Yes. In line with the EIA CEA, the number of impacts assessed in the in-combination assessment has been reduced as	Section 6.4

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
				• Presentation of the species densities to be taken through to assessment; • Approach and results of the EIA project alone population modelling; • Approach to Unexploded Ordnance (UXO) sound modelling and results; • Approach to vessel sound modelling, results and assessment; • Approach to the RIAA in-combination assessment in relation to the EIA CEA.	discussed in the overview of Section 6.4.	
November 2025	Annex II marine mammals	NatureScot	Email response to the CEA note submitted to NatureScot in October as well as response to the underwater sound and marine mammal workshop (see row above).	NatureScot advised that the time period for the CEA (and thus in-combination assessment) should consider up to a year on either side of construction.	Projects have been screened in where the timelines fall a year either side of Morven North and Morven South combined.	Section 6.4.1
				NatureScot advised that all impacts that are non-significant for Morven North alone should not be scoped out of in-combination assessment; example is disturbance from piling.	Disturbance from piling and disturbance from vessels is taken through to the in-combination assessment even though there is no impact from Morven North alone; all other impacts were scoped out of the in-combination assessment	Section 6.4.1

Date	Receptor group	Consultee	Type of consultation	Summary of consultation	Change required to screening outcomes?	Where addressed in this document
					with detailed justification provided in Table 6.43.	
				NatureScot acknowledge that the Effective Deterrent Ranges (EDRs) have been updated in 2025 but advise that for quantitative assessment of Tier 2 and 3 projects the most precautionary EDRs between the 2020 and new 2025 EDRs should be applied.	The in-combination assessment is based on the most up-to-date published guidance; selecting on the basis only of the largest EDR is not scientifically justified if this is in contrast to the most recent publication.	Section 6.4.2
				NatureScot advised that the 50km screening buffer may not be the most appropriate method of screening in projects for vessel noise, both during construction and operation, as the most likely transit routes to and from port should be included within the assessment.	The screening buffer was increased to 86km on the basis of NatureScot advice: this is the furthest distance between either the Morven North or Morven South boundary and the UK coast to capture transit to/from ports. Aberdeen port lies approximately 63km from Morven North and Morven South.	Section 6.4.3
February 2026	Annex II marine mammals	NatureScot	Email response to meeting minutes of the underwater sound and marine mammal workshop held 23 October 2025.	NatureScot confirmed that effects on marine mammals due to changes in prey availability (“impact of changes in fish and shellfish resources”) can remain screened out of the RIAA for all SACs.	No	Section 3.2.3

3 Summary of Habitats Regulations Appraisal screening conclusions

3.1.1.1 This section summarises all pathways for potential LSE[2] on Annex I habitats and Annex II diadromous fish and marine mammal features of SACs (arising alone or in-combination with other plans and projects).

3.2 Screening outcomes for Morven South alone

3.2.1.1 The potential for LSE[2] as a result of Morven South alone has been identified following the LSE[2] screening with respect to nine SACs (Figure 3.1 and Table 3.1).

3.2.1.2 There were no SACs designated for Annex I habitats or Annex II European otter *(Lutra lutra)* advanced to the RIAA stage during the LSE[2] screening (Morven Site HRA Screening Report), and therefore these are not included in this RIAA Part 2 for further assessment.

3.2.2 Annex II diadromous fish

3.2.2.1 A total of five SACs designated for Annex II diadromous fish and dependent features were advanced to the RIAA. These are as follows:

- River Dee SAC (for Atlantic salmon (*Salmo salar)* and freshwater pearl mussel (*Margaritifera margaritifera)*;
- River South Esk SAC (for Atlantic salmon and freshwater pearl mussel);
- River Tweed SAC (for Atlantic salmon);
- River Tay SAC (for Atlantic salmon);
- River Teith SAC (for Atlantic salmon).

3.2.2.2 Recent evidence on Atlantic salmon migration from rivers in the Moray Firth suggests that smolts head north and directly across the North Sea relatively rapidly, rather than moving in a southern/coastal direction upon leaving their natal rivers (Marine Scotland Science, 2019b, Newton *et al.*, 2017). Similar evidence of a rapid easterly migration out into the North Sea has also been shown for the River Dee in Aberdeenshire (Marine Scotland Science, 2019b) and the River Conon in Ross-shire (Newton *et al.*, 2021). Evidence from an Atlantic salmon smolt tagging study also indicated a strong directional movement heading east/northeast out of several rivers in the Moray Firth (Conon, Deveron, Findhorn, Ness, Oykel, Shin and Spey) (Marine Scotland Science, 2019a). For adult Atlantic salmon, while there is some evidence that adult Atlantic salmon may migrate along the east coast of Scotland, adult migration to natal rivers in the Moray Firth is most likely from the north (ABPmer, 2014, Malcolm *et al.*, 2010).

3.2.2.3 Based on this information and considering the location of Morven South in relation to the predominant migration routes, barriers to Atlantic salmon migrating to and from SACs flowing into the Moray Firth are considered to be very low. All SACs for Atlantic salmon (and freshwater pearl mussel) located south of Fraserburgh and the Moray Firth have been screened in and all sites north of this, and within the Moray Firth itself, have been screened out.

3.2.2.4 Three of the five SACs advanced to the RIAA (River Tweed SAC, River Tay SAC and River Teith SAC) are also designated for Annex II river lamprey (*Lampetra fluviatilis)* and sea lamprey (*Petromyzon marinus)*. However, as stated in the Morven Site HRA Screening Report, these species were not considered as all three SACs were outside of the 100km buffer used to screen for lamprey and the marine phase of their life cycle is restricted to the coastal/estuarine environment. Given the distance of the Morven South Boundary offshore (approximately 86km from the nearest coastline), interactions between river lamprey and sea lamprey and activities associated with Morven South are not anticipated and no LSE[2] is predicted.

3.2.2.5 Two of the SACs (River Dee SAC and River South Esk SAC) are also designated for Annex II freshwater pearl mussel, which will not be directly affected by Morven South as it is restricted to freshwater environments but has the potential to be indirectly impacted due to its symbiotic life cycle with Atlantic salmon. The freshwater pearl mussel relies on Atlantic salmon, the host species during a critical parasitic phase of its life cycle, where its larvae attach to the gills of Atlantic salmon in mid to late summer and drop off in spring (Taeubert and Geist, 2017). Therefore, there could be an indirect effect upon the freshwater pearl mussel feature of European sites, should the Atlantic salmon population be adversely affected by Morven South.

3.2.2.6 As per the Morven Site HRA Screening Report, the re-screening in Section 5 of RIAA Part 1 and on the basis of no further comments being received from statutory stakeholders, the impacts outlined in Table 3.1 are screened in and the following impacts remain screened out of further assessment of Annex II diadromous fish and in this Stage 2 RIAA:

- temporary habitat loss and disturbance of habitats;
- increased suspended sediment concentrations and associated sediment deposition;
- long-term habitat loss;
- colonisation of hard structures.

3.2.2.7 A summary of the five SACs for Annex II diadromous fish features, alongside corresponding impacts for each phase of Morven South for which LSE[2] could not be ruled out and therefore were carried forward to the RIAA, are presented in Table 3.1.

3.2.3 Annex II marine mammals

3.2.3.1 A total of five SACs designated for Annex II marine mammals were advanced to the RIAA. These are as follows:

- Berwickshire and North Northumberland Coast SAC (for grey seal (*Halichoerus grypus*));
- Isle of May SAC (for grey seal);
- Firth of Tay and Eden Estuary SAC (for harbour seal (*Phoca vitulina*));
- Southern North Sea SAC (for harbour porpoise (*Phocoena phocoena*));
- Moray Firth SAC (for bottlenose dolphin (*Tursiops truncatus*)).

3.2.3.2 While it is acknowledged that NatureScot advised screening out the three SACs for seals based on the recommended 20km and 50km connectivity buffers for grey seal and harbour seal respectively (Table 2.1), Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the Environmental Impact Assessment (EIA) Report suggests connectivity with all three SACs (discussed further in Section 6.2.2). Therefore, they remain screened into the RIAA for further assessment.

3.2.3.3 For completeness, and to align the assessment of underwater sound impacts with the EIA, injury has been included along with disturbance to marine mammals from pre-construction site investigation surveys and from vessel use and other (non-piling) sound-producing activities. Furthermore, injury and disturbance to marine mammals from site investigation surveys has been assessed for both the construction phase and operation and maintenance (O&M) phase (only the construction phase was originally screened in in Morven Site HRA Screening Report) to ensure alignment with the EIA. This assessment has been undertaken as a combined assessment across both of these phases as the equipment parameters are the same. Further narrative has also been added to the disturbance to bottlenose dolphin associated with the Moray Firth SAC from vessel use on the advice of NatureScot (Table 2.1). These impacts are discussed in Section 6.3 for adverse effects of Morven South alone.

3.2.3.4 As per the Morven Site HRA Screening Report, the re-screening in Section 5 of RIAA Part 1 and on the basis of no further comments being received from statutory stakeholders, the impacts outlined in Table 3.1 are screened in and the following impacts remain screened out of further assessment of Annex II marine mammals in this Stage 2 RIAA:

- injury to marine mammals due to collision;
- effects on marine mammals due to changes in prey availability;

- accidental pollution;
- increased suspended sediment concentrations and associated sediment deposition;
- impact from Electromagnetic Field (EMF) from surface lain or buried cables;
- disturbance to marine mammals from operational sound from wind turbine operation.

3.2.3.5 A summary of the five SACs and relevant Annex II marine mammal features alongside corresponding impacts for each phase of Morven South for which LSE[2] could not be ruled out and therefore were carried forward to the RIAA, is presented in Table 3.1.

3.3 Screening outcomes for Morven South in-combination with other plans and projects

3.3.1 Annex II diadromous fish

3.3.1.1 A precautionary approach to the selection of relevant European sites for Annex II diadromous fish was adopted in the Morven Site HRA Screening Report. This involved the use of a large buffer of 100km and screening in all SACs which flowed into the Firth of Forth (Morven Site HRA Screening Report and Section 5 of RIAA Part 1). Due to this approach, all SACs relevant for Appropriate Assessment, particularly due to the potential for disruption to species migration (i.e. barriers to migration) to/from natal rivers, have been identified. Therefore, there is no potential for connectivity between the Morven South Boundary and Annex II diadromous fish from any additional SACs beyond those identified as relevant in the Morven Site HRA Screening Report.

3.3.1.2 No potential impact pathways were identified between Morven South and any additional sites designated for Annex II diadromous fish. Therefore, there is no potential for in-combination effects at any sites apart from those which are screened in for further assessment in this RIAA Part 2 (i.e. those listed in paragraph 3.2.2.1 and Table 3.1 as per the Morven Site HRA Screening Report and Section 5 of RIAA Part 1).

3.3.2 Annex II marine mammals

3.3.2.1 A precautionary approach to selection of relevant European sites for Annex II marine mammals was adopted in the Morven Site HRA Screening Report. Marine mammals are highly mobile animals with the potential to forage over wide areas. Therefore, all European sites for marine mammal features with a range that overlaps with the Morven South Boundary were considered. The screening area extended to the relevant marine mammal Management Units (MU) and Seal Management Units (SMU) for each species, as defined by the Inter Agency Marine Mammal Working Group (IAMMWG) for cetaceans (IAMMWG, 2022, IAMMWG, 2023), and by the Special Committee on Seals (SCOS) for harbour seal and grey seal (SCOS, 2024). For grey seal and harbour seal, the Morven South Boundary is located within the East Scotland Seal SMU and borders the Northeast England Seal SMU. Thus, any European sites that are located within the East Scotland SMU were considered, and a precautionary buffer of 100km was used to identify SACs within the adjacent SMU which had the potential for connectivity with Morven South. For harbour porpoise, the Morven South Boundary is within the North Sea MU, and SACs within this MU were considered for potential connectivity. The Morven South Boundary is located within the Greater North Sea MU for bottlenose dolphin, however the population associated with the Moray Firth SAC is known to be Coastal East Scotland MU, so SACs with potential connectivity to both these MUs were considered.

3.3.2.2 There were 19 transboundary sites identified within the search areas outlined above. However, all potential impact pathways were considered highly unlikely, given the distance between the Morven South Boundary and the sites (from 272.8km to 720.0km depending on the site) (Morven Site HRA Screening Report). As a result, only negligible effects would be apparent and could not contribute, in any material way, to an in-combination effect. As such, LSE[2] associated with planned projects or other activities in the vicinity of the Morven South Boundary are also not anticipated for marine mammal features of any transboundary site. This conclusion remained the same during the LSE2 re-screening exercise (Section 5 of RIAA Part 1).

3.3.2.3 No potential impact pathways were identified between Morven South and any additional sites designated for Annex II marine mammals. Therefore, there is no potential for in-combination effects at any sites apart from those which are screened in for further assessment in this RIAA Part 2 (i.e. those listed in paragraph 3.2.2.1 and Table 3.1). The potential in-combination impacts listed in Table 3.1 have been updated from the Morven Site HRA Screening Report due to the refinement of the in-combination screening in line with the Cumulative Effects Assessment (CEA) carried out for marine mammals in Volume 2, Chapter 10: Marine Mammals, of the EIA Report and consultation with NatureScot (Table 2.1). The in-combination assessment approach is detailed in Section 4.6 and in-combination impacts for Annex II marine mammals are discussed in Section 6.4.

Table 3.1: Summary of all Special Areas of Conservation for which the potential for Likely Significant Effect could not be discounted, and for which an Appropriate Assessment is required

Site ID	Site name	Distance to Morven South (km)	Relevant qualifying features	Project phase	Potential impact
Annex II diadromous fish					
UK0030251	River Dee SAC	93.6	Atlantic salmon Freshwater pearl mussel	Construction	• Underwater sound impacting fish and shellfish receptors (alone and in-combination)
UK0030262	River South Esk SAC	101.1	Atlantic salmon Freshwater pearl mussel		
UK0012691	River Tweed SAC	113.2	Atlantic salmon	Operation and maintenance (O&M)	• EMF from subsea electrical cables (alone and in-combination)
UK0030312	River Tay SAC	149.7	Atlantic salmon		
UK0030263	River Teith SAC	215.0	Atlantic salmon		
Annex II marine mammals					
UK0017072	Berwickshire and North Northumberland Coast SAC	97.2	Grey seal	Construction	• Injury and disturbance from underwater sound generated from piling (alone for all species and in-combination for all species excluding bottlenose dolphin) • Injury and disturbance from underwater sound generation from UXO clearance (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone)
UK0030172	Isle of May SAC	108.6	Grey seal		

Site ID	Site name	Distance to Morven South (km)	Relevant qualifying features	Project phase	Potential impact
					• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone and in-combination)
UK0030311	Firth of Tay and Eden Estuary SAC	109.3	Harbour seal	O&M	• Injury and disturbance to marine mammals from site investigation surveys (alone) • Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone and in-combination)
UK0030395	Southern North Sea SAC	135.1	Harbour porpoise	Decommissioning	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)
UK0019808	Moray Firth SAC	215.8	Bottlenose dolphin		

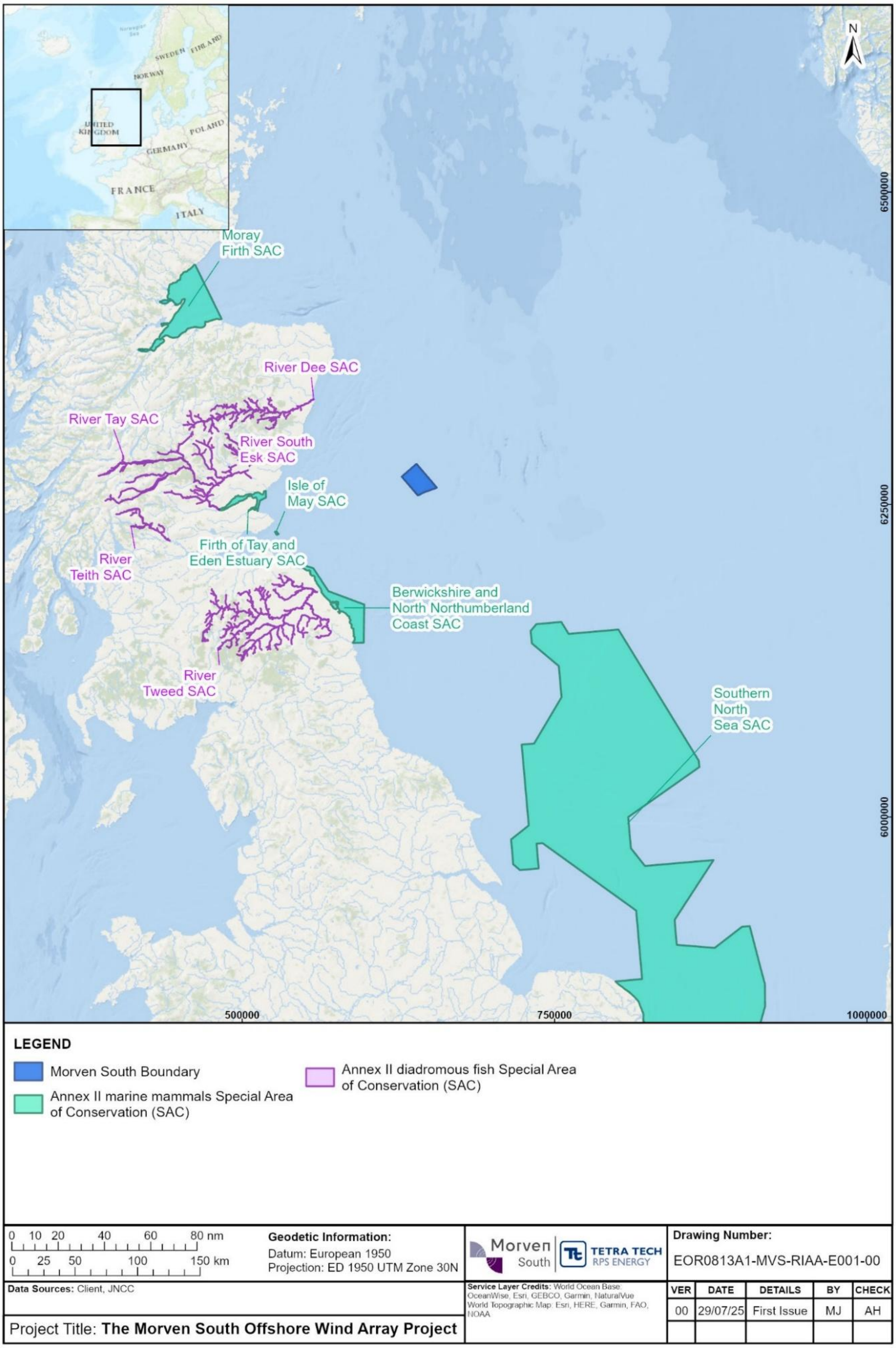

Figure 3.1: Location of all Special Areas of Conservation designated for Annex II diadromous fish and marine mammals for which an Appropriate Assessment is required

4 Information to inform the Appropriate Assessment

4.1 Introduction

4.1.1.1 As described in the RIAA Part 1, a European site is progressed to the Appropriate Assessment stage (Stage 2 of the HRA process) where it is not possible to exclude an LSE[2] on one or more of its qualifying features. European sites, features and potential impacts requiring an Appropriate Assessment for Morven South are therefore those for which LSE[2] could not be ruled out during the HRA screening exercise and following consultation.

4.1.1.2 Information to inform the Appropriate Assessment for SACs is provided in Sections 5 and 6of this RIAA Part 2. The information provided includes a description of the SACs under consideration, their qualifying interest features, and an assessment of the potential AEOI of the site in light of the conservation objectives of each site. A cross-referencing approach has been adopted to aid readability and reduce repetition where relevant, and this has been carefully carried out to ensure that all information required for a robust HRA of each site is presented.

4.2 Maximum Design Scenarios

4.2.1.1 The SAC assessments of impacts to qualifying features of SACs and effects on site integrity, presented in this RIAA Part 2 have been based on a realistic Maximum Design Scenario (MDS), which was derived from the details provided in the project description (Section 4 of RIAA Part 1). An overview of the MDS considered for the assessment of potential impacts on Annex II species is presented per impact (see Section 5 for diadromous fish and Section 6 for marine mammals). This MDS is consistent with that used for the assessments in Volume 2, Chapter 9: Fish and Shellfish Ecology and Volume 2, Chapter 10: Marine Mammals, of the EIA Report.

4.3 Designed-in measures

4.3.1.1 As part of the Morven South design process, a number of designed-in measures have been included in Morven South and are committed to be delivered by the Applicant as part of Morven South. These designed-in measures are integrated into the project description for Morven South and are not considered as mitigation measures intended to specifically avoid or reduce effects on European sites.

4.3.1.2 For the purposes of this Stage 2 RIAA, in alignment with the EIA Report, the term 'designed in measure' is used to include the following measures (adapted from Institute of Environmental Management and Assessment (IEMA) (2016, IEMA, 2024):

- Measures included as part of the Morven South Project design. These include modifications to the location or design of Morven South, which are integrated into the application for consent. These measures are considered standard industry practice for this type of development and are referred to as primary mitigation in IEMA (2016) and IEMA (2024).
- Measures required to meet legislative requirements, or actions that are generally standard practice used to manage commonly occurring environmental effects. These measures are secured through the conditions of the marine licences and referred to as tertiary mitigation in IEMA (2016) and IEMA (2024).

4.3.1.3 As there is a commitment to implementing these measures, they are considered inherently part of the design of Morven South and have therefore been considered in the assessments presented in Sections 5 and 6.

4.3.1.4 Measures intended specifically to avoid or reduce effects on European sites were not considered during the HRA LSE[2] Screening but are included within the HRA Stage 2 Appropriate Assessment for determination of AEOI of the site. Where relevant, this RIAA Part 2 indicates whether adverse effects on the qualifying features of European sites are likely and if so, whether those effects can be avoided through the introduction of mitigation measures that avoid or reduce the effect. These measures are referred to as additional mitigation and may be taken from the relevant chapters of the EIA Report (Volume 2, Chapter 9: Fish and Shellfish Ecology or Volume 2, Chapter 10: Marine Mammals). Where the latter is the case, this has been made clear throughout. All measures are detailed in Volume 3 Annex 6.4: EIA Commitments Register, of the EIA Report.

4.4 Baseline information

4.4.1.1 Baseline information on the SACs identified for further assessment within the HRA Stage 2 RIAA has been collated through a comprehensive review of existing desktop studies and datasets. Key desktop data sources are presented in Sections 5.2 and 6.2 for Annex II diadromous fish and marine mammals, respectively. Where applicable, any additional data sources used in the HRA Stage 2 RIAA are also included in these sections. Further baseline information is presented within the respective topic chapters in the EIA Report and accompanying technical reports for fish and shellfish and marine mammals (Volume 2, Chapter 9: Fish and Shellfish Ecology, Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report, Volume 2, Chapter 10: Marine Mammals and Volume 3, Annex 10.1: Marine Mammals Shared Baseline Technical Report, of the EIA Report).

4.5 Conservation objectives and conservation advice

4.5.1.1 The Statutory Nature Conservation Bodies (SNCBs) have produced conservation advice for European sites under their statutory remit. Their conservation advice provides supplementary information on European sites and their features, and although the content provided is similar, the format of the advice provided varies between the different SNCBs.

4.5.1.2 Owing to the location of Morven South, European sites with the potential to be impacted fall under the remit of the Joint Nature Conservation Committee (JNCC), NatureScot, and/or Natural England. For example, the conservation advice for the Berwickshire and North Northumberland Coast SAC was developed jointly by NatureScot and Natural England but is hosted on Natural England's Designated Site System as an interactive Conservation Advice Package (CAP), while the River Tweed SAC's CAP was produced by NatureScot and is hosted on the NatureScot sitelink system. The conservation advice for the Southern North Sea SAC has been jointly developed by Natural England and the JNCC but is hosted on JNCC's website in the form of a 'Conservation Objectives and Advice on Operations' document.

4.5.1.3 For those European sites under the statutory remit of NatureScot, CAP documents have been produced for all terrestrial SACs (many of the river SACs screened in for Annex II diadromous fish are considered terrestrial), while Conservation and Management Advice (CMA) documents cover marine SACs. These documents contain revised and updated conservation objectives for the features of each European site, site specific clarifications, advice for the conservation objectives to be achieved, and advice on management required to achieve said conservation objectives. At the time of writing, the River Teith SAC was the only site that does not have a CAP, CMA document, or conservation advice documents such as those detailed in paragraph 4.5.1.2.

4.5.1.4 Conservation objectives of European sites set the framework for establishing appropriate conservation measures for each feature and provide a framework against which plans or projects can be assessed. The conservation objectives present the essential elements needed to ensure that the Favourable Conservation Status (FCS) of a qualifying habitat or species is maintained or restored at the site. The integrity of the site will be maintained if all the conservation objectives are met.

4.5.1.5 Within the NatureScot CAPs and CMAs, the conservation objectives comprise overarching objectives (objectives 1 and 2) that apply to all qualifying features of the site, and additional objectives (2a, 2b and 2c) that have been written for each qualifying feature. Site specific supplementary advice is provided for each objective.

4.5.1.6 It is recognised in the conservation advice that if any feature of the European site is in unfavourable condition, the integrity of the site is deemed to be compromised, and the overarching objective is therefore to restore site integrity. NatureScot guidance, however, states that with the 'new style' conservation objectives it is not expected that plans or projects must include measures that lead to restoration of features (where restore objectives are in place) in order to gain approval from a competent authority (NatureScot, 2021, NatureScot, 2023a). Instead, a plan or project should not prevent site integrity from being able to be restored where necessary. HRAs should, therefore, focus on and consider if the plan or project is likely to undermine the conservation objectives of the site.

4.5.1.7 The assessment of Morven South alone and in-combination with other plans and projects focuses on the individual species-specific conservation objectives. This allows a proportionate approach, by demonstrating that potential impacts associated with Morven South alone and in-combination with other plans and projects will not have an adverse effect on the species-specific conservation objectives (2a to 2c/2d), and the overarching conservation objectives will, therefore, not be impaired.

4.6 Approach to the in-combination assessment

4.6.1.1 The approach taken for the assessment of in-combination impacts has been partly informed by the CEA carried out for relevant topics in the EIA Report (Volume 2, Chapter 9: Fish and Shellfish Ecology and Volume 2, Chapter 10: Marine Mammals). The methodology for the in-combination assessment is compliant with HRA guidance (NatureScot, 2023a) and is summarised in the following paragraphs.

4.6.1.2 The Morven Programme comprises four distinct projects: Morven North, Morven South, Morven Hawthorn Pit Grid Connection Project (MHPGC Project), and Morven Branxton Area Grid Connection Project (MBAGC Project).

4.6.1.3 The following assessment scenarios have been considered to identify the potential effects of Morven South in combination with other projects, as follows (and summarised in Table 4.1):

- Whole project assessment: to identify the potential impacts associated with Morven South together with each grid connection option in turn, (Scenario 1: MHPGC and Scenario 2: MBAGC Project), each of which would comprise a “whole project”;
- Morven Programme assessment: to identify potential impacts associated with all four components of the Morven Programme (Scenario 3);
- In-combination assessment: to identify the potential impacts associated with Morven South together with other relevant projects, plans and activities including other components of the Morven Programme, using a tiered approach (Scenario 4).

Table 4.1: Scenarios to be considered in the Morven South whole project assessment and in-combination assessment

Whole project assessment		Morven Programme assessment (RIAA Part 3 only)	In-combination assessment
Scenario 1	**Scenario 2**	**Scenario 3**	**Scenario 4**
Morven South + MHPGC Project	Morven South + MBAGC Project	Morven South + Morven North + MHPGC Project + MBAGC Project	Morven South + Tier 1, Tier 2 and Tier 3 Plans/Projects screened in

4.6.1.4 For the purposes of this RIAA Part 2, Scenarios 1, 2, and 4 have been taken forward for assessment; Scenario 3 has not been included as it is not applicable. As discussed in Volume 1, Chapter 6: EIA Methodology, of the EIA Report, the Morven Programme assessment (Scenario 3) is only required for specific topics (i.e. offshore ornithology in RIAA Part 3) to provide further context to, and to support, the conclusions of Scenario 4, in agreement with the relevant stakeholders for these topics. As Scenario 3 does not form the basis of the Scenario 4 conclusions, it is considered a supplementary assessment to Scenario 4 for these specific topics.

4.6.1.5 The screening undertaken for the CEA in Volume 2, Chapter 9: Fish and Shellfish Ecology and Volume 2, Chapter 10: Marine Mammals of the EIA Report, has been used to inform the list of projects and plans relevant to the in-combination assessment. Each project or plan has been considered on a case-by-case basis for screening in or out of this in-combination assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved. See Volume 3, Appendix 6.3: CEA Annex, of the EIA Report for further details on the screening process.

4.6.1.6 In undertaking the in-combination assessment for Morven South, it should be noted that other projects and plans under consideration will have differing potential for proceeding to an operational stage and hence a differing potential to ultimately contribute to a cumulative impact alongside Morven South. Therefore, a tiered approach has been adopted, whereby all third-party projects and plans considered have been allocated into 'tiers' reflecting their current stage within the planning and development process This provides a framework for placing relative weight upon the potential for each project/plan included in the in-combination assessment to ultimately be realised, based upon the project/plan's current stage of maturity and certainty in the project/plan's parameters. This includes the allocation of the other three components of the Morven Programme into Tiers for assessment in the in-combination assessment.

4.6.1.7 The tiered approach utilised within the Morven South in-combination assessment employs the following tiers:

- Tier 1 assessment – Existing developments either built (operational) or under construction[2]; approved developments awaiting implementation; and permitted/submitted application(s), but not yet determined, plus Morven North.
- Tier 2 assessment – All plans/projects assessed under Tier 1, plus MHPGC Project and plans/projects where a scoping report has been submitted and is in the public domain.
- Tier 3 assessment – All plans/projects assessed under Tier 1 and 2, plus MBAGC Project and plans/projects that are reasonably foreseeable (e.g. projects identified in development plans, projects in other plans and programmes, offshore renewable energy projects that have a Crown Estate Scotland Lease Option Agreement) and for which is sufficient information available in the public domain to enable a meaningful assessment.

4.6.1.8 The specific projects scoped into the in-combination assessment for Annex II diadromous fish and Annex II marine mammals are presented in Sections 5.4 and 6.4, respectively.

[2] Note that existing developments are included in Tier 1 CEA long list but are generally screened out of the CEA assessments, aside from the following exceptions:

a) Existing developments which were not present at the time of baseline characterisation, where a potential cumulative impact-receptor pathway has been identified.

b) Existing developments are screened into tier 1 assessments for specific topics where there is a large conceptual, temporal and spatial overlap between project impacts. In these instances, the potential for ongoing effects through cumulative impact-receptor pathways throughout project lifetime, across the development phases, means that they are considered within quantitative assessment for these topic CEAs (e.g., offshore ornithology assessments consider the cumulative effects of operational offshore wind farms).

5 Assessment of potential adverse effects on integrity: Annex II diadromous fish

5.1 Introduction

5.1.1.1 This section provides background information and an explanation for the approach taken to assess the potential impacts of Morven South on European sites designated for Annex II diadromous fish.

5.1.1.2 As stated in Section 3.2, the potential for LSE[2] was identified for the Annex II diadromous fish features of five SACs, which are listed in Table 5.1 and Figure 5.1.

Table 5.1: European sites designated for Annex II diadromous fish features for which an Appropriate Assessment is required

Site	Feature of potential impact	Period of potential impact
River Dee SAC	Atlantic salmon Freshwater pearl mussel	Construction and O&M phases
River South Esk SAC	Atlantic salmon Freshwater pearl mussel	
River Tweed SAC	Atlantic salmon	
River Tay SAC	Atlantic salmon	
River Teith SAC	Atlantic salmon	

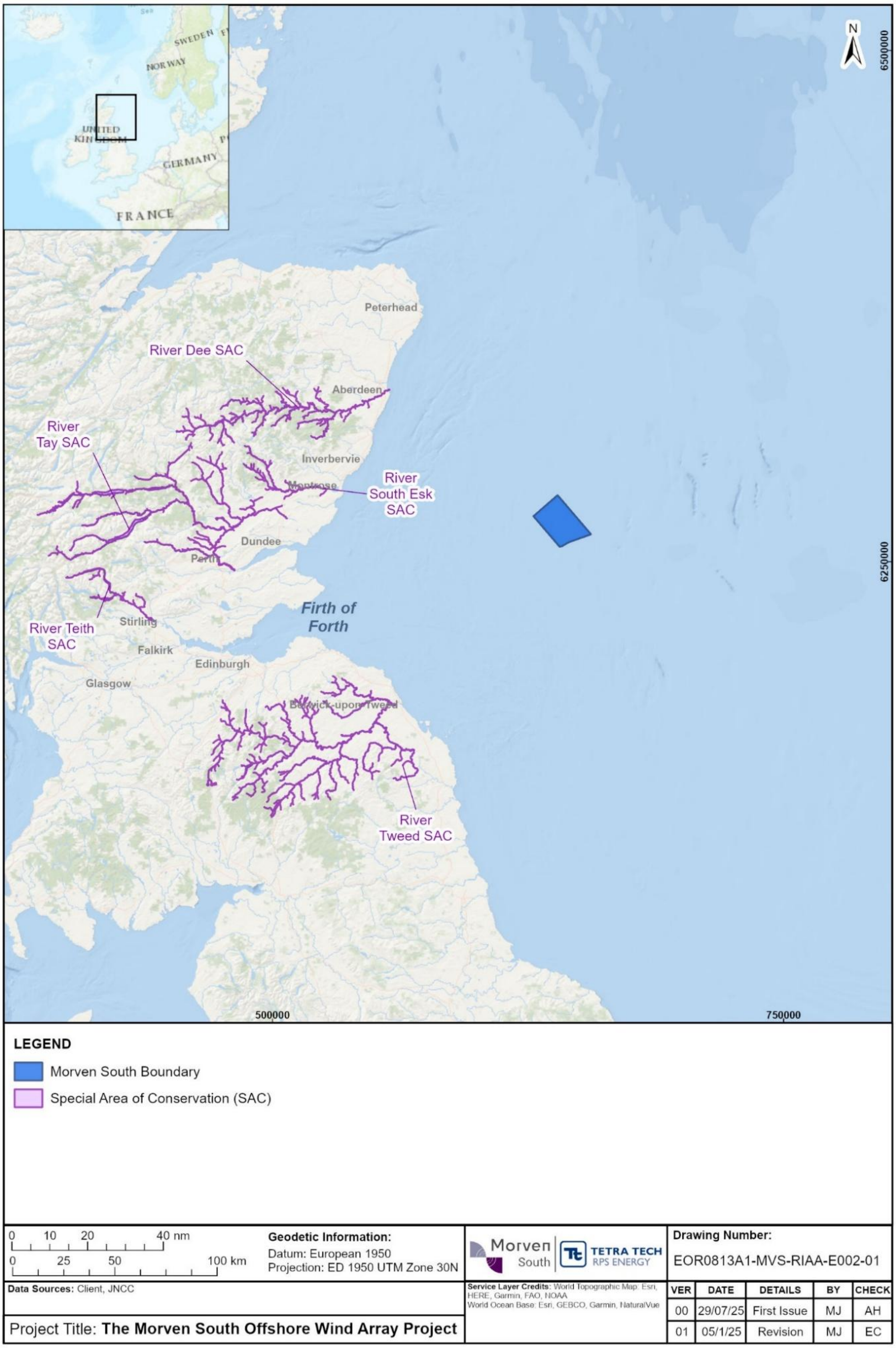

Figure 5.1: Location of European sites designated for Annex II diadromous fish for which an Appropriate Assessment is required

5.1.1.3 The potential for LSE[2]s on the SACs presented in Table 5.1 were identified for potential impact pathways during the construction and O&M phases of Morven South, which are outlined below in Table 5.2. A range of designed-in measures have been committed to as part of Morven South, and these are presented, where relevant, in Section 5.3 per impact, as well as in Volume 3 Annex 6.4: EIA Commitments Register, of the EIA Report.

Table 5.2: Potential impacts to Annex II diadromous fish of the European sites identified for Appropriate Assessment

Project phase	Potential impact
Construction	Underwater sound impacting fish and shellfish receptors
O&M	EMF from subsea electrical cables

5.1.1.4 The Appropriate Assessment (considering effects of Morven South both alone and in-combination) for European sites designated for Annex II diadromous fish are presented in Section 5.3 and 5.4 respectively. A summary of assessments undertaken within this RIAA Part 2 is provided in Section 7.

5.2 Baseline

5.2.1.1 Baseline information on the relevant Annex II diadromous fish and freshwater pearl mussel features screened in has been gathered through a comprehensive desktop study of existing datasets and materials. Full detail is provided in Volume 2, Chapter 9: Fish and Shellfish Ecology and Volume 3, Annex 9.1: Fish and Shellfish Ecology Shared Technical Report, of the EIA Report.

5.2.2 Feature accounts for Annex II diadromous fish

Atlantic salmon

5.2.2.1 Atlantic salmon is a diadromous fish, which lives in freshwater as a juvenile and in the marine environment as an adult. The life cycle of adult Atlantic salmon involves spawning in rivers. After eggs hatch, the newly hatched alevins remain in the gravel for several weeks before emerging as fry. The fry feed on microscopic life in the river and grow quickly transforming into parr at around a year old. The parr remain in the rivers feeding on small aquatic insects until they reach a size when they transform into smolt and begin their migration to the sea. Following one to three years at sea, salmon return as adults, typically, to their natal river. The return journey is guided by environmental cues, including the position of the sun, the Earth’s magnetic field (Hansen and Quinn, 1998), tidal phase and time of day (Smith and Smith, 1997). Upstream migration near estuaries often occurs at night during ebb tides (Smith and Smith, 1997). Smolts migrating downstream tend to be more active at night, using daytime for prey detection and avoiding predators (Hedger *et al.*, 2008).

5.2.2.2 Smolt emigration timing across Scotland was assessed by Malcolm *et al.* (2015), who concluded that most salmon tend to leave rivers from mid-April until the end of May, and that smolt emigration is occurring earlier (approximately 1.5 days earlier per decade over 50 years). An eastwards migration of Atlantic salmon smolts into the Moray Firth from the Cromarty Firth was determined by Glasgow University, for Beatrice Offshore Windfarm Ltd (Beatrice OWF Limited, 2017). This study also showed that when migrating, smolts tended to occupy the upper 1m of the water column.

5.2.2.3 Smolt were also tracked off Aberdeen to investigate the spatiotemporal distributions of juvenile Atlantic salmon migrating seawards from the Dee and Don rivers (Main *et al.*, 2023). This three-year study involved the tagging of 187 Dee salmon and 125 Don salmon. Results showed that salmon travelled at an average speed of 0.45m/s from Aberdeen Harbour to 4km offshore. From 4km to 20km offshore, speed reduced to 0.24m/s and specimens typically swam within 3m of the surface.

5.2.2.4 Atlantic salmon numbers have declined throughout their geographic range, including in Scottish rivers (JNCC, 2025h, NatureScot, 2025d). Data from recreational fishing in 2022 reported 42,204 Atlantic salmon individuals; an increase from the 35,693 individuals recorded in 2021 across Scotland, though the fourth lowest record since recordings began in 1952 by the Marine Directorate (Scottish Government, 2023). Recreational fishing data from Scottish east coast rivers (Tweed, Teith, Tay, South Esk, and Dee) show that Atlantic salmon migrate to and from east coast Scottish rivers, and that migrating smolts or returning adults may therefore pass through the Morven South Boundary during migration (Scottish Government, 2023).

5.2.2.5 Atlantic salmon are of considerable cultural and conservation importance (Hindar *et al.*, 2011). The species is subject to many pressures in both marine and freshwater environments. These include pollution, the introduction of non-native salmon stocks, physical barriers to migration, exploitation from netting and angling, physical degradation of spawning and nursery habitat, and increased marine mortality (Oslo Paris Convention Commission (OSPAR Commission, 2022)). Since 2016, as a result of the Salmon Conservation Regulations, Atlantic salmon caught in coastal waters must be released. This was implemented to prevent the killing of Atlantic salmon in coastal waters and estuaries to protect stocks that were in poor conservation status.

5.2.2.6 Alongside other salmonids (such as sea trout (*Salmo trutta)*), Atlantic salmon are host species for the parasitic larval phase of freshwater pearl mussel. Freshwater pearl mussel are strictly a freshwater species and have seen population declines throughout their United Kingdom (UK) range. A decline in Atlantic salmon stocks is one of the factors corresponding to this population decline. As stated in paragraph 3.2.2.5, the potential impact to Atlantic salmon can directly affect populations of Annex II freshwater pearl mussel, which has been assessed alongside Atlantic salmon in this RIAA Part 2.

Freshwater pearl mussel

5.2.2.7 Freshwater pearl mussel is a long-lived freshwater mollusc that lives in beds of clear, well-oxygenated, and fast-flowing rivers that are free of turbidity and pollution (JNCC, 2025l). They burrow into sandy substrates, often between boulders and pebbles (JNCC, 2025l). During their parasitic larval stage, freshwater pearl mussels are dependent upon a healthy population of salmonids (young Atlantic salmon or sea trout) which act as host species (Taeubert and Geist, 2017). Freshwater pearl mussel larvae attach to the gills of salmonid fish in mid to late summer and drop off the following spring. When they detach from their hosts they must land in sandy or gravelly substrates to settle and grow to adulthood (JNCC, 2025l). In suitable conditions they can live for over 100 years and grow up to 20cm.

5.2.2.8 Freshwater pearl mussels are filter feeders and are therefore particularly vulnerable to pollution and other changes in water quality (NatureScot, 2023b). Other threats to freshwater pearl mussels include hydrological alterations (including river engineering and abstractions), habitat degradation of river beds and banks, illegal fishing, and availability of host salmonids (JNCC, 2025l, NatureScot, 2023b).

5.2.2.9 Freshwater pearl mussel is widely distributed in Europe and northeastern North America but has suffered serious population declines and is threatened with extinction or is highly vulnerable in every part of its former range (JNCC, 2025l, NatureScot, 2023b). It is listed as 'critically endangered' in Europe by the International Union for the Conservation of Nature and Natural Resources (Moorkens, 2024). The species was formerly widespread throughout western and northern parts of the UK. However, England and Wales are each now believed to support only a single recruiting population. In Northern Ireland the species formerly occurred widely in several catchments but is now restricted to a few sites (NatureScot, 2023b). Many UK rivers now contain only scattered individuals, with no juvenile mussels recorded; such populations may become extinct due to lack of recruitment. Despite serious declines in both range and total population, Scotland is the remaining European stronghold for the species, supporting functional populations in over 50 rivers, mainly in the Highlands. Of the

26 SACs designated for freshwater pearl mussel, 19 are in Scotland, and two are included in this RIAA Part 2 (e.g. the River Dee SAC and the River South Esk SAC).

5.2.3 River Dee Special Area of Conservation

Site description

5.2.3.1 At its closest point, the River Dee SAC is located 93.6km northwest from the Morven South Boundary. The entire length of the River Dee is designated as a SAC due to its importance for Atlantic salmon and freshwater pearl mussel. The River Dee originates in the Cairngorms and flows through southern Aberdeenshire to reach the North Sea at Aberdeen. The River Dee SAC covers an area of 2,334.48ha and is designated for the following Annex II features: Atlantic salmon and freshwater pearl mussel (NatureScot, 2020c).

5.2.3.2 The ecology of Atlantic salmon is as described above in Section 5.2.2. Atlantic salmon within the River Dee SAC is considered a high-quality population with a high proportion of the River Dee accessible to Atlantic salmon, therefore, the river is able to support the entire range of life-history types found in Scotland including sub-populations of spring, summer salmon and grilse (salmon that have been at sea for a single year) being present. The River Dee supports a significant proportion of the Scottish salmon resource with the river contributing to approximately 4 – 5% of all salmon caught in Scotland (JNCC, 2025a).

5.2.3.3 The ecology of freshwater pearl mussel is as described above in Section 5.2.2. Freshwater pearl mussel relies upon salmonids of which the River Dee supports. Freshwater pearl mussel was historically common within the River Dee, with the population recorded approximately 30km from the river source to 6 to 7km upstream from the mouth. However, as noted in paragraph 5.2.3.8, the population has declined and is currently considered to be in unfavourable condition. The juvenile population of freshwater pearl mussel contributes to 30% of the total recorded population, indicating that there is strong recruitment, and is considered one of the most important populations of freshwater pearl mussel in the UK (JNCC, 2025a).

Conservation objectives

5.2.3.4 Conservation objectives for the River Dee SAC have been developed by NatureScot as part of a CAP (NatureScot, 2020c). Conservation objectives for all qualifying features of this SAC are:

- to ensure that the qualifying features of the River Dee SAC are in favourable condition and make an appropriate contribution to achieving FCS;
- to ensure that the integrity of the River Dee SAC is restored by meeting objectives 2a, 2b, 2c for each qualifying feature (and 2d for freshwater pearl mussel).

5.2.3.5 Conservation objectives for Atlantic salmon are as follows:

- 2a. Maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site;
- 2b. Maintain the distribution of Atlantic salmon throughout the site;
- 2c. Maintain the habitats supporting Atlantic salmon within the site and availability of food.

5.2.3.6 Conservation objectives for Freshwater pearl mussel are as follows:

- 2a. Restore the population of freshwater pearl mussel as a viable component of the site;
- 2b. Restore the distribution of freshwater pearl mussel throughout the site;
- 2c. Restore the habitats supporting freshwater pearl mussel within the site and availability of food;
- 2d. Maintain the distribution and viability of freshwater pearl mussel host species and their supporting habitats.

Condition assessment

5.2.3.7 Atlantic salmon was last assessed for their condition within the River Dee SAC in 2015 with freshwater pearl mussel last assessed in 2024 (NatureScot, 2025b). The outcome of these assessments are as follows:

- Atlantic salmon: favourable – maintained;
- freshwater pearl mussel: unfavourable – declining.

5.2.3.8 Freshwater pearl mussel was assessed as being in unfavourable condition due to the low number and density of freshwater pearl mussels present. This is due to low levels of juvenile recruitment, water flow, river morphology, the presence of filamentous algae, and water quality at the SAC (NatureScot, 2020c).

5.2.4 River South Esk SAC

Site description

5.2.4.1 At its closest point, the River South Esk SAC is located 101.1km west from the Morven South Boundary. The River South Esk SAC is located in Angus in Eastern Scotland and covers 471.85ha. The SAC is designated solely for Atlantic salmon and freshwater pearl mussel (NatureScot, 2020b).

5.2.4.2 The ecology of Atlantic salmon is as described above in Section 5.2.2. The River South Esk SAC once supported a large, high-quality Atlantic salmon population but as noted in paragraph 5.2.4.7, the population is currently considered to be in unfavourable condition. The River South Esk has a strong nutrient gradient along its length, rising in the nutrient-poor Grampians and flowing for half of its length through the rich agricultural lands of Strathmore. A high proportion of the River South Esk which is accessible to salmon, and the range of ecological conditions in the river, allows it to support the full range of life-history types found in Scotland, with sub-populations of spring, summer salmon and grilse all being present (JNCC, 2025c).

5.2.4.3 The ecology of freshwater pearl mussel is as described above in Section 5.2.2. This species is abundant in the River South Esk and is highest in the middle reaches of the river where they once attained densities of more than $20m^2$ (JNCC, 2025c). The River South Esk SAC once had an abundance of juveniles, comprising approximately 20% of the population (JNCC, 2025c). However, as noted in paragraph 5.2.4.8, the population has declined due to low juvenile recruitment (NatureScot, 2020b).

Conservation objectives

5.2.4.4 Conservation objectives for the River South Esk SAC have been developed by NatureScot as part of a CAP (NatureScot, 2020b). Conservation objectives for all qualifying features of this SAC are:

- to ensure that the qualifying features of the River South Esk SAC are in favourable condition and make an appropriate contribution to achieving FCS;
- to ensure that the integrity of the River South Esk SAC is restored by meeting objectives 2a, 2b, 2c for each qualifying feature (and 2d for freshwater pearl mussel).

5.2.4.5 Conservation objectives for Atlantic salmon are as follows:

- 2a. Restore the population of Atlantic salmon, including range of genetic types, as a viable component of the site;
- 2b. Restore the distribution of Atlantic salmon throughout the site;
- 2c. Restore the habitats supporting Atlantic salmon within the site and availability of food.

5.2.4.6 Conservation objectives for Freshwater pearl mussel are as follows:

- 2a. Restore the population of freshwater pearl mussel as a viable component of the site;
- 2b. Restore the distribution of freshwater pearl mussel throughout the site;

- 2c. Restore the habitats supporting freshwater pearl mussel within the site and availability of food;
- 2d. Restore the distribution and viability of freshwater pearl mussel host species and their supporting habitats.

Condition assessment

5.2.4.7 Atlantic salmon was last assessed for their condition within the River South Esk SAC in 2015 and freshwater pearl mussel in 2024 (NatureScot, 2025b). The outcome of these assessments are as follows:

- Atlantic salmon: unfavourable – recovering;
- freshwater pearl mussel: unfavourable – declining.

5.2.4.8 Freshwater pearl mussel was assessed as being in unfavourable condition due to the low number and density of freshwater pearl mussels present. This is due to low levels of juvenile recruitment, biological oxygen demand and disturbance of mussel beds through largely historical fishing (NatureScot, 2020b).

5.2.5 River Tweed Special Area of Conservation

Site description

5.2.5.1 At its closest point, the River Tweed SAC is located 113.2km southwest from the Morven South Boundary. The River Tweed SAC, located in Eastern Scotland and Northumberland and Tyne and Wear encompasses 3,742.62ha of the River Tweed's catchment and 1,285km of watercourse (NatureScot, 2020a). The SAC is designated for Annex I habitats and Annex II species, including a diadromous fish species relevant to this assessment: Atlantic salmon.

5.2.5.2 The ecology of Atlantic salmon is as described above in Section 5.2.2. The River Tweed supports a very large, high-quality population of Atlantic salmon, with sub-catchments in both Scotland and England. The river is the best example in the UK of a large river showing a strong nutrient gradient along its length, with oligotrophic conditions in its headwaters, and nutrient-rich lowland conditions just before it enters the sea at Berwick (JNCC, 2025d). The river supports the full range of salmon life history types, with sub-populations of spring, summer salmon and grilse all being present (JNCC, 2025d). Research by Gauld (2014) and Gauld *et al.* (2016) suggested that Atlantic salmon mainly spawn in the main lower stretches of the channel of the River Tweed. The extensive system supports a significant proportion of the Scottish salmon resource. In recent years, the salmon catch in the River Tweed is the highest in Scotland, with up to 15% of all salmon caught (JNCC, 2025d).

Conservation objectives

5.2.5.3 The River Tweed SAC crosses the border between England and Scotland. Management of the River Tweed SAC is shared by Natural England and NatureScot and conservation objectives for the site have been published by both SNCBs (Natural England, 2022, NatureScot, 2020a). In this assessment, both sets of conservation objectives have been consulted as the feature being assessed is a diadromous fish and therefore may migrate to and from the English or Scottish parts of the SAC.

5.2.5.4 A CAP for the River Tweed SAC has been developed by NatureScot (2020a). Conservation objectives for qualifying features are:

- to ensure that the qualifying features of the River Tweed SAC are in favourable condition and make an appropriate contribution to achieving FCS;
- to ensure that the integrity of the River Tweed SAC is restored by meeting objectives 2a, 2b, 2c for each qualifying feature.

5.2.5.5 Conservation objectives for Atlantic salmon are as follows:

- 2a. Maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site;
- 2b. Maintain the distribution of Atlantic salmon throughout the site;
- 2c. Maintain the habitats supporting Atlantic salmon within the site and availability of food.

5.2.5.6 Conservation objectives and related supplementary advice developed by Natural England apply to those parts of the SAC in England (Natural England, 2022). The high-level objectives for the site are:

- to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the FCS of its Qualifying Features, by maintaining or restoring:
  - the extent and distribution of qualifying natural habitats and habitats of qualifying species;
  - the structure and function (including typical species) of qualifying natural habitats;
  - the structure and function of the habitats of qualifying species;
  - the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
  - the populations of qualifying species;
  - the distribution of qualifying species within the site.

5.2.5.7 The second conservation objective: 'the structure and function (including typical species) of qualifying natural habitats' is only relevant to the Annex I habitat features of the River Tweed SAC and is therefore not included further in this assessment on Annex II diadromous fish features.

5.2.5.8 Supplementary advice on conservation objectives (published on 31 August 2022) (Natural England, 2022) provides the site specific attributes and targets specific to the Atlantic salmon of the SAC and are summarised here:

- restore the population to that expected under un-impacted conditions, allowing for natural fluctuations;
- maintain juvenile densities at those expected under un-impacted conditions throughout the site, taking into account natural habitat conditions and allowing for natural fluctuations;
- restore the distribution of spawning to reflect un-impacted conditions through the site, and avoid reductions in existing levels;
- maintain or where necessary restore the distribution and continuity of the feature and its supporting habitat, including where applicable its component vegetation types and associated transitional vegetation types, across the site;
- maintain or where necessary restore the total extent of the habitats which support the feature at 156.20km (the entire length of the English portion of the river), including habitat mosaics, supply of coarse and fine sediment, water flows, underlying soil types, water quality, vegetation, and thermal regime;
- the movement of other characteristic biota should not be artificially constrained;
- maintain or where necessary restore the feature's ability, and that of its supporting habitat, to adapt or evolve to wider environmental change, either within or external to the site;
- ensure non-native species categorised as 'high-impact' in the UK under the Water Framework Directive (WFD) are either rare or absent but if present are causing minimal damage to the feature;
- maintain or, where necessary, restore concentrations and deposition of air pollutants to at or below the site-relevant Critical Load or Level values given for this feature of the site;
- ensure exploitation (e.g. netting or angling) of Atlantic salmon is undertaken sustainably without compromising any components of the population, including multi-sea winter fish and seasonal components of the adult run;
- ensure fish stocking introductions do not interfere with the ability of the river to support self-sustaining populations of the feature;
- maintain a sufficient proportion of all aquatic macrophytes to allow them to reproduce in suitable habitat and unaffected by river management practices.

Condition assessment

5.2.5.9 Atlantic salmon was last assessed for their condition within the River Tweed SAC in 2015 (NatureScot, 2025b). The outcome of these assessments are as follows:

- Atlantic salmon: favourable – maintained.

5.2.6 River Tay Special Area of Conservation

Site description

5.2.6.1 At its closest point, the River Tay SAC is located 149.7km west from the Morven South Boundary. The SAC comprises the longest river in Scotland, originating in western Scotland, flowing easterly across the Highlands before becoming tidal at the Firth of Tay. The River Tay drains a very large catchment and has the greatest flow of all UK rivers (JNCC, 2025e). The River Tay SAC covers an area of 9,461.63ha. The SAC is designated for Annex I habitats and Annex II species including the diadromous fish species relevant to this assessment: Atlantic salmon (NatureScot, 2020d).

5.2.6.2 The ecology of Atlantic salmon is as described above in Section 5.2.2. The River Tay supports a high-quality Atlantic salmon population, with rod catch returns showing that it is consistently one of the top three salmon rivers in Scotland (JNCC, 2025e). In 1999 the catch was 7,230 fish, over 10% of the Scottish total (JNCC, 2025e). There is considerable ecological variety in the River Tay catchment, resulting in the SAC supporting the full range of salmon life history types found in Scotland, with adult salmon entering the River Tay throughout the year to spawn in different parts of the catchment (JNCC, 2025e).

5.2.6.3 As stated in paragraph 5.2.2.4, Atlantic salmon numbers have declined throughout their geographic range, including in Scottish rivers. In the River Tay, the proliferation of small scale hydro schemes, Invasive Non Native Species (INNS) such as the North American signal crayfish (*Pacifastacus leniusculus)*, and diffuse pollution from agriculture are having a notable impact upon the Atlantic salmon population (NatureScot, 2020d). However, in spite of this, as noted in paragraph 5.2.6.6, the last condition assessment was favourable.

Conservation objectives

5.2.6.4 Conservation objectives for the River Tay SAC have been developed by NatureScot as part of a CAP (NatureScot, 2020d). Conservation objectives for all qualifying species features are:

- to ensure that the qualifying features of River Tay SAC are in favourable condition;
- to ensure that the integrity of the River Tay is maintained by meeting objectives 2a, 2b and 2c for each qualifying feature and make an appropriate contribution to achieving FCS.

5.2.6.5 Conservation objectives for Atlantic salmon are as follows:

- 2a. maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site;
- 2b. maintain the distribution of Atlantic salmon throughout the site;
- 2c. maintain the habitats supporting Atlantic salmon within the site and availability of food.

Condition assessment

5.2.6.6 The condition of Atlantic salmon condition within the River Tay SAC was assessed in 2015 (NatureScot, 2025b). The outcomes of these feature condition assessments were as follows:

- Atlantic salmon: favourable – maintained.

5.2.7 River Teith Special Area of Conservation

Site description

5.2.7.1 At its closest point, the River Teith SAC is located 215.0km southwest from the Morven South Boundary. The river begins in Loch Lomond and the Trossachs National Park and flows through Stirling and into the Firth of Forth. The SAC encompasses 1,289.33ha and is designated for Annex II diadromous fish species, including Atlantic salmon, which is relevant to this assessment (JNCC, 2025j, NatureScot, 2015).

5.2.7.2 The ecology of Atlantic salmon is as described above in Section 5.2.2. Atlantic salmon are present as a qualifying feature of this SAC, but not a primary reason for site selection. This, in combination with no CAP available for this site, results in a lack of site specific information about this species. However, it is noted in the Standard Data Form for this SAC that it is considered to support a significant presence of Atlantic salmon (JNCC, 2015), although as noted in paragraph 5.2.7.5, the last condition assessment was unfavourable.

Conservation objectives

5.2.7.3 A CAP has not yet been published for the River Teith SAC. However, conservation objectives for all qualifying species have been defined to avoid deterioration of their habitats or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained, and that the site makes an appropriate contribution to achieving FCS for each of the qualifying species (NatureScot, 2015). The following conservation objectives are to be maintained in the Long-term for the qualifying species:

- the population of the species, including range of genetic types for Atlantic salmon, as a viable component of the site;
- the distribution of the species within site;
- the distribution and extent of habitats supporting the species;
- the structure, function and supporting processes of habitats supporting the species;
- there is no significant disturbance of the species.

5.2.7.4 Conservation objectives specific to Atlantic salmon (e.g. 2a, 2b, and 2c) were not provided (NatureScot, 2015).

Condition assessment

5.2.7.5 As stated in paragraph 4.5.1.3, there was no CAP available for the River Teith SAC at the time of writing. However, NatureScot last assessed the condition of Atlantic salmon within the SAC in 2015 (NatureScot, 2025b) as unfavourable – recovering.

5.3 Assessment of the adverse effects of Morven South alone

5.3.1 Underwater sound impacting fish and shellfish receptors

5.3.1.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction phase, LSE[2] could not be ruled out for underwater sound impacting fish and shellfish receptors. This relates to the following sites and relevant Annex II diadromous fish features:

- River Dee SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River South Esk SAC:
  - Atlantic salmon;

    - freshwater pearl mussel.

- River Tweed SAC:
  - Atlantic salmon.
- River Tay SAC:
  - Atlantic salmon.
- River Teith SAC:
  - Atlantic salmon.

5.3.1.2 The MDS and designed-in measures considered for the assessment of underwater sound impacting fish and shellfish receptors are shown in Table 5.3 and Table 5.4, respectively.

Table 5.3: Maximum Design Scenario considered for the assessment of potential impacts to Annex II diadromous fish due to underwater sound impacting fish and shellfish receptors during the construction phase

Project phase	MDS	Justification
Construction	**Piling** Concurrent piling with up to two vessels, at a minimum distance of 1km and a maximum distance of 27.7km, piling at 73 foundations comprising: • 67 wind turbines: – 16m diameter monopiles; – Maximum hammer energy of 6,600kJ; – Maximum duration of 24h piling per monopile, with a maximum of two foundations per day (concurrently); – Total of 34 days of concurrent piling. • Four HVAC collector Offshore Substation Platforms (OSPs) : – 16m diameter monopiles; – Maximum hammer energy of 6,600kJ; – Maximum duration of 24h piling per monopile, with a maximum of two foundations per day (concurrently); – Total of two days of concurrent piling. • One bridge-linked (=two foundations) High Voltage Direct Current (HVDC) converter OSP: – Two six-legged jacket foundations (bridge-linked); – 24 x 5m (modelled as 5.3m) diameter pin piles per foundation, equals 48 pin piles for two bridge-linked foundations; – Maximum hammer energy of 4,000kJ; – Maximum duration of 9h piling per pin pile, with an average of two piles per day; – Total of 12 days of piling (based on four piles per day); Total duration of piling = 34 + 2 + 12 = 48 days. **UXO Clearance** • Clearance of up to 15 UXOs within the Morven South Boundary;	**Piling** The MDS assumes that concurrent piling of the largest diameter monopiles (16m) using the greatest hammer energy (6,600kJ) would lead to the largest spatial extent of ensonification at any one time. The MDS assumes the maximum number of piles would be installed per day. Minimum spacing between concurrent piling (1km) represents the highest risk of injury to animals as noise from adjacent foundations could combine to produce a greater radius of effect compared to a single piling event. Maximum spacing between concurrent piling (27.65km) represents the highest risk of behavioural effects to fish and shellfish receptors as a larger area would be ensonified at any one time. **UXO Clearance** Maximum number and maximum realistic size of UXOs encountered is based on the UXO Hazard Assessment undertaken for Morven South (MvOWL, 2023).

Project phase	MDS	Justification
	• maximum charge weight of 554kg Net Explosive Quantity (NEQ); • most likely charge weight of 132kg NEQ; • maximum of one detonation within 24 hours; • total duration of UXO clearance campaign 15 days (excluding downtime for e.g. weather); • clearance during daylight hours only.	

Table 5.4: Designed-in measures considered for the assessment of potential impacts to Annex II diadromous fish to underwater sound impacting fish and shellfish receptors during the construction phase

Reference number	Designed-in measure	Justification	Primary or tertiary
MM-40	Development of and adherence to a piling strategy which will include a soft-start procedure (including low hammer initiation and ramp up) to be implemented for pile driving.	To reduce the likelihood of injury from elevated underwater noise to marine receptors (i.e. diadromous fish) in the immediate vicinity of piling operations as much as possible, allowing individuals to move away from the area before sound levels reach a level at which injury may occur.	Primary
MM-16	UXO clearance using low order disposal techniques where technically feasible	Where reasonably practical, low order techniques will be adopted as mitigation to reduce sound levels and thereby minimise injury and disturbance to sound-sensitive receptors (i.e. diadromous fish) during UXO clearance.	Primary

Information to inform the assessment

Sensitivity of Annex II diadromous fish to underwater sound

5.3.1.3 Underwater sound can potentially have an adverse impact on fish species ranging from physical injury and mortality to behavioural effects. Recent peer reviewed guidelines have been published by the Acoustical Society of America (ASA) and provide directions and recommendations for setting criteria (including injury and behavioural criteria) for fish. The Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al.*, 2014) are considered the most relevant and best available guidelines for impacts of underwater sound on fish species.

5.3.1.4 The Popper *et al.* (2014) guidelines broadly group fish into the following categories according to the presence or absence of a swim bladder and on the potential for that swim bladder to improve the hearing sensitivity and range of hearing:

- Group 1: Fishes lacking swim bladders (e.g. elasmobranchs, flatfish and lampreys). These species are only sensitive to particle motion, not sound pressure and show sensitivity to only a narrow band of frequencies.
- Group 2: Fishes with a swim bladder but the swim bladder does not play a role in hearing (e.g. Atlantic salmon). These species are considered more sensitive to particle motion than sound pressure and show sensitivity to only a narrow band of frequencies.
- Group 3: Fishes with swim bladders that are close, but not connected, to the ear (e.g. gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than Groups 1 and 2, extending to approximately 500Hz.
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring (*Clupea harengus*)). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3.
- Eggs and larvae: separated due to greater vulnerability and reduced mobility. Only few peer-reviewed studies report on the response of eggs and larvae to anthropogenic underwater sound.

5.3.1.5 Group 4 hearing specialist fish possess an otic bulla, which is a gas filled sphere connected to the swim bladder, which enhances hearing ability. Atlantic salmon do not have this anatomy, although their gas filled swim bladders may be involved in their hearing capability in some way (Popper *et al.*, 2014). While there is no direct link to the inner ear, Atlantic salmon can detect lower noise frequencies and as such are considered to be a Group 2 species and therefore have a higher hearing sensitivity than Group 1 species, but comparatively low with respect to Group 3 and Group 4 species (Popper *et al.*, 2014).

5.3.1.6 For freshwater pearl mussel, only indirect effects due to a symbiotic life cycle with Atlantic salmon are possible, given that they are a freshwater-resident species, and there will be no underwater sound produced at Morven South which will reach freshwater habitats along the coast.

Summary of underwater sound modelling conducted for Morven South

5.3.1.7 Piling and UXO clearance activities may lead to direct injury and/or disturbance to Atlantic salmon and indirect effects upon freshwater pearl mussel. Underwater sound modelling has been undertaken based on the MDS for this impact (Table 5.3) to understand the extent of noise emissions from piling and UXO clearance during the construction phase. The full details of this modelling can be found in Volume 3, Annex 3.1: Underwater Shared Sound Technical Report, of the EIA Report, with a brief summary provided in the following sections to inform the assessment of potential for adverse effects on Annex II diadromous fish and shellfish.

Injury and disturbance from piling

5.3.1.8 The MDS for this impact assumes concurrent piling of 16m diameter monopile foundations, leading to the largest area of effect at any one time, for which underwater sound modelling was undertaken

(Table 5.3). The following assumptions were identified for concurrent piling, based on the parameters provided in Volume 1, Chapter 3: Project Description, of the EIA Report, and site bathymetry (see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report):

- minimum separation distance of 1km between concurrent piling events as the MDS for potential injury;
- maximum separation distance of up to 37.1km as the MDS for potential disturbance.

5.3.1.9 A summary of the piling parameters for the MDS is shown below in Table 5.5. The underwater sound modelling presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report, selected three conservative pile types to represent the suite of different options available; two of these pile types (16m monopiles and 5.3m pin pile) have been presented here as the basis for the assessment.

Table 5.5: Details of hammer and helmet weights in the modelling and representations of different foundation types/hammer energies presented in this assessment

Pile	Hammer model	Hammer energy (kJ)	Foundation/ hammer Represented	Justification
16m monopile	IQIP IQ6	6,600	16m monopile, 6,600kJ	16m monopile is the maximum adverse spatial for wind turbines and OSP Option 1
5.3m pin pile	IQIP IQ6	4,500	5.0m pin pile, 4.5m pin pile, 4,000kJ	The 5.3m pin pile was selected to capture the maximum ranges across all pin pile diameters (i.e. for the OSP Option 2) including the 5.0m and 4.5m.

5.3.1.10 As detailed in Table 5.4, the use of soft-starts (including low hammer initiation and ramping up to full hammer energy) during piling is considered to be a primary designed-in measure. This may allow time for Atlantic salmon to flee the area prior to full power piling.

5.3.1.11 The underwater sound modelling presented outputs as Best Estimates (BE) and Upper Bound (UB) to represent the median and maximum geoacoustic profiles respectively. These are described as realistic and conservative for the BE and UB respectively. Effect ranges for Cumulative Sound Exposure Level (SEL_{cum}) were given as the absolute maximum (R_{max}) and the maximum after removing the most distant 5% (i.e. the outliers) ($R_{95\%}$). For Peak Sound Pressure Level (SPL_{pk}), four depths were modelled A-D, with A representing the shallowest and D represented representing the deepest water depth for piling. For the different piling scenarios, the modelling using the SEL_{cum} metric considered fish as static receptors. It should be noted that, in reality, most fish are not likely to remain static for the duration of piling, and therefore being modelled as static receptors is highly precautionary.

5.3.1.12 The Popper *et al.* (2014) guidelines set out criteria for the onset of mortality, recoverable injury, and Temporary Threshold Shift (TTS) due to impulsive piling and include two parameters for assessment: SEL_{cum} and SPL_{pk}, both of which are unweighted. The thresholds for Group 2 fish (Atlantic salmon) are presented in Table 5.6. Physiological effects relating to injury criteria are as follows (Hawkins and Popper, 2014, Popper *et al.*, 2014):

- Mortality and potential mortal injury: either immediate mortality or tissue and/or physiological damage that is sufficiently severe (e.g. a barotrauma) that death occurs sometime later due to decreased fitness. Mortality has a direct effect upon animal populations, especially if it affects individuals close to maturity.
- Recoverable injury: Tissue and other physical damage or physiological effects, that are recoverable, but which may place animals at lower levels of fitness, may render them more

open to predation, impaired feeding and growth, or lack of breeding success, until recovery takes place.

- TTS: Short-term changes in hearing sensitivity may, or may not, reduce fitness and survival. Temporary impairment of hearing may affect the ability of animals to capture prey and avoid predators and also cause deterioration in communication between individuals affecting growth, survival, and reproductive success. After termination of a noise that causes TTS, normal hearing ability returns over a period that is variable, depending on many factors, including the intensity and duration of exposure.

Table 5.6: Criteria for the onset of injury to group 2 fish (i.e. Atlantic salmon) from impulsive piling (Popper *et al.*, 2014)

Hearing Group	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	TTS
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	SEL, dB re 1µPa^{2}s	210	203	>186
	SPL_{pk}, dB re 1µPa	>207	>207	-

5.3.1.13 Behavioural reactions of fish to underwater sound have been found to vary between species based on their hearing sensitivity. Typically, fish sense sound via particle motion in the inner ear which is detected from sound-induced motions in the fish's body (see Volume 3, Appendix 10.2: Underwater Sound Shared Technical Report, of the EIA Report for further details). The detection of sound pressure is restricted to those fish which have air filled swim bladders; however, particle motion (induced by sound) can be detected by fish without swim bladders. The gas filled swim bladder in Atlantic salmon may be involved in their hearing capabilities, so although there is no direct link to the inner ear, these species are able to detect lower sound frequencies and as such are considered to be of medium sensitivity to sound.

5.3.1.14 Popper *et al.* (2014) sets out qualitative criteria for disturbance due to different sources of sound. The risk of behavioural effects is categorised in relative terms as "high", "moderate" or "low" at three distances from the source: "near", "intermediate" or "far" as shown in Table 5.7. Since these criteria are qualitative not quantitative, an underwater sound source of a particular type (e.g. piling) would be predicted to result in the same potential impact, no matter the level of underwater sound produced or the propagation characteristics.

5.3.1.15 Criteria presented in the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011) have been used to inform other offshore wind farm underwater sound assessments for predicting the distances at which behavioural effects may occur due to underwater sound from impulsive piling (e.g. Ossian Offshore Windfarm Limited (Ossian OWFL, 2024c)). This manual suggests an unweighted SPL of 150dB re 1µPa (Root Mean Square (rms)) as the criterion for onset of behavioural effects, based on work by Hastings (2002). SPL in excess of 150dB re 1µPa (rms) may to cause temporary behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area. The document notes that levels exceeding this threshold are not expected to cause direct permanent injury but may indirectly affect the individual fish (such as by impairing predator detection). It is important to note that this threshold is a guide for onset of effects, and not necessarily an 'AEOI' threshold.

5.3.1.16 In addition, a study by Harding *et al.* (2016) failed to produce physiological or behavioural responses in Atlantic salmon when subjected to noise similar to piling. However, the noise levels tested were estimated at <160 dB re 1µPa (rms), below the level at which injury or behavioural disturbance would be expected for this species. Nedwell *et al.* (2006) compared behavioural responses to piling in Atlantic salmon and found no significant behavioural response. Physical impacts on migrating salmonids exposed to piling noise of 218dB re 1µPa^{2}s (SEL) were recorded by Bagočius (2015), although at these high noise levels, avoidance reactions would be expected, in order to avoid injury. Following consultation with NatureScot during the Scoping Workshop, it was agreed that the modelled sound contours at 160dB re 1µPa (SPL_{pk}) would be used as a guide for the potential for behavioural disturbance across all fish species. This value was based on a number of literature sources (McCauley *et al.*, 2000, Mueller-Blenkle *et al.*, 2010) and was deemed appropriate and proportionate for this assessment. As such, the modelled SPL_{pk} 160dB re 1µPa contours have been applied to the assessment of disturbance due to piling for Atlantic salmon. It should be noted that this is highly precautionary for Atlantic salmon, which are a Group 2 species, and therefore less sensitive to underwater sound than Group 3 and 4 species (upon which most literature sources focus on).

Table 5.7: Criteria for the onset of behavioural effects in Atlantic salmon (a Group 2 fish species) from different underwater sound sources (Popper *et al.*, 2014)

Hearing Group	Relative Risk of Behavioural Effects	
	Impulsive piling	Explosives
Group 2 Fish: where swim bladder is not involved in hearing (particle motion detection)	(Near) High (Intermediate) Moderate (Far) Low	(Near) High (Intermediate) High (Far) Low

5.3.1.17 The potential mortality, recoverable injury and TTS ranges modelled for concurrent piling of the wind turbine foundation scenario are presented in Table 5.8 for fish modelled as static receptors using the SEL_{cum} metric; this is based on minimum spacing between 16m monopile operations.

5.3.1.18 The modelling results suggest that the thresholds for mortality will be exceeded for Atlantic salmon and could occur out to a range of 7.38km, with recoverable injury out to 14.0km (Table 5.8). TTS ranges were higher, at a range of 37.1km; however, this is considered to be reversible.

Table 5.8: Potential mortality, recoverable injury and Temporary Threshold Shift ranges for concurrent 16m wind turbine monopile installation, based on the SEL_{cum} metric for static fish

Hearing Group	Response	Threshold (SEL: db re 1µPa2s)	Range (km)
Group 2 Fish (Atlantic salmon)	Mortality	210	7.38
	Recoverable injury	203	14.0
All hearing groups	TTS	186	37.1

5.3.1.19 The potential ensonified areas over which mortality and recoverable injury could occur due to concurrent piling of the wind turbine foundations are presented in Table 5.9 for fish modelled as static receptors using the SPL_{pk} metric; this is based on minimum spacing between 16m monopile operations. The modelling results suggest that the thresholds for mortality and recoverable injury will be exceeded for Atlantic salmon, with an ensonified area of 1.94km^2 (Table 5.9).

Table 5.9: Potential mortality and recoverable injury areas for concurrent 16m wind turbine monopile installation, based on the Peak Sound Pressure Level metric for static fish

Hearing Group	Response	Threshold (SPL_{pk} dB re 1μPa)	Ensonified area to level (km^2)
Group 2 fish (Atlantic salmon)	Mortality	207	1.94
	Recoverable injury	207	1.94

5.3.1.20 The potential injury and disturbance ranges for concurrent piling of the OSP foundations are presented in Table 5.10 for fish modelled as static receptors using the SEL_{cum} metric; this is based on minimum spacing between 5.3m pin pile operations. The modelling results suggest that the thresholds for mortality and recoverable injury will be exceeded for Atlantic salmon and that mortality could occur out to a range of 4.11km and recoverable injury out to 8.97km. TTS ranges were higher, at out to 37.4km; however, these are reversible.

Table 5.10: Potential mortality, recoverable injury and Temporary Threshold Shift ranges for concurrent Offshore Substation Platform installation (5.3m pin pile), based on the Cumulative Sound Exposure Level metric for static fish

Hearing Group	Response	Threshold (SEL: dB re $1\mu Pa^2 s$)	Range (km)
Group 2 Fish (Atlantic salmon)	Mortality	210	4.11
	Recoverable injury	203	8.97
All hearing groups	TTS	186	37.4

5.3.1.21 The potential ensonified areas over which injury could occur for concurrent piling of OSPs are presented in Table 5.11 for fish modelled as static receptors using the SPL_{pk} metric; this is based on minimum spacing between 5.3m pin pile operations. The modelling results suggest that the thresholds for mortality and recoverable injury will be exceeded Group 2 fish (which includes Atlantic salmon). The maximum ensonified area was modelled as $0.33km^2$ (Table 5.11).

Table 5.11: Potential mortality and recoverable injury ranges for concurrent Offshore Substation Platform foundation installation (5.3m pin pile), based on the SPL_{pk} metric

Hearing Group	Response	Threshold (SPL_{pk} db re 1 μPa)	Ensonified area to SPL_{pk} threshold (km^2)
Group 2 fish (Atlantic salmon)	Mortality	207	0.33
	Recoverable injury	207	0.33

5.3.1.22 As detailed in paragraph 5.3.1.16, sound contours at 160dB re 1μPa (SPL_{pk}) have been used as a guide for the potential for behavioural disturbance to Atlantic salmon. As noted, this is highly precautionary for Atlantic salmon, which are a Group 2 species, and therefore less sensitive to underwater sound than Group 3 and 4 species. It should also be noted that these ranges are based on the conservative piling scenarios modelled and therefore represent the MDS, which is unlikely to occur in reality under a realistic piling scenario. Additional information is provided here with regards to behavioural disturbance for Atlantic salmon.

5.3.1.23 The modelled SPL_{pk} sound contours are presented on Figure 5.2, and present the following four piling scenarios:

- single piling of the UB piling scenario for the 16m monopile foundation, at the deepest location;
- single piling of the UB piling scenario for the 5.3m pin pile foundation, at the deepest location;
- concurrent piling of the UB piling scenario for the 16m monopile foundation, at the deepest location, with the monopiles at maximum spacing of 37.1km;
- concurrent piling of the maximum piling scenario for the 5.3m pin pile foundation, at the deepest location, with the pin piles at maximum spacing of 37.1km.

5.3.1.24 Given that there is limited evidence of behavioural disturbance from underwater sound, TTS is often used as a proxy for behavioural disturbance in fish. This is because it can be assumed that individuals experiencing TTS will likely also experience some disturbance. The assessment of behavioural disturbance using TTS as a proxy is based on the MDS presented in Table 5.3. The largest TTS range of 37.1km was modelled for concurrent piling of two 16m monopiles at the maximum spacing, with fish modelled as static receptors based on the SEL_{cum} metric (Table 5.8). This is of a similar order of magnitude as the modelled sound contours at 160dB re 1µPa (SPL_{pk}) (see Figure 5.2). As detailed in paragraph 5.3.1.16, these have been used as a guide for the potential for behavioural disturbance, however they are likely to be overconservative for Group 2 Atlantic salmon, which are less sensitive to underwater sound than some other fish species. These results also broadly align with qualitative thresholds for behavioural effects on fish as set out in Table 5.7, with moderate risk of behavioural effects in the range of hundreds of metres to thousands of metres from the piling activity. The low tens of kilometres modelled using the TTS threshold and the 160dB re 1µPa (SPL_{pk}) underwater sound contours do not extend to the coast of Scotland and northern England wherein the SACs are located. These will not therefore result in a barrier to migration of Atlantic salmon to and from these SACs, nor impede behaviour in the marine environment given their limited extent within the North Sea as a whole.

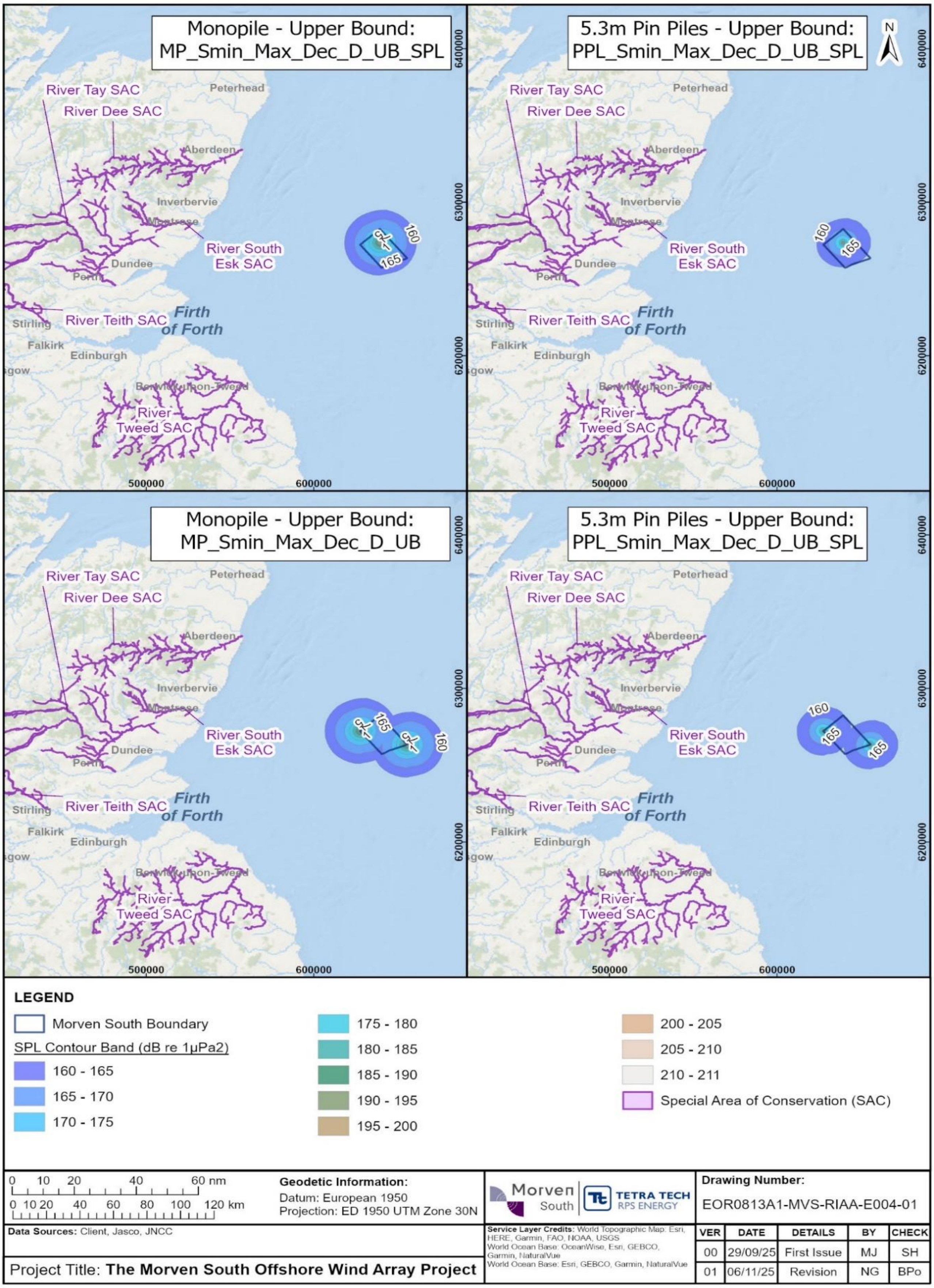

Figure 5.2: Modelled underwater sound contours (SPL_{pk} dB re 1µPa) for single and concurrent piling of 16m monopiles and 5.3m pin piles for Morven South

Injury and disturbance from UXO clearance

5.3.1.25 Compared to piling, UXO detonations will be single, isolated events of very short duration; as such, potential behavioural effects upon Annex II diadromous fish will be extremely short lived and reversible. The Popper *et al.* (2014) guidelines contain criteria for the onset of injury to fish due to explosives, which are based on the SPL_{pk} metric (Table 5.12). The qualitative behavioural disturbance criterion for fish due to explosives is as detailed in Table 5.7.

Table 5.12: Criteria for the onset of injury to Group 2 fish from explosives (Popper *et al.*, 2014)

Hearing Group	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury	TTS
Group 2 Fish (Atlantic salmon)	SPL_{pk}, dB re 1µPa	229 - 234	(Near) High (Intermediate) High (Far) Low	(Near) High (Intermediate) Moderate (Far) Low

5.3.1.26 The modelled scenarios presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report, define the identified possible cases of UXO clearance in the region. Due to uncertainties in size of UXOs the RIAA considers a range of charge weights, highlighting the most likely size (common) to be encountered (132kg), a smaller hazard (25kg), as well as the maximum UXO size predicted (554kg: Table 5.3)

5.3.1.27 As detailed in Table 5.4, the use of low order disposal techniques for UXOs (e.g. deflagration and clearance shots) will be used where possible as a designed-in mitigation measure to reduce underwater sound levels. There is a small risk that low order disposal could unintentionally arise in a high order detonation and therefore this scenario has also been assessed as the MDS (i.e. a maximum mass of 554kg Net Explosive Quantity (NEQ); Table 5.3).

5.3.1.28 The modelled mortality and potential mortal injury ranges for UXO clearance are presented in Table 5.13. For the different UXO clearance scenarios modelled, the impact ranges for mortality and potential mortal injury are in the hundreds of metres to low kilometres (Table 5.13). It should be noted that, due to a combination of dispersion (i.e. where the waveform elongates), multiple reflections from the sea surface and seabed and molecular absorption of high frequency energy, the underwater sound is unlikely be impulsive in character once it has propagated more than a few kilometres. Furthermore, the modelling assumes that the UXO acts like a charge suspended in open water whereas in reality it is likely to be partially buried in the sediment. In addition, it is possible that the explosive material will have deteriorated over time meaning that the predicted underwater sound levels are likely to be overestimated. In combination, these factors mean that the results should be treated as precautionary potential impact ranges which are likely to be significantly lower than predicted.

5.3.1.29 As the, already highly precautionary, impact ranges are in the hundreds of metres to low kilometres, UXO clearance associated with Morven South will not result in barrier effects to the migration of Atlantic salmon within the North Sea.

Table 5.13: Potential injury ranges for Atlantic salmon due to Unexploded Ordnance clearance activities based on the Peak Sound Pressure Level threshold from Popper *et al.* (2014)

Hearing group	Modelled explosive mass (kg)	Threshold (dB re 1μPa SPL_{pk})	Impact Range (km)
Group 2 fish (Atlantic salmon)	554 (high order detonation of the maximum size)	229	1.87
		234	0.80
	132 (high order detonation of the most likely size)	229	0.77
		234	0.51
	25 (high order detonation of the smaller hazard size)	229	0.44
		234	0.17
	deflagration of the UXO using a smaller donor charge of 0.25kg	229	Threshold not exceeded
		234	Threshold not exceeded

Construction phase

River Dee Special Area of Conservation and River South Esk Special Area of Conservation

Atlantic salmon

5.3.1.30 Atlantic salmon qualifying features of the River Dee SAC and River South Esk SAC in the close vicinity to piling and UXO clearance operations may experience injury or mortality, based on the results of the underwater sound modelling. However, Atlantic salmon are highly mobile and are unlikely to be particularly reliant on the marine environment within the Morven South Boundary other than to pass through during their migration to and from higher latitude feeding grounds. Therefore, piling and UXO clearance will not result in significant mortality of this species offshore. The use of soft start piling procedures as a designed-in mitigation measure (Table 5.4) would allow individuals in close proximity to flee the ensonified area and will also reduce the overall acoustic energy entering the marine environment, therefore further reducing the likelihood of injury and mortality.

5.3.1.31 Atlantic salmon may experience behavioural disturbance in response to underwater sound. However, as discussed in paragraphs 5.3.1.22 to 5.3.1.24, these would be expected to occur at ranges up to low tens of kilometres. Due to the distance of the modelled underwater sound contours from the SACs along the coast (see Figure 5.2), potential behavioural impacts are highly unlikely to cause barrier effects to Atlantic salmon as they migrate to and from these SACs, due to the relatively limited area around piling and UXO clearance events where noise levels are high enough to cause behavioural responses.

Freshwater pearl mussel

5.3.1.32 As adult freshwater pearl mussel are not present within the marine environment (wherein the ZoI is located), there is no pathway for direct effects associated with this impact to these features of the River Dee SAC and River South Esk SAC. However, there is potential for indirect impacts on the larval stage of freshwater pearl mussel if Atlantic salmon (their host species) are impacted. As summarised in paragraphs 5.3.1.30 and 5.3.1.31, underwater sound associated with the construction phase of Morven South will not lead to significant mortality or injury to Atlantic salmon and is unlikely to result in barriers to migration. Therefore, it can also be concluded that there will be no indirect impact to freshwater pearl mussel within these SACs.

Conclusion

5.3.1.33 Adverse effects on the Atlantic salmon and freshwater pearl mussel qualifying features of the River Dee SAC and River South Esk SAC that undermine their conservation objectives will not occur as a result of underwater sound impacting fish and shellfish receptors during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 5.2.3.4 to 5.2.3.6 and 5.2.4.4 to 5.2.4.6 respectively) are presented in Table 5.14.

5.3.1.34 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Dee SAC and River South Esk SAC as a result of underwater sound impacting the Atlantic salmon and freshwater pearl mussel qualifying features with respect to the construction phase of Morven South.

River Tweed Special Area of Conservation, River Tay Special Area of Conservation and River Teith Special Area of Conservation

Atlantic salmon

5.3.1.35 Atlantic salmon qualifying features of the River Tweed SAC, River Tay SAC and River Teith SAC in the close vicinity to piling and UXO clearance operations may experience injury or mortality, based on the results of the underwater sound modelling. However, Atlantic salmon are highly mobile and are unlikely to be particularly reliant on the marine environment within the Morven South Boundary other than to pass through during their migration to and from higher latitude feeding grounds. Therefore, piling and UXO clearance will not result in significant mortality of this species offshore. The use of soft start piling procedures as a designed-in mitigation measure (Table 5.4) would allow individuals in close proximity to flee the ensonified area and will also reduce the overall acoustic energy entering the marine environment, therefore further reducing the likelihood of injury and mortality.

5.3.1.36 Atlantic salmon may experience behavioural disturbance in response to underwater sound. However, as discussed in paragraphs 5.3.1.18 to 5.3.1.24, these would be expected to occur at ranges up to low tens of kilometres. Due to the distance of the modelled underwater sound contours from the SACs along the coast (see Figure 5.2), potential behavioural impacts are highly unlikely to cause barrier effects to Atlantic salmon as they migrate to and from these SACs, due to the relatively limited area around piling and UXO clearance events where noise levels are high enough to cause behavioural responses.

Conclusion

5.3.1.37 Adverse effects on the Atlantic salmon qualifying feature of the River Tweed SAC, River Tay SAC and River Teith SAC that undermine their conservation objectives will not occur as a result of underwater sound impacting fish and shellfish receptors during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 5.2.5.5 to 5.2.5.8, 5.2.6.4 to 5.2.6.5, and 5.2.7.3 to 5.2.7.4, respectively) are presented in Table 5.14.

5.3.1.38 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Tweed SAC, River Tay SAC and River Teith SAC as a result of underwater sound impacting the Atlantic salmon qualifying features with respect to the construction phase of Morven South.

Table 5.14: Conclusions against the conservation objectives of the Special Areas of Conservation designated for Annex II diadromous fish from underwater sound impacting fish and shellfish receptors during the construction phase

SAC	Feature	Conservation objective	Conclusion
River Dee SAC River South Esk SAC River Tay SAC	Atlantic salmon	Restore/maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site Restore/maintain the distribution of Atlantic salmon throughout the site	As detailed by the underwater sound modelling (summarised in paragraphs 5.3.1.7 to 5.3.1.29), Atlantic salmon within close proximity to piling and UXO clearance may experience injury or mortality. However, they are highly mobile and may only use the Morven South Boundary to pass through during migration to and from higher latitude feeding grounds. As such, and with implementation of designed-in measures (Table 5.4), mortality or injury to this species at a population-level is not predicted to occur. This impact will therefore not prevent the populations, distributions, nor genetic diversity of Atlantic salmon within the SACs from being restored or maintained. Atlantic salmon may also experience behavioural effects in response elevated underwater sound, however the sound modelling indicates these effects would not result in barriers to migration to and from any of the SACs given their localised nature (within the low tens of kilometres) in the offshore environment and no overlap of sound contours with the SACs as the River Dee SAC is 93.6km away, the River South Esk SAC is 101.1km away, and the River Tay SAC is 149.7km away from the Morven South Boundary. Further, underwater sound from piling and UXO clearance will be short-term and intermittent during the construction phase (i.e. 48 days of piling and 15 days of UXO clearance; Table 5.3). As above for injury and mortality, there is therefore no barrier to migration of Atlantic salmon due to behavioural disturbance. As a result, this impact will not prevent the populations, the distributions, nor genetic diversity of Atlantic salmon within this site from being restored or maintained.
		Restore/maintain the habitats supporting Atlantic salmon within the site and availability of food	There is no conceptual pathway for impact between underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SACs. With respect to availability of food, Volume 2, Chapter 9: Fish and Shellfish Ecology

SAC	Feature	Conservation objective	Conclusion
			of the EIA Report concluded that for prey species of Atlantic salmon potential impacts from underwater sound would be of minor adverse significance, which is not significant in EIA terms. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
River Tweed SAC	Atlantic Salmon	Natural England conservation objectives: Maintain or restore: • the extent and distribution of qualifying natural habitats and habitats of qualifying species; • the structure and function of the habitats of qualifying species; • the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	There is no conceptual pathway for impact between underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SAC. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
		Natural England conservation objectives: Maintain or restore: • the populations of qualifying species; • distribution of qualifying species within the site.	As detailed by the underwater sound modelling (summarised in paragraphs 5.3.1.7 to 5.3.1.29), Atlantic salmon within close proximity to piling and UXO clearance may experience injury or mortality. However, they are highly mobile and may only use the Morven South Boundary to pass through during migration to and from higher latitude feeding grounds. As such, and with implementation of designed-in measures (Table 5.4, mortality or injury to this species at a population-level is not predicted to occur. This impact will therefore not prevent the population nor distribution of Atlantic salmon within the SAC from being restored or maintained. Atlantic salmon may also experience behavioural effects in response elevated underwater sound, however the sound modelling indicates these effects would not result in barriers to migration to and from the SAC given their localised nature (within the low tens of kilometres) in the offshore environment and no overlap of sound contours with the

SAC	Feature	Conservation objective	Conclusion
			SAC as the River Tweed SAC is 113.2km away from the Morven South Boundary. Further, underwater sound from piling and UXO clearance will be short-term and intermittent during the construction phase (i.e. 48 days of piling and 15 days of UXO clearance; Table 5.3). As above for injury and mortality, there is therefore no barrier to migration of Atlantic salmon due to behavioural disturbance. As a result, this impact will not prevent the population nor distribution of Atlantic salmon within this site from being restored or maintained.
		NatureScot conservation objectives: • Maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site; • Maintain the distribution of Atlantic salmon throughout the site.	As per the justification and conclusions in the row above for the equivalent Natural England conservation objectives, this impact will not prevent the population nor distribution of Atlantic salmon within this site from being maintained.
		NatureScot conservation objectives: • Maintain the habitats supporting Atlantic salmon within the site and availability of food.	There is no conceptual pathway for impact between underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SACs. With respect to availability of food, Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report concluded that for prey species of Atlantic salmon potential impacts from underwater sound would be of minor adverse significance, which is not significant in EIA terms. Therefore, this impact will not prevent this conservation objective from being maintained.
River Teith SAC	Atlantic salmon	Maintain: • the population of the species, including range of genetic types for Atlantic salmon, as a viable component of the site; • the distribution of the species within site;	As detailed by the underwater sound modelling (summarised in paragraphs 5.3.1.7 to 5.3.1.29), Atlantic salmon within close proximity to piling and UXO clearance may experience injury or mortality. However, they are highly mobile and may only use the Morven South Boundary to pass through during migration to and from higher latitude feeding grounds. As such, and with implementation of designed-in measures (Table 5.4), mortality or injury to this species at a population-level is not predicted to occur.

SAC	Feature	Conservation objective	Conclusion
		Ensure there is no significant disturbance of the species.	This impact will therefore not prevent the population, distribution, nor genetic diversity of Atlantic salmon within the SAC from being maintained or restored. Atlantic salmon may also experience behavioural effects in response elevated underwater sound, however the sound modelling indicates these effects would not result in barriers to migration to and from any of the SACs given their localised nature (within the low tens of kilometres) in the offshore environment and no overlap of sound contours with the SACs as the River Teith SAC is 215.0km from the Morven South Boundary. Further, underwater sound from piling and UXO clearance will be short-term and intermittent during the construction phase (i.e. 48 days of piling and 15 days of UXO clearance; Table 5.3). As above for injury and mortality, there is therefore no barrier to migration of Atlantic salmon due to behavioural disturbance and no significant disturbance of Atlantic salmon. As a result, this impact will not prevent the populations, the distributions, nor genetic diversity of Atlantic salmon within this site from being maintained or restored.
		Maintain: • the distribution and extent of habitats supporting the species; • the structure, function and supporting processes of habitats supporting the species.	There is no conceptual pathway for impact between underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SAC. Therefore, this impact will not prevent this conservation objective from being maintained or restored.
River Dee SAC River South Esk SAC	Freshwater pearl mussel	Restore the population of freshwater pearl mussel as a viable component of the site Restore the distribution of freshwater pearl mussel throughout the site	As a freshwater resident species, there is no direct pathway between this impact (which occurs within the marine environment only) and the population and distribution of freshwater pearl mussel within the site. Instead, there is potential for indirect impacts through impacts to the host species, Atlantic salmon. As presented in the rows above for Atlantic salmon, underwater sound in during piling and UXO

SAC	Feature	Conservation objective	Conclusion
			clearance will not lead to significant mortality or injury to Atlantic salmon and is unlikely to result in barriers to migration for this host species. Therefore, it can also be concluded that underwater sound will not indirectly prevent the freshwater pearl mussel population from being a viable component of the site or prevent the distribution of this species within the site from being restored.
		Restore the habitats supporting freshwater pearl mussel within the site and availability of food	As above for Atlantic salmon, there is no conceptual pathway for impact between underwater sound generated during piling and UXO clearance and the habitats that support freshwater pearl mussel within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being restored
		Restore/maintain the distribution and viability of freshwater pearl mussel host species and their supporting habitats	As presented in the rows above for Atlantic salmon, this impact will not prevent the distribution and viability of the host species of freshwater pearl mussel (i.e. Atlantic salmon) and its supporting habitats from being restored or maintained.

5.3.2 Electromagnetic Fields from subsea electrical cables

5.3.2.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the O&M phases, LSE[2] could not be ruled out for EMF from subsea electrical cables. This relates to the following site(s) and relevant Annex II diadromous fish features:

- River Dee SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River South Esk SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River Tweed SAC:
  - Atlantic salmon.
- River Tay SAC:
  - Atlantic salmon.
- River Teith SAC:
  - Atlantic salmon.

5.3.2.2 The MDS and designed-in measures considered for the assessment of EMF from subsea electrical cables are shown in Table 5.15 and Table 5.16, respectively.

Table 5.15: Maximum Design Scenario considered for the assessment of potential impacts to Annex II diadromous fish due to Electromagnetic Fields from subsea electrical cables during the Operation and Maintenance phase

Project phase	MDS	Justification
O&M	There will be a total of up to **684km** of subsea electrical cables, comprised of: • 420km of 66kV inter-array cables; • 264km of 275kV High Voltage Alternating Current (HVAC) interconnector cables. There will be a target burial depth of 1m, with a minimum and maximum burial depth of 0.5m and 3m, respectively. Up to 10% of the cables will require cable protection as opposed to burial, equating to 68.4km in total. The O&M phase will last up to 35 years.	The MDS for this impact has been based on maximum length of potential cables at the seabed.

Table 5.16: Designed-in measures considered for the assessment of potential impacts to Annex II diadromous fish from Electromagnetic Fields from subsea electrical cables during the Operation and Maintenance phase

Reference number	Designed-in measure	Justification	Primary or tertiary
MM-2	Development of and adherence to a Cable Plan which will include a Cable Burial Risk Assessment (CBRA) and cable burial and protection monitoring throughout the operational phase.	A Cable Plan will set out the approach to protection of cables during the project lifecycle. It will reduce the risks of vessel underwater allision with cable protection, anchor or fishing gear interaction with subsea cables and interference with magnetic position fixing equipment. The Cable Plan will implement management and monitoring of cable protection (via burial or external protection where adequate burial depth, as identified via risk assessment, is not feasible) with any damage, destruction or decay of cables notified to Maritime and Coastguard Agency, Northern Lighthouse Board, Kingfisher and UK Hydrographic Office no later than 24 hours after discovered. This will reduce the probability of cables	Primary

Reference number	Designed-in measure	Justification	Primary or tertiary
		becoming unburied and impacting other sea users and marine ecology receptors (i.e. diadromous fish). It will include the requirement of minimum burial depths of 0.5m or the use of cable protection around inter-array and interconnector cables and will include a Cable Burial Risk Assessment. Cable protection may be necessary in some locations where sufficient cable burial depth cannot be achieved or where cables become exposed during the lifetime of Morven South. The CBRA will consider relevant activities in the vicinity of inter-array and interconnector cables and confirm appropriate means of protection taking account of the final inter-array and interconnector cable. The CBRA will identify the appropriate target burial depth to ensure the cable remain buried, or appropriately protected, where target burial depths cannot be achieved, for the duration of the Morven North, to reduce the risk of interaction with other sea users or cable exposure.	

Information to inform the assessment

Background information on Electromagnetic Fields

5.3.2.3 EMFs are comprised of the following:

- electrical fields, measured in volts per metre (V/m);
- magnetic fields, measured in microtesla (μT), millitesla (mT), milligauss (mG) or gauss.

5.3.2.4 Within the North Sea background electric field levels of 25μV/m and magnetic field levels of 50μT have been estimated (Tasker *et al.*, 2010). Subsea power cables associated with offshore wind projects are constructed using magnetic outer sheathing materials. These partially block the emission of the direct electrical field, meaning that only the magnetic field and the resultant induced electrical field are emitted (Hervé, 2021). Similarly, both Alternating Current (AC) and Direct Current (DC) cables typically contain two to three conductor bundles which are superimposed and twisted around each other. This cable design feature results in a partial self-cancellation of the total magnetic field emitted (Hervé, 2021, Snyder *et al.*, 2019). In addition, a project-specific modelling study for the Eastern Green Link 2 (EGL 2) cable project showed that the magnetic field resulted in a combined field strength of 404μT at the seabed, reducing to slightly above background levels at 20m from the cables (National Grid, 2022a). In the model, the bundled cable had significantly lower magnetic fields due to cancellation of the magnetic fields between poles. EMF from the bundled cable reduced to the background geomagnetic field strength around 5m to 10m from the cable, having only a very localised effect (National Grid, 2022a). Therefore, the design features of subsea cables themselves mitigate the EMF levels emitted into the marine environment.

5.3.2.5 In addition, the standard industry measure of cable burial (and cable protection where burial is not possible; both of which have been incorporated into the MDS, see Table 5.15) can further reduce the EMF levels emitted. This is because the strength of the magnetic field (and consequently, the induced electrical fields) decreases rapidly horizontally and vertically with distance from the cable and will attenuate to baseline levels within a few metres to few tens of metres (both horizontally and vertically) from the cable (Hutchison *et al.*, 2021). Therefore, should impacts from EMF occur, they would be highly localised to the immediate vicinity of the cable at the seabed and not represent a significant barrier to migration for this species. Cable burial and protection can, therefore, reduce EMF levels at the seabed as a result of field decay with distance of the seabed from the cable (Chapman *et al.*, 2023, Gill *et al.*, 2009, Snyder *et al.*, 2019). For example, Snyder *et al.* (2019) demonstrated that cables associated with OWFs buried between depths of 1m to 2m reduced the magnetic field at the seabed surface up to four times than unburied cables. For unburied cables protected by concrete mattresses or rock berms, the field levels were found to be similar to those of the buried cables (Snyder *et al.*, 2019). Magnetic field levels directly over live AC cables associated with OWF projects ranged between 65mG at the seabed and 5mG at 1m vertically from the seabed and between 10mG and <0.1mG horizontally at the seabed (Snyder *et al.*, 2019). Therefore, the designed-in commitments to cable burial and cable protection incorporated into the MDS further reduce the range of effects and potential for barrier effects associated with EMFs.

5.3.2.6 A minimum burial depth of 0.5m represents part of the MDS for this impact (Table 5.15). Although there was no EMF modelling conducted for Morven North, this has been undertaken for other offshore cable and OWF projects. For example, recent modelling for the Sea Link Subsea Power Cable in the southern North Sea reported that, irrespective of the burial depth, magnetic fields reduced rapidly with distance from the cables due to bundling of the cables. This was modelled for a minimum burial depth of 0.5m (National Grid, 2025b). Similarly, a recent EMF modelling study for the Seagreen OWF (within the Regional Fish and Shellfish Ecology Study Area) demonstrated that the magnetic field reduced to negligible levels within 5m horizontal distance from the cable when buried at a depth of 0.5m (Seagreen, 2023). In addition, at a minimum burial depth of 0.4m (which is lower than that associated with the MDS for Morven North), a value of 59μT was modelled at the surface, which is near background levels of approximately 50μT for the North Sea (Seagreen, 2023). Thus, it has been anticipated that EMF levels will still decrease rapidly to background levels within metres from subsea cables buried at the minimum depth of 0.5m.

Sensitivity of Annex II diadromous fish species to Electromagnetic Fields

5.3.2.7 Many species are able to detect the Earth's natural electric and magnetic fields (referred to as 'magnetoreception') and use them to navigate (Nordmann *et al.*, 2017). Given their highly migratory life histories, accurate navigation is essential for Atlantic salmon. Magnetoreception and/or the possession of magneto-receptive material has been demonstrated in salmonid species (Lohmann and Lohmann, 2019, Moore *et al.*, 1990, Naisbett-Jones *et al.*, 2020, Putman *et al.*, 2014). EMFs associated with subsea electrical cables could therefore interfere with the navigational ability of Atlantic salmon and could indirectly impact freshwater pearl mussel due to their life histories.

5.3.2.8 Salmonids are thought to use chemical and olfactory signals in coastal waters to navigate to their natal rivers (Ueda, 2014) and magnetoreception during offshore migrations (Gill and Bartlett, 2010, Lohmann *et al.*, 2008). As Atlantic salmon are pelagic and tend to remain near the surface and upper metres of the water column during their marine phase, the effects of EMF would mostly be perceived in shallower waters where they are closer to cables at the seabed than in the offshore waters associated with Morven South (Snyder *et al.*, 2019). Research on the effects of subsea cables on salmonid species has, however, illustrated limited impacts on migration success (Kavet *et al.*, 2016, Wyman *et al.*, 2018). Further, Armstrong *et al.* (2015) investigated the effects of mains frequency (50Hz) magnetic fields on the behaviour of captive Atlantic salmon. This study found that large individuals (62cm to 85cm long) demonstrated no significant differences in approach, traverse or departure times associated with coils emitting a magnetic field of 95μT. In addition, there was no evidence that the numbers of post-smolts passing through the coils was related to the intensity of the magnetic fields. There were also no observations of unusual behaviours in association with magnetic fields tested (Armstrong *et al.*, 2015). A study specifically on EMFs generated by subsea cables on chinook salmon (*Oncorhynchus tshawytscha*) migration in San Francisco Bay, United States, resulted in mixed effects (Wyman *et al.*, 2018). Smolts were attracted to some cables but avoided others, and the authors concluded that there was no strong effect on smolt migration and no barrier effects were observed (Wyman *et al.*, 2018).

5.3.2.9 Given that diadromous fish offshore may not come into contact with EMF associated with subsea cables at the seabed (EMF predicted within metres to low tens of metres, see paragraph 5.3.2.5), large- scale barriers to migration as a result on EMF will not occur. It should be noted that although there is limited information available in the literature on the impacts and sensitivities of shellfish species to EMFs, the freshwater pearl mussel would not be directly impacted by EMFs produced by subsea cables associated with Morven South given that they are a freshwater resident species and there will be no subsea cables associated with Morven South in any freshwater habitats. Indirect impacts on the larval stage of freshwater pearl mussel may, however, arise if Atlantic salmon (their host species) are impacted.

Operation and maintenance phase

River Dee Special Area of Conservation and River South Esk Special Area of Conservation

Atlantic salmon

5.3.2.10 As outlined in paragraph 5.3.2.5, EMFs emitted by subsea electrical cables will be highly localised to the immediate surroundings of the cables at the seabed. These will be located entirely within the Morven South Boundary, which will also not represent a barrier to migration for Atlantic salmon qualifying features of the River Dee SAC and River South Esk SAC due to its distance offshore. Although Atlantic salmon may be able to respond to and/or detect alterations in the magnetic field (see paragraphs 5.3.2.7 to 5.3.2.9), barriers to migration are not anticipated due to this limited extent of impacts associated with EMF and that Atlantic salmon are typically pelagic when in offshore waters (such as those within the Morven South Boundary). This pelagic nature renders this species less susceptible to EMF emissions at the seabed. In addition, Atlantic salmon are highly mobile and are capable of changing course during migration between natal rivers and the open sea.

Freshwater pearl mussel

5.3.2.11 Adult freshwater pearl mussel features of the River Dee SAC and River South Esk SAC are only present within freshwater environments, and there is therefore no pathway for direct effects associated with this impact. However, indirect impacts on the larval stage of freshwater pearl mussel are possible if Atlantic salmon (their host species) were to be impacted. As summarised in paragraph 5.3.2.10, EMFs from subsea electrical cables within the Morven South Boundary are unlikely to result in barriers to migration for Atlantic salmon. Therefore, it has been concluded that there will be no indirect impact to freshwater pearl mussel.

Conclusion

5.3.2.12 Adverse effects on the Atlantic salmon and freshwater pearl mussel qualifying features of the River Dee SAC and River South Esk SAC that undermine their conservation objectives will not occur as a result of EMF from subsea electrical cables during the O&M phase. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 5.2.3.4 to 5.2.3.6 and 5.2.4.4 to 5.2.4.6 respectively) are presented in Table 5.17.

5.3.2.13 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Dee SAC and River South Esk SAC as a result of EMF from subsea electrical cables with respect to the O&M phases of Morven South.

River Tweed Special Area of Conservation, River Tay Special Area of Conservation and River Teith Special Area of Conservation

Atlantic salmon

5.3.2.14 As outlined in paragraph 5.3.2.5, EMFs emitted by subsea electrical cables will be highly localised to the immediate surroundings of the cables at the seabed. These will be located entirely within the Morven South Boundary which will also not represent a barrier to migration for Atlantic salmon qualifying features of the River Tweed SAC, River Tay SAC and River Teith SAC due to its distance offshore. Although Atlantic salmon may be able to respond to and/or detect alterations in the magnetic field (see paragraphs 5.3.2.7 to 5.3.2.9), barriers to migration are not anticipated due to this limited extent of impacts associated with EMF and that Atlantic salmon are typically pelagic when in offshore waters (such as those within the Morven South Boundary). This pelagic nature renders this species less susceptible to EMF emissions at the seabed. In addition, Atlantic salmon are highly mobile and are capable of changing course during migration between natal rivers and the open sea.

Conclusion

5.3.2.15 Adverse effects on the Atlantic salmon qualifying feature of the River Tweed SAC, River Tay SAC and River Teith SAC that undermine their conservation objectives will not occur as a result of EMF from subsea electrical cables during the O&M phase. An assessment of the effects from this impact against the relevant conservation objectives (as presented in paragraphs 5.2.5.5 to 5.2.5.8, 5.2.6.4 to 5.2.6.5, and 5.2.7.3 to 5.2.7.4, respectively) are presented in Table 5.17.

5.3.2.16 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Tweed SAC, River Tay SAC and River Teith SAC as a result of EMF from subsea electrical cables with respect to the O&M phases of Morven South.

Table 5.17: Conclusions against the conservation objectives of the Special Areas of Conservation designated for Annex II diadromous fish from Electromagnetic Fields from subsea electrical cables during the operations and maintenance phases

SAC	Feature	Conservation objective	Conclusion
River Dee Sac River South Esk SAC River Tay SAC	Atlantic salmon	Restore/maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site	There will be no barriers to migration of Atlantic salmon due to the highly localised effects of EMFs from subsea electrical cables. This impact will not prevent the populations of Atlantic salmon from being restored or maintained as a viable component of these sites nor the distributions or genetic diversity of Atlantic salmon from being restored or maintained.
		Restore/maintain the distribution of Atlantic salmon throughout the site	
		Restore/maintain the habitats supporting Atlantic salmon within the site and availability of food	There is no conceptual pathway for impact between EMFs associated with Morven South and the habitats that support Atlantic salmon within these SACs and availability of food. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
River Tweed SAC	Atlantic Salmon	Natural England conservation objectives: Maintain or restore: • the extent and distribution of qualifying natural habitats and habitats of qualifying species; • the structure and function of the habitats of qualifying species; • the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	There is no conceptual pathway for impact between EMFs associated with Morven South and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
		Natural England conservation objectives: Maintain or restore: • the populations of qualifying species; • distribution of qualifying species within the site.	There will be no barriers to migration of Atlantic salmon due to the highly localised effects of EMFs from subsea electrical cables. This impact will not prevent the populations, the distributions nor genetic diversity of Atlantic salmon from being restored or maintained.
		NatureScot conservation objectives: • Maintain the population of Atlantic salmon, including range of genetic	As per the justification and conclusions in the row above for the equivalent Natural England conservation objectives, this impact

SAC	Feature	Conservation objective	Conclusion
		types, as a viable component of the site • Maintain the distribution of Atlantic salmon throughout the site	will not prevent the population nor distribution of Atlantic salmon within this site from being maintained.
		NatureScot conservation objectives: • Maintain the habitats supporting Atlantic salmon within the site and availability of food.	There is no conceptual pathway for impact between EMFs associated with Morven South and the habitats that support Atlantic salmon within these SACs and availability of food. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
River Teith SAC	Atlantic salmon	Maintain: • the population of the species, including range of genetic types for Atlantic salmon, as a viable component of the site; • the distribution of the species within site. Ensure there is no significant disturbance of the species.	There will be no barriers to migration of Atlantic salmon, nor significant disturbance, due to the highly localised effects of EMFs from subsea electrical cables. This impact will not prevent the population of Atlantic salmon from being restored as a viable component of the site nor the distribution or genetic diversity of Atlantic salmon from being maintained or restored.
		Maintain: • the distribution and extent of habitats supporting the species; • the structure, function and supporting processes of habitats supporting the species.	There is no conceptual pathway for impact between EMFs associated with Morven South and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being maintained or restored.
River Dee Sac River South Esk SAC	Freshwater pearl mussel	Restore the population of freshwater pearl mussel as a viable component of the site	As a freshwater resident species, there is no direct pathway for impact between EMFs associated with Morven South and the population and distribution of freshwater pearl mussel within the site. Instead, there is potential for indirect impacts through impacts to the host species, Atlantic salmon. As detailed in the rows above for Atlantic salmon, EMFs will not lead to barriers to migration of host species for freshwater pearl mussel. Therefore, it can also be concluded that this impact will not indirectly prevent
		Restore the distribution of freshwater pearl mussel throughout the site	

SAC	Feature	Conservation objective	Conclusion
			the populations of freshwater pearl mussel from being a viable component of this site or the distributions of this species from being restored.
		Restore the habitats supporting freshwater pearl mussel within the site and availability of food	There is no conceptual pathway for impact between EMFs associated with Morven South and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being restored.
		Restore/maintain the distribution and viability of freshwater pearl mussel host species and their supporting habitats	As detailed in the rows above for Atlantic salmon, this impact will not prevent the distribution and viability of host species (i.e. Atlantic salmon) and their supporting habitats from being restored or maintained.

5.4 Assessment of the adverse effects of Morven South in-combination with other plans and projects

5.4.1 Overview

5.4.1.1 Two screening buffers were used to identify plans and projects with the potential for in-combination effects:

- 50km around the Morven South Boundary for the impact of EMF. This is considered to be highly precautionary given the likely range of effects for EMF from subsea electrical cables will be limited to metres to tens of metres from cables.
- 100km around the Morven South Boundary for the impact of underwater sound, given its potential for a higher range of effects than EMF. This is still considered to be highly precautionary, given that behavioural disturbance was modelled to a maximum of the low tens of kilometres, with far lower ranges modelled for injury and mortality (see paragraphs 5.3.1.7 to 5.3.1.29).

5.4.1.2 The other plans and projects that have been identified as having the potential for in-combination effects are presented in Figure 5.3 and Table 5.18.

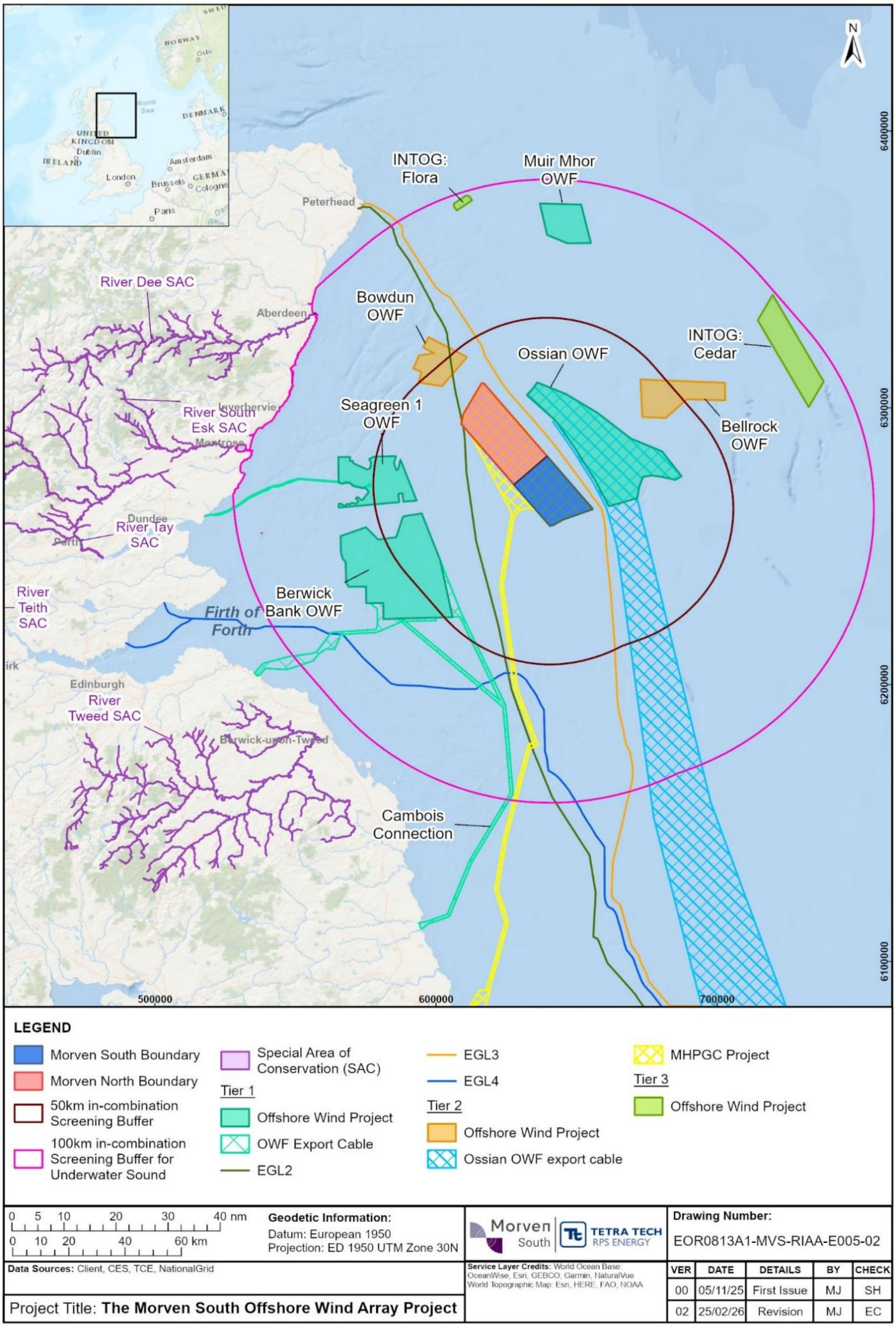

Figure 5.3: Location of other plans and projects considered for the in-combination effects assessment on Special Areas of Conservation with Annex II diadromous fish features

Table 5.18: List of other plans and projects with potential for in-combination effects on Annex II diadromous fish features for scenario 4 (see Section 4.6)

Plan/Project	Status	Distance from Morven South (km)	Description	Estimated dates of construction	Estimated dates of operation	Overlap with Morven South
Tier 1						
Energy projects and cables						
Morven North	Application submitted/awaiting decision	0	Proposed for up to 96 wind turbines at a capacity of 1500MW.	2033 – 2042[3]	2038 – 2073 or 2043 to 2078[4]	Part of Scenario 4
Berwick Bank OWF	Consented	34	Up to 307 wind turbines with a capacity of up to 4,100MW.	2025 - 2032	2033 - 2068	The O&M phase of Berwick Bank OWF overlaps with the construction and O&M phases of Morven South.
Cambois Connection	Consented	34	Up to four HVDC offshore export cables bundled with up to four fibre optic cables up to 40km in length from up to two offshore convertor station platforms within the Berwick Bank OWF to the Scottish/English border.	2025 - 2032	2033 - 2068	The O&M phase of the Cambois Connection overlaps with the construction and O&M phases of Morven South.

[3] At this stage, Morven North and Morven South could be constructed anywhere between 2033 to 2042, with both projects possibly being constructed concurrently or one after another. As a precaution, the widest possible construction phase of ten years has been used in the in-combination assessment.

[4] While Morven North and Morven South could be constructed anywhere between 2033 to 2042, the O&M phase has been assumed as commencing in 2038 as a precaution in the instance that one project is constructed first and operational while the other is still in its construction phase. The operational lifecycle of Morven North and Morven South is 35 years and could end in either 2073 (if operational in 2038) or in 2078 (if operational in 2043).

Plan/Project	Status	Distance from Morven South (km)	Description	Estimated dates of construction	Estimated dates of operation	Overlap with Morven South
Muir Mhòr OWF	Application submitted, awaiting decision	77	Muir Mhòr OWF is proposed for a capacity of 798MW.	2030 – 2033	2034 - 2069	The construction phase of Muir Mhòr OWF overlaps with that of Morven South for one year in 2033. As this project is outwith the 50km screening buffer for all impacts except underwater sound, Muir Mhòr OWF would only be screened in for the latter. Given that there is potential for in-combination piling and UXO clearance at Morven South and Muir Mhòr OWF, this project is screened in for this impact only.
Ossian OWF	Application submitted	5	The Ossian OWF is proposed for up to 3,610MW capacity.	2029 – 2038	2039 - 2074	The construction and O&M phases (and possibly the decommissioning phase) of the Ossian OWF overlap with those of Morven South.
Seagreen 1 OWF	Operational	35	Seagreen 1 OWF consists of up to 114 wind turbines at a capacity of 1,075MW.	Currently operational	Present day to 2049	The O&M phase of the Seagreen 1 OWF overlaps with the construction and O&M phases of Morven

Plan/Project	Status	Distance from Morven South (km)	Description	Estimated dates of construction	Estimated dates of operation	Overlap with Morven South
						South. The decommissioning phase overlaps with the O&M phase of Morven South.
Cables and pipelines						
Eastern Green Link 2 (EGL2)	Construction	16	High voltage electricity link between Scotland and England.	2025 – 2029	2030 onwards	The O&M phase of EGL2 overlaps with the construction and O&M phases of Morven South.
Eastern Green Link 3 (EGL3)	Joint Preliminary Environmental Information Report (PEIR) published	3	EGL3 and EGL4 are two offshore high voltage electricity links between Scotland and England, with converter stations and associated onshore infrastructure.	2028 - 2033	2034 onwards	The construction phase of EGL3 and EGL4 overlaps with that of Morven South for one year in 2033. The O&M (and possibly the decommissioning phases) of EGL3 and EGL4 also overlap with those of Morven South. The decommissioning phase is currently unknown. Given that EGL4 is outwith the 50km Screening Buffer for all impacts except underwater sound, this project is only considered for the impact of in-
Eastern Green Link 4 (EGL4)		55				

Plan/Project	Status	Distance from Morven South (km)	Description	Estimated dates of construction	Estimated dates of operation	Overlap with Morven South
						combination underwater sound.
Tier 2						
Energy projects and cables						
MHPGC Project	Consenting/pre-construction	0	Comprise parts of Scenario 1 and 4.	Unknown	Unknown	The O&M phase of Bellrock OWF overlaps with the O&M phase of Morven South. The decommissioning phase is currently unknown.
Bellrock OWF	Consenting/pre-construction	35	Bellrock Floating OWF is proposed for a capacity of 800MW and up to 132 wind turbines.	2027 – 2030	2031 onwards	The construction and O&M phases of the Bowdun OWF overlap with those of Morven South. The decommissioning phase is currently unknown.
Bowdun OWF	Consenting/pre-construction	44	Bowdun OWF is proposed for up to 67 wind turbines at a capacity of 1,008MW.	2029 – 2033	2034 onwards	The timing of the construction and O&M phase of the Ossian OWF Export Cable are currently not available. As a precaution, it has been assumed that all phases of development could overlap with those of Morven South.

Plan/Project	Status	Distance from Morven South (km)	Description	Estimated dates of construction	Estimated dates of operation	Overlap with Morven South
Ossian OWF Export Cable	Consenting/pre-construction	5	Maximum of six offshore export cables, with no indicative construction start date or transmission capacity publicly available.	Unknown	Unknown	
Cables and pipelines						
Eastern Green Link 5 (EGL5)	Scoping report published	4	Scotland to England cable connector of up to 555km in length.	2030 – 2034	2034 onwards	The construction phase of EGL5 may overlap with that of Morven South, alongside overlapping O&M phases of both projects.
Tier 3						
Energy projects and cables						
MBAGC Project	In planning	0	Comprise parts of Scenario 2 and 4.	Unknown	Unknown	Part of Scenarios 2 and 4
Innovation and Targeted Oil and Gas Leasing Round (INTOG): Flora	Consenting/pre-construction	94	INTOG site 4 is proposed for up to 50MW.	Unknown	Unknown	These INTOG projects are outwith the 50km screening buffer for all impact except underwater sound. As Tier 3 projects, the construction phases (in which underwater sound from piling and UXO clearance would be produced) are currently unknown. As a precaution, these projects
INTOG: Cedar	Consenting/pre-construction	85	INTOG site 10 is proposed for up to 1,008MW.	Unknown	Unknown	

Plan/Project	Status	Distance from Morven South (km)	Description	Estimated dates of construction	Estimated dates of operation	Overlap with Morven South
						have been included in the in-combination assessment for the impact of underwater sound only.

5.4.2 Underwater sound impacting fish and shellfish receptors

5.4.2.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction phase, in-combination LSE[2] could not be ruled out for underwater sound impacting fish and shellfish receptors. This relates to the following site(s) and relevant Annex II diadromous fish and freshwater pearl mussel features:

- River Dee SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River South Esk SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River Tweed SAC:
  - Atlantic salmon.
- River Tay SAC:
  - Atlantic salmon.
- River Teith SAC:
  - Atlantic salmon.

5.4.2.2 The MDS considered for this in-combination assessment is shown in Table 5.19. The designed-in measures are presented in Table 5.4 for the assessment of Morven South.

Table 5.19: Maximum Design Scenario considered for the assessment of potential impacts to Annex II diadromous fish due to underwater sound impacting fish and shellfish receptors in the construction phase of Morven South in-combination with other plans and projects

Project phase	MDS	Justification
Construction	**Scenario 1** MDS as described for Morven South (Table 5.3), assessed in-combination with the MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 5.3), assessed in-combination with the MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 5.3), assessed in-combination with the following other projects and plans: <u>Tier 1</u> • Morven North (in its construction phase); • Muir Mhòr OWF (in its construction phase); • Ossian OWF (in its construction phase); • EGL 3 and EGL 4 (in their construction phase). <u>Tier 2</u> • MHPGC Project (in its construction phase); • Bowdun OWF (in its construction phase); • Ossian OWF Export Cable (in its construction phase); • EGL 5 (in its construction phase). <u>Tier 3</u> • INTOG projects (Flora and Cedar) in their construction phases; • MBAGC Project (in its construction phase).	A precautionary, buffer of 100km was used to screen in plans and projects into the assessment for this impact. The Scenario 4 projects have been screened in as they have the potential to generate underwater sound noise from piling and/or UXO clearance during their construction phases and therefore require consideration.

5.4.2.3 There is potential for in-combination impact from underwater sound during piling and UXO clearance in Morven South's construction phase alongside that associated with other projects screened in for this impact.

5.4.2.4 The summary of the whole project assessment for this impact is presented in Table 5.20 and the in-combination impact assessment for Scenario 4 is presented in Table 5.22. A range of Tier 1 to 3 projects were screened into the in-combination assessment due to the potential for underwater sound to be generated during piling and UXO clearance in their construction phases. Underwater sound modelling parameters associated with the Tier 1 projects (wherein quantitative data were available) are presented in Table 5.21.

Table 5.20: Morven South whole project assessment for underwater sound impacting fish and shellfish receptors

Whole project assessment	
Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Construction phase	
Scenario 1 includes the piling and UXO clearance for Morven South and the MHPGC Project during their construction phases. There are no publicly available parameters or underwater sound modelling for the MHPGC Project, although it is unlikely that this project will involve any piling. While UXO clearance may be undertaken during the site preparation for the MHPGC Project, the underwater sound levels and associated injury and disturbance ranges for fish and shellfish would be lower than those associated with piling (as per the underwater sound modelling results detailed in Section 5.3.1 for Morven South alone). Compared to piling activities, UXO clearance will consist of single, isolated events of very short duration. As detailed for Morven South alone, the use of low order disposal of UXOs (e.g. deflagration and clearance shots) where possible will be a designed in measure adopted for the MHPGC Project, as it is an industry standard practice. This will reduce underwater sound levels during UXO clearance for the MHPGC Project and thereby reduce the in-combination potential for injury and disturbance to Atlantic salmon and indirect effects upon freshwater pearl mussel. The whole project impact will be of high reversibility with the soundscape returning to near baseline conditions upon completion of UXO clearance. LSE's from underwater sound have not been screened in for further assessment at any SAC designated for Annex II diadromous fish qualifying features in the MHPGC Project HRA Screening Report (MvOWL, 2025).	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the whole project assessment, the assessment for Scenario 2 is as provided in the column for Scenario 1.

Table 5.21: In-combination potential for the generation of underwater sound during scenario 4 in the construction phase of Morven South

Project	MDS	Reference
Morven South	**Piling:** The MDS considers concurrent piling of up to 67 wind turbines (16m monopiles) four HVAC collector OSPs and one bridge-linked HVDC converter OSP (two six-legged jacket foundations), on either monopiles or pin pile foundations. A maximum hammer energy of 6,600kJ represents the MDS for monopiles and 4,000kJ for pin piles. There is a potential for up to 48 days total piling. **UXO Clearance:** The MDS considers clearance of up to 15 UXO within the site boundary, over a number of potential charge weights and over a total of 15 days.	Table 5.3
Tier 1 Projects		
Morven North	**Piling:** The MDS considers concurrent piling of up to 68 wind turbines (16m monopiles) four HVAC collector OSPs and one bridge-linked HVDC converter OSP (two six-legged jacket foundations), on either monopiles or pin pile foundations. A maximum hammer energy of 6,600kJ represents the MDS for monopiles and 4,000kJ for pin piles. There is a potential for up to 48 days total piling. **UXO Clearance:** The MDS considers clearance of up to 15 UXO within the site boundary, over a number of potential charge weights and over a total of 15 days.	MvOWL (2026c)
Ossian OWF (in its construction phase)	**Piling:** The MDS considers concurrent piling of up to 265 semi-submersible floating wind turbine foundations (with up to six anchors per foundation and one 4.5m diameter pile per anchor; 1,590 piles) and concurrent piling of OSPs (up to three large and 12 small jacket foundations), with a maximum of 216 piles. A maximum hammer energy of 3,000kJ represents the MDS for floating wind turbine foundations and 4,400kJ for OSP foundations. There is a potential for up to 530 days piling (over a piling phase of 63 months, over a period of seven years) for floating wind turbine foundations and up to 72 days piling (over a piling phase of 72 months, over a period of eight years) for OSP foundations.	Ossian OWFL (2024c)

Project	MDS	Reference
	UXO Clearance: The MDS considers clearance of up to 15 UXO within the site boundary, over a number of potential charge weights and over a total of eight days.	
Muir Mhòr OWF (in its construction phase)	**Piling:** The MDS considers concurrent piling of up to 67 wind turbine generators (with up to nine anchors per wind turbine and one pile per anchor) and concurrent piling of two Offshore Electrical Platforms (with a maximum of 12 piles per platform. A maximum hammer energy of 2,400kJ represents the MDS for wind turbine anchors and 3,200kJ for Offshore Electrical Platforms piles. There is a potential for up to 175 days total piling, with Offshore Electrical Platforms piling between May and August 2030 and WTG piling between 2029 and 2031. **UXO Clearance:** No number of UXOs requiring clearance is provided in the MDS but the MDS outlines that the primary method will be low order deflagration, with high order assessed as the realistic worst-case scenario. UXO clearance will take place from the year prior to offshore construction commencing, potentially running concurrently with the first year of offshore construction.	Muir Mhòr Offshore Wind Farm (2024a)
EGL3 and EGL4 (in their construction phase)	No MDS for underwater sound is presented for the joint PEIR for EGL 3 and EGL 4. With regard to underwater sound changes arising from these projects, it is assumed that UXO clearance will be undertaken under a separate Marine Licence application. In the assessment for underwater sound presented in the PEIR, there was consideration of sound arising from geophysical survey equipment and vessels and other equipment; however, these have been scoped out of the assessment for Morven South and have not been considered further in the in-combination assessment.	National Grid (2025c)

Table 5.22: Morven South in-combination assessment for underwater sound impacting fish and shellfish receptors

In-combination assessment
Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
Construction phase
Tier 1 The Tier 1 assessment includes Morven South and the following Tier 1 projects: • Morven North; • Muir Mhòr OWF; • Ossian OWF; • EGL3; • EGL4. The piling and UXO clearance parameters included in the assessments for the Tier 1 projects are detailed in Table 5.21. As detailed in Table 5.21, the PEIR for EGL3 and EGL4 did not include an underwater sound modelling assessment for UXO clearance and there was no piling included in the scope (National Grid, 2025c). Therefore, there is not considered to be a potential for in-combination impact associated with this Tier 1 project. For the Tier 1 OWFs, the potential for injury and disturbance associated with underwater sound from piling and UXO clearance associated was not concluded to be significant for the fish and shellfish species assessed in their individual EIAs and not concluded to cause barrier effects to Atlantic salmon (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c). The underwater sound modelling undertaken for these projects predicted impact ranges of a similar scale to that undertaken for Morven North and Morven South, with behavioural disturbance possible out to the low tens of kilometres, with lower ranges predicted for injury (i.e. in the hundreds of metres to low kilometres) (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c). Given the wide availability of suitable migratory habitat within the North Sea, barrier effects are not likely to occur as a result of this in-combination impact. **Tier 2** The Tier 2 assessment includes Morven South, the Tier 1 projects, and the following Tier 2 projects: • MHPGC Project; • Bowdun OWF; • Ossian OWF Export Cable; • EGL5. It is possible that the construction phases of the Tier 2 projects may overlap with that of Morven South, however there are no details available in the public domain on their construction programmes. For the MHPGC Project, impacts from underwater sound were scoped into the EIA during the construction phase for UXO clearance and pre-construction site investigation surveys in the EIA Scoping Report (EnBW, 2024), however no specific details such as number of UXOs requiring

In-combination assessment
clearance are currently available. While there may be spatial overlap between Morven North and the MHPGC Project, it is not expected that in-combination underwater sound produced during UXO clearance or other noise-producing activities along the MHPGC corridor will result in any in-combination impact to the features of any SACs as no SACs designated for Annex II diadromous fish qualifying features were screened into the MHPGC Project Screening Report (MvOWL, 2025), as discussed in Table 5.20. For the Bowdun OWF, impacts of underwater sound were scoped in during the construction phase due to piling and UXO clearance, site investigation surveys and other construction activities (Bowdun OWF Limited, 2024a). No specific details are currently available regarding underwater sound-producing parameters, such as maximum piling durations, maximum hammer energies, and number of UXOs requiring clearance, however these are likely to be of a similar scale to that of Morven South, given the similar scales of development and relative proximity between Morven South and Bowdun OWF. Given the extent of the possible ranges of behavioural disturbance associated with underwater sound modelled for Morven North alone (see Figure 5.2) and that Bowdun OWF is at least 44km away, it is not likely that in-combination underwater sound produced during piling and UXO clearance at the Bowdun OWF will result in significant overlapping underwater sound contours with those modelled for Morven South alone to cause barrier effects to Atlantic salmon. In contrast, in the Scoping Reports for the Ossian OWF Export Cable, impacts of underwater sound were only scoped in for site investigation surveys in the construction phase (Ossian OWFL, 2025). Similarly, impacts of underwater sound were scoped out of the Scoping Report for EGL5 due to insignificant effects that were predicted for a similar project (EGL3, which is a Tier 1) (National Grid, 2025a), therefore the potential for in-combination impact associated with these Tier 2 projects are unlikely. **Tier 3** The Tier 3 assessment includes Morven North and Morven South, the Tier 1 and 2 projects, and the Tier 3 INTOG projects (Flora and Cedar) and the MBAGC Project. It is possible that the construction phases of the Tier 3 projects may overlap with that of Morven South, however there are no details on their construction programmes currently available in the public domain. Given the distance of the INTOG projects from Morven South (94km and 85km), it is not likely that underwater sound contours associated with the Tier 3 projects would overlap with those associated with Morven South alone (see Figure 5.2) to cause barrier effects to Atlantic salmon.

Construction phase

River Dee Special Area of Conservation and River South Esk Special Area of Conservation

Atlantic salmon

5.4.2.5 As presented for the assessment of Morven South alone (Section 5.3.1), this potential impact was not predicted to result in an AEOI with respect to the Atlantic salmon feature of the River Dee SAC and the River South Esk SAC. Based on the Scenario 1, 2 and 4 assessments presented in Table 5.20 to Table 5.22, this conclusion is also applicable to the in-combination assessment. Any in-combination effects are predicted to be of short to medium term duration (such as short-term UXO clearance, and more medium-term piling schedules) and intermittent in nature. Further, the construction phases of Morven South and those of the Tier 1, 2, and 3 projects in reality, may have limited overlap, and therefore the potential for in-combination effects will be reduced. Finally, it is likely that the Tier 1, 2, and 3 projects will also include similar designed-in mitigation measures as those committed to for Morven South (Table 5.4), which will further reduce the total amount of underwater sound emitted into the marine environment and the likelihood of injury, disturbance, and barrier effects to Atlantic salmon.

Freshwater pearl mussel

5.4.2.6 As adult freshwater pearl mussel are not present within the marine environment (wherein Morven South is located), there is no pathway for direct effects associated with this in-combination impact. However, there is potential for indirect impacts on the larval stage of freshwater pearl mussel features of the River Dee SAC and the River South Esk SAC if Atlantic salmon (their host species) are impacted. As summarised in paragraph 5.4.2.5, underwater sound associated with the construction phase of Morven South and Scenarios 1, 2 and 4 will not lead to significant mortality or injury to Atlantic salmon and will not result in barriers to migration. Therefore, it can also be concluded that there will be no indirect impact to freshwater pearl mussel within these SACs.

Conclusion

5.4.2.7 Adverse effects on the Atlantic salmon and freshwater pearl mussel qualifying features of the River Dee SAC and the River South Esk SAC that undermine their conservation objectives will not occur as a result of in-combination underwater sound during construction activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 5.2.3.4 to 5.2.3.6 and 5.2.4.4 to 5.2.4.6 respectively) are presented in Table 5.23.

5.4.2.8 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Dee SAC and the River South Esk SAC as a result of underwater sound with respect to the construction phase of Morven South in-combination with other plans and projects.

River Tweed Special Area of Conservation, River Tay Special Area of Conservation and River Teith Special Area of Conservation

Atlantic salmon

5.4.2.9 As presented for the assessment of Morven South alone (Section 5.3.1), this potential impact was not predicted to cause an AEOI with respect to the Atlantic salmon qualifying features of the River Tweed SAC, River Tay SAC and River Teith SAC. Based on the Scenario 1, 2 and 4 assessments presented in Table 5.20 to Table 5.22, this conclusion is also applicable to the in-combination assessment. Any in-combination effects are predicted to be of short to medium term duration (such as short-term UXO clearance, and more medium-term piling schedules) and intermittent in nature. Further, the construction phases of Morven South and those of the Tier 1, 2, and 3 projects in reality, may have limited overlap, and therefore the potential for in-combination effects will be reduced. Finally, it is likely that the Tier 1, 2, and 3 projects will also include similar designed-in mitigation measures as those committed to for Morven South (Table 5.4), which will further reduce the total amount of underwater sound emitted into the marine environment and the likelihood of injury, disturbance, and barrier effects to Atlantic salmon.

Conclusion

5.4.2.10 Adverse effects on the Atlantic salmon qualifying feature of the River Tweed SAC, River Tay SAC and River Teith SAC that undermine their conservation objectives will not occur as a result of in-combination underwater sound during construction activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 5.2.5.5 to 5.2.5.8, 5.2.6.4 to 5.2.6.5, and 5.2.7.3 to 5.2.7.4, respectively) are presented in Table 5.23.

5.4.2.11 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Tweed SAC, River Tay SAC and River Teith SAC as a result of underwater sound with respect to the construction phase of Morven South in-combination with other plans and projects.

Table 5.23: Conclusions against the conservation objectives of the Special Areas of Conservation designated for Annex II diadromous fish for in-combination underwater sound during the construction phase

SAC	Feature	Conservation objective	Conclusion
River Dee SAC River South Esk SAC River Tay SAC	Atlantic salmon	Restore/maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site Restore/maintain the distribution of Atlantic salmon throughout the site	As for the assessment of Morven South alone, Atlantic salmon within close proximity to piling and UXO clearance associated with Scenarios 1, 2 and 4 may experience injury or mortality. However, they are highly mobile and may only use the Morven South Boundary to pass through during migration to and from higher latitude feeding grounds. As such, and with implementation of designed-in measures for Morven South (Table 5.4) and similar measures committed to by the Tier 1 projects (wherein EIA and HRA Reports were publicly available (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c)), mortality or injury to this species at a population-level is not predicted to occur. This in-combination impact will therefore not prevent the population, distribution, nor genetic diversity of Atlantic salmon within the sites from being restored or maintained. Atlantic salmon may also experience behavioural effects in response to elevated underwater sound from Scenarios 1, 2 and 4, however the sound modelling indicates these effects would not result in barriers to migration to and from any of the SACs given their localised nature in the offshore environment (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c). Further, underwater sound from piling and UXO clearance will be short-term and intermittent during the construction phase of the projects screened in for in-combination assessment. As above for injury and mortality, there will therefore be no barriers to migration of Atlantic salmon due to behavioural disturbance. As a result, this in-combination impact will not prevent the populations, the distributions, nor genetic diversity of Atlantic salmon within these sites from being restored or maintained.
		Restore/maintain the habitats supporting Atlantic salmon within the site and availability of food	There is no conceptual pathway for impact between in-combination underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SACs. With respect to availability of food, Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report concluded that for prey species of Atlantic salmon potential impacts from underwater sound would be of minor adverse significance,

SAC	Feature	Conservation objective	Conclusion
			which is not significant in EIA terms. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
River Tweed SAC	Atlantic Salmon	Natural England conservation objectives: Maintain or restore: • the extent and distribution of qualifying natural habitats and habitats of qualifying species; • the structure and function of the habitats of qualifying species; • the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	There is no conceptual pathway for impact between in-combination underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SAC. Therefore, this impact will not prevent this conservation objective from being restored or maintained
		Natural England conservation objectives: Maintain or restore: • the populations of qualifying species; • distribution of qualifying species within the site.	As for the assessment of Morven South alone, Atlantic salmon within close proximity to piling and UXO clearance associated with Scenarios 1, 2 and 4 may experience injury or mortality. However, they are highly mobile and may only use the Morven South Boundary to pass through during migration to and from higher latitude feeding grounds. As such, and with implementation of designed-in measures for Morven South (Table 5.4) and similar measures committed to by the Tier 1 projects (wherein EIA and HRA Reports were publicly available (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c)), mortality or injury to this species at a population-level is not predicted to occur. This in-combination impact will therefore not prevent the population, distribution, nor genetic diversity of Atlantic salmon within the site from being restored or maintained. Atlantic salmon may also experience behavioural effects in response to elevated underwater sound from Scenarios 1, 2 and 4, however the sound modelling indicates these effects would not result in barriers to migration to and from any of the SACs given their localised nature in the offshore environment (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c).

SAC	Feature	Conservation objective	Conclusion
			Further, underwater sound from piling and UXO clearance will be short-term and intermittent during the construction phase of the projects screened in for in-combination assessment. As above for injury and mortality, there will therefore be no barriers to migration of Atlantic salmon due to behavioural disturbance. As a result, this in-combination impact will not prevent the population, the distribution, nor genetic diversity of Atlantic salmon within the site from being restored or maintained.
		NatureScot conservation objectives: • Maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site; • Maintain the distribution of Atlantic salmon throughout the site.	As per the justification and conclusions in the row above for the equivalent Natural England conservation objectives, this in-combination impact will not prevent the population nor distribution of Atlantic salmon within this site from being maintained.
		NatureScot conservation objectives: • Maintain the habitats supporting Atlantic salmon within the site and availability of food.	There is no conceptual pathway for impact between in-combination underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SACs. With respect to availability of food, Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report concluded that for prey species of Atlantic salmon potential impacts from underwater sound would be of minor adverse significance, which is not significant in EIA terms. Therefore, this impact will not prevent this conservation objective from being maintained.
River Teith SAC	Atlantic salmon	Maintain: • the population of the species, including range of genetic types for Atlantic salmon, as a viable component of the site;	As for the assessment of Morven South alone, Atlantic salmon within close proximity to piling and UXO clearance associated with Scenarios 1, 2 and 4 may experience injury or mortality. However, they are highly mobile and may only use the Morven South Boundary to pass through during migration to and from higher latitude feeding grounds. As such, and with implementation of designed-in measures for Morven South (Table 5.4) and similar measures committed to by the Tier 1 projects (wherein EIA and HRA Reports were publicly available (Muir Mhòr Offshore Wind Farm, 2024a,

SAC	Feature	Conservation objective	Conclusion
		• the distribution of the species within site; Ensure there is no significant disturbance of the species.	Ossian OWFL, 2024c)), mortality or injury to this species at a population-level is not predicted to occur. This in-combination impact will therefore not prevent the population nor distribution of Atlantic salmon within the site from being restored or maintained. Atlantic salmon may also experience behavioural effects in response to elevated underwater sound from Scenarios 1, 2 and 4, however the sound modelling indicates these effects would not result in barriers to migration to and from any of the SACs given their localised nature in the offshore environment (Muir Mhòr Offshore Wind Farm, 2024a, Ossian OWFL, 2024c). Further, underwater sound from piling and UXO clearance will be short-term and intermittent during the construction phase of the projects screened in for in-combination assessment. As above for injury and mortality, there will therefore be no barriers to migration of Atlantic salmon due to behavioural disturbance. As a result, this in-combination impact will not prevent the population nor the distribution of Atlantic salmon within the site from being restored or maintained.
		Maintain: • the distribution and extent of habitats supporting the species; • the structure, function and supporting processes of habitats supporting the species.	There is no conceptual pathway for impact between in-combination underwater sound generated during piling and UXO clearance and the habitats that support Atlantic salmon within the SAC. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
River Dee SAC River South Esk SAC	Freshwater pearl mussel	Restore the population of freshwater pearl mussel as a viable component of the site	As a freshwater resident species, there is no direct pathway for impact between this in-combination impact (which occurs within the marine environment only) and the population and distribution of freshwater pearl mussel within the site. Instead, there is potential for indirect in-combination impacts through impacts to the host species, Atlantic salmon As presented in the rows above for Atlantic salmon, underwater sound in during piling and UXO clearance will not lead to significant mortality or injury to Atlantic salmon and is unlikely to result in barriers to migration for this host species.
		Restore the distribution of freshwater pearl mussel throughout the site	

SAC	Feature	Conservation objective	Conclusion
			Therefore, it can also be concluded that underwater sound will not indirectly prevent the freshwater pearl mussel population from being a viable component of the site or prevent the distribution of this species within the site from being restored.
		Restore the habitats supporting freshwater pearl mussel within the site and availability of food	As above for Atlantic salmon, there is no conceptual pathway for in-combination impact between underwater sound generated during piling and UXO clearance and the habitats that support freshwater pearl mussel within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being restored
		Restore/maintain the distribution and viability of freshwater pearl mussel host species and their supporting habitats	As presented in the rows above for Atlantic salmon, this in-combination impact will not prevent the distribution and viability of the host species of freshwater pearl mussel (i.e. Atlantic salmon) and its supporting habitats from being restored or maintained.

5.4.3 Electromagnetic Fields from subsea electrical cables

5.4.3.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the O&M phase, in-combination LSE[2] could not be ruled out for EMF from subsea electrical cables. This relates to the following site(s) and relevant Annex II diadromous fish and freshwater pearl mussel features:

- River Dee SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River South Esk SAC:
  - Atlantic salmon;
  - freshwater pearl mussel.
- River Tweed SAC:
  - Atlantic salmon.
- River Tay SAC:
  - Atlantic salmon.
- River Teith SAC:
  - Atlantic salmon.

5.4.3.2 The MDS considered for this in-combination assessment is shown in Table 5.24. The designed-in measures are presented in Table 5.16 for the assessment of Morven South.

Table 5.24: Maximum Design Scenario considered for the assessment of potential impacts to Annex II diadromous fish due to Electromagnetic Fields from subsea electrical cables from subsea electrical cables in the operation and maintenance phase of Morven South in-combination with other plans and projects

Project phase	MDS	Justification
O&M	**Scenario 1** MDS as described for Morven South (Table 5.15), assessed in-combination with the MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 5.15), assessed in-combination with the MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 5.15), assessed in-combination with the following other projects and plans: Tier 1 • Morven North (in its O&M phase); • Berwick Bank OWF and the Cambois Connection (in their O&M phase); • Ossian OWF (in its O&M phase); • Seagreen 1 OWF (in its O&M phase); • EGL2 (in its O&M phase); • EGL3 (in its O&M phase). Tier 2 • MHPGC Project (in its O&M phase); • Bellrock OWF (in its O&M phase); • Bowdun OWF (in O&M phase); • Ossian OWF Export Cable (in its O&M phase); • EGL5 (in its O&M phase). Tier 3 • Other than the MBAGC Project, no Tier 3 projects identified for this impact.	A precautionary buffer of 50km was used to screen in plans and projects into the assessment for this impact. The Scenario 4 projects have been screened in as they have the potential to release EMFs and therefore require consideration.

5.4.3.3 There is potential for in-combination impact from EMFs from subsea electrical cables in the O&M phase of Morven South alongside that associated with the other projects screened in for this impact.

5.4.3.4 The summary of the whole project assessment for this impact is presented in Table 5.25 and the in-combination impact assessment for Scenario 4 is presented in Table 5.27. A range of Tier 1 to 3 projects were screened into the in-combination assessment due to the potential for EMFs to be released from subsea and floating cables in their O&M phases. Subsea and floating cable parameters associated with the Tier 1 projects (wherein quantitative data were available) are presented in Table 5.26.

Table 5.25: Morven South whole project assessment for Electromagnetic Fields from subsea electrical cables

Whole project assessment	
Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Construction phase	
There will be a total length of 684km of subsea electrical cables associated with Morven South, comprised of 66kV inter-array cables and 275kV HVAC interconnector cables. These will be buried to a target depth of 1m or protected with cable protection where burial is not possible (Table 5.15). Although cable lengths and voltages are not currently available for the MHPGC Project, it is likely that cables associated with it will be buried to similar depths to that of the array and interconnector cables for Morven South with cable protection used where minimum burial depths are not possible, as per industry standard practice. As for the assessment for Morven South alone (Section 5.3.2), the strength of magnetic fields (and consequently, the induced electrical fields) decreases rapidly horizontally and vertically with distance from a cable. This reduction in magnetic field (and consequent induced electrical fields) also occurs due to cable burial, which increases the distance between the cable and fish and shellfish receptors. Although Scenario 1 involves additional electrical cables within the marine environment than those associated with Morven South alone, effects of EMFs emitted by the additional cables are highly localised to metres to tens of metres from them (see the literature summarised in Section 5.3.2). LSEs from EMFs were not screened in for further assessment at any SAC designated for Annex II diadromous fish qualifying features in the MHPGC Project HRA Screening Report (MvOWL, 2025).	Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the whole project assessment, the assessment for Scenario 2 is as provided in the column for Scenario 1.

Table 5.26: In-combination sources of Electromagnetic Fields within scenario 4 in the Operation and Maintenance phase of Morven South

Project	MDS	Reference
Morven South	684km of cables	Table 5.3
Tier 1 Projects		
Morven North	908km of cables	MvOWL (2026c)
Berwick Bank OWF (in its O&M phase)	2,097km of inter array and export cables	SSE Renewables (2022a)
Cambois Connection (in its O&M phase)	Presence of up to four 180km long HVDC cables in a 320kV symmetrical monopole arrangement or two 180km long HVDC cables as a bipole arrangement at 525kV. Therefore, a maximum length of 720km.	SSE Renewables (2023a), (2023b)
Ossian OWF (in its O&M phase)	1,381km of cables at the seabed and 116km of floating cables within the water column	Ossian OWFL (2024c)
Seagreen 1 OWF (in its O&M phase)	355km of cables	Seagreen Wind Energy Limited (2012)
EGL2 (in its O&M phase)	486km of cables (although these are not all within the Fish and Shellfish Ecology Study Area).	National Grid (2022b)
EGL3 (in its O&M phase)	Length of cables not provided in the PEIR for EGL3.	National Grid (2025c)
Total*	**6,631km** of subsea cables at the seabed and **116km** within the water column	

*Total is the total length of known project cables.

Table 5.27: Morven South in-combination assessment for Electromagnetic Fields from subsea electrical cables

In-combination assessment
Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
O&M phase
Tier 1 The Tier 1 assessment includes Morven South and the following projects: • Morven North; • Berwick Bank OWF and the Cambois Connection; • Ossian OWF; • Seagreen 1 OWF; • EGL2; • EGL3. The maximum quantifiable total length of subsea cables associated with the Tier 1 projects was at least 6,631km on the seabed and 116km within the water column (Table 5.26). It should be noted that not all of these cables will be within the 50km screening buffer, as projects such as EGL2, and EGL3 all extend outwith this area (see Figure 5.3). Given that cable type (HVAC or HVDC), voltages, burial depths, and protection methods varied between the projects, only a maximum length of cable was quantified. EMFs from subsea cables are influenced by a variety of design and installation factors, including distance between cable and cable sheathing. As for the assessment for Morven South alone (Section 5.3.2), the strength of magnetic fields (and consequently, the induced electrical fields) decreases rapidly horizontally and vertically with distance from a cable. Although an extensive network of subsea cables and floating cables (e.g. from Ossian OWF) was identified across the Tier 1 projects, tangible effects associated with EMF are likely to be highly localised to within metres to tens of metres from individual cables. For example, an EMF modelling study undertaken for the Tier 1 EGL 2 project demonstrated that EMF levels would reduce to slightly above the background levels at 20m distance from the cables (see Table 5.26). **Tier 2** The Tier 2 assessment includes Morven North and Morven South, the Tier 1 projects and the following Tier 2 projects: • MHPGC Project; • Bellrock OWF; • Bowdun OWF; • Ossian OWF Export Cable;

In-combination assessment
• EGL5. As with the Tier 1 assessment, although an extensive network of subsea cables and floating cables was identified across the Tier 2 projects, tangible effects associated with EMF are likely to be highly localised to within metres to tens of metres from cables. While there may be some spatial overlap with the MHPGC Project boundary it is unlikely that this will result in a significant in-combination effect as discussed in Table 5.25. There will be no spatial overlap between the Morven South Boundary and the other Tier 2 projects (Figure 5.3). The in-combination impact of Scenario 4, therefore, represents no additional material impact to that defined for the assessment of Morven South alone and Scenarios 1 and 2. **Tier 3** The only Tier 3 project identified for this impact was the MBAGC Project. The Tier 3 assessment is therefore no different to the Tier 2 assessment as there are no further details about the MBAGC Project to quantify further.

Operation and maintenance phase

River Dee Special Area of Conservation and River South Esk Special Area of Conservation

Atlantic salmon

5.4.3.5 As presented for the assessment of Morven South alone (Section 5.3.2), the effects associated with EMFs under Scenarios 1, 2 and 4 will be highly localised to the immediate surroundings of individual subsea and floating cables. This limited extent of effects will not represent a barrier to migration for Atlantic salmon. Although Atlantic salmon features of the River Dee SAC and the River South Esk SAC may be able to respond to and/or detect alterations in the magnetic field (see paragraphs 5.3.2.7 to 5.3.2.9), barriers to migration are not anticipated due to this limited in-combination effect and that Atlantic salmon are typically pelagic when in offshore waters (such as those within the 50km screening buffer for this impact). In addition, Atlantic salmon are highly mobile and are capable of changing course during migration between natal rivers and the open sea.

Freshwater pearl mussel

5.4.3.6 Adult freshwater pearl mussel features of the River Dee SAC and the River South Esk SAC are only present within freshwater environments, and there is therefore no pathway for direct effects associated with this in-combination impact. However, indirect impacts on the larval stage of freshwater pearl mussel are possible if Atlantic salmon (their host species) were to be impacted. As summarised in paragraph 5.4.3.5. EMFs from subsea and floating electrical cables associated with Scenarios 1, 2, and 4 are unlikely to result in barriers to migration for Atlantic salmon. Therefore, it has been concluded that there will be no indirect in-combination impact to freshwater pearl mussel.

Conclusion

5.4.3.7 Adverse effects on the Atlantic salmon and freshwater pearl mussel qualifying features of the River Dee SAC and River South Esk SAC that undermine their conservation objectives will not occur as a result of in-combination EMF from subsea and floating electrical cables during the O&M phase. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 5.2.3.4 to 5.2.3.6 and 5.2.4.4 to 5.2.4.6 respectively) are presented in Table 5.28.

5.4.3.8 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Dee SAC and River South Esk SAC as a result of EMF from subsea and floating electrical cables with respect to the O&M phase of Morven South in-combination with other plans and projects.

River Tweed Special Area of Conservation, River Tay Special Area of Conservation and River Teith Special Area of Conservation

Atlantic salmon

5.4.3.9 As presented for the assessment of Morven South alone (Section 5.3.2), the effects associated with EMFs under Scenarios 1, 2 and 4 will be highly localised to the immediate surroundings of individual subsea and floating cables. This limited extent of effects will not represent a barrier to migration for Atlantic salmon. Although Atlantic salmon features of the River Tweed SAC, River Tay SAC and River Teith SAC may be able to respond to and/or detect alterations in the magnetic field (see paragraphs 5.3.2.7 to 5.3.2.9), barriers to migration are not anticipated due to this limited in-combination effect and that Atlantic salmon are typically pelagic when in offshore waters (such as those within the 50km screening buffer for this impact). In addition, Atlantic salmon are highly mobile and are capable of changing course during migration between natal rivers and the open sea.

Conclusion

5.4.3.10 Adverse effects on the Atlantic salmon qualifying feature of the River Tweed SAC, River Tay SAC and River Teith SAC that undermine their conservation objectives will not occur as a result of in-combination EMF from subsea and floating electrical cables during the O&M phase. An assessment of the effects from this impact against the relevant conservation objectives (as presented in paragraphs 5.2.5.5 to 5.2.5.8, 5.2.6.4 to 5.2.6.5, and 5.2.7.3 to 5.2.7.4, respectively) are presented in Table 5.28.

5.4.3.11 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the River Tweed SAC, River Tay SAC and River Teith SAC that as a result of EMF from subsea and floating electrical cables with respect to the O&M phase of Morven South in-combination with other plans and projects.

Table 5.28: Conclusions against the conservation objectives of the Special Areas of Conservation designated for Annex II diadromous fish for in-combination Electromagnetic Fields from subsea electrical cables during the operation and maintenance phase

SAC	Feature	Conservation objective	Conclusion
River Dee Sac River South Esk SAC River Tay SAC	Atlantic salmon	Restore/maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site	There will be no barriers to migration of Atlantic salmon due the highly limited effects of in-combination EMFs from subsea and floating electrical cables and this impact will not prevent the populations of Atlantic salmon from being restored as a viable component of these sites nor the distributions or genetic diversity of Atlantic salmon from being restored or maintained.
		Restore/maintain the distribution of Atlantic salmon throughout the site	
		Restore/maintain the habitats supporting Atlantic salmon within the site and availability of food	There is no conceptual pathway for impact between this in-combination impact and the habitats that support Atlantic salmon within the SACs and availability of food. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
River Tweed SAC	Atlantic Salmon	Natural England conservation objectives: Maintain or restore: • the extent and distribution of qualifying natural habitats and habitats of qualifying species; • the structure and function of the habitats of qualifying species; • the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	There is no conceptual pathway for impact between this in-combination impact and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being restored or maintained.
		Natural England conservation objectives: Maintain or restore: • the populations of qualifying species; • distribution of qualifying species within the site.	There will be no barriers to migration of Atlantic salmon due the highly limited effects of in-combination EMFs from subsea and floating electrical cables and this impact will not prevent the populations of Atlantic salmon from being restored as a viable component of the site nor the distributions of Atlantic salmon from being restored or maintained.

SAC	Feature	Conservation objective	Conclusion
		NatureScot conservation objectives: • Maintain the population of Atlantic salmon, including range of genetic types, as a viable component of the site. • Maintain the distribution of Atlantic salmon throughout the site.	As per the justification and conclusions in the row above for the equivalent Natural England conservation objectives, this impact will not prevent the population nor distribution of Atlantic salmon within this site from being maintained.
		NatureScot conservation objectives: • Maintain the habitats supporting Atlantic salmon within the site and availability of food.	There is no conceptual pathway for impact between this in-combination impact and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being maintained.
River Teith SAC	Atlantic salmon	Maintain: • the population of the species, including range of genetic types for Atlantic salmon, as a viable component of the site; • the distribution of the species within site. Ensure there is no significant disturbance of the species.	There will be no barriers to migration of Atlantic salmon due the highly limited effects of in-combination EMFs from subsea and floating electrical cables and this impact will not prevent the populations of Atlantic salmon from being restored as a viable component of the site nor the distributions of Atlantic salmon from being maintained or restored.
		Maintain: • the distribution and extent of habitats supporting the species; • the structure, function and supporting processes of habitats supporting the species.	There is no conceptual pathway for impact between this in-combination impact and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being maintained or restored.
River Dee Sac River South Esk SAC	Freshwater pearl mussel	• Restore the population of freshwater pearl mussel as a viable component of the site.	As a freshwater resident species, there is no direct pathway for impact between this in-combination impact and the population and distribution of freshwater pearl mussel within

SAC	Feature	Conservation objective	Conclusion
		• Restore the distribution of freshwater pearl mussel throughout the site.	the site. Instead, there is potential for indirect in-combination impacts through impacts to the host species, Atlantic salmon. As detailed in the rows above for Atlantic salmon, EMFs will not lead to barriers to migration of host species for freshwater pearl mussel. Therefore, it can also be concluded that this impact will not indirectly prevent the populations of freshwater pearl mussel from being a viable component of this site or the distributions of this species from being restored.
		Restore the habitats supporting freshwater pearl mussel within the site and availability of food.	There is no conceptual pathway for impact between this in-combination impact and the habitats that support Atlantic salmon within the SAC and availability of food. Therefore, this impact will not prevent this conservation objective from being restored.
		Restore/maintain the distribution and viability of freshwater pearl mussel host species and their supporting habitats.	As detailed in the rows above for Atlantic salmon, this in-combination impact will not prevent the distribution and viability of host species (i.e. Atlantic salmon) and their supporting habitats from being restored or maintained.

6 Assessment of potential adverse effects on integrity: Annex II marine mammals

6.1 Introduction

6.1.1.1 This section provides background information and explanation for the approach taken to assess the potential impacts of Morven South on European sites designated for Annex II marine mammals.

6.1.1.2 As stated in Section 3.2, the potential for LSE[2] was identified for the Annex II marine mammals features of five SACs, which are listed in Table 6.1 and Figure 6.1. The MUs relevant to the SACs and used in the assessment within this RIAA Part 2 are presented in Figure 6.2.

Table 6.1: European sites designated for Annex II marine mammals features for which an Appropriate Assessment is required

Site	Feature of potential impact	Period of potential impact
Berwickshire and North Northumberland Coast SAC	Grey seal	Construction, O&M and decommissioning
Isle of May SAC	Grey seal	
Firth of Tay and Eden Estuary SAC	Harbour seal	
Southern North Sea SAC	Harbour porpoise	
Moray Firth SAC	Bottlenose dolphin	

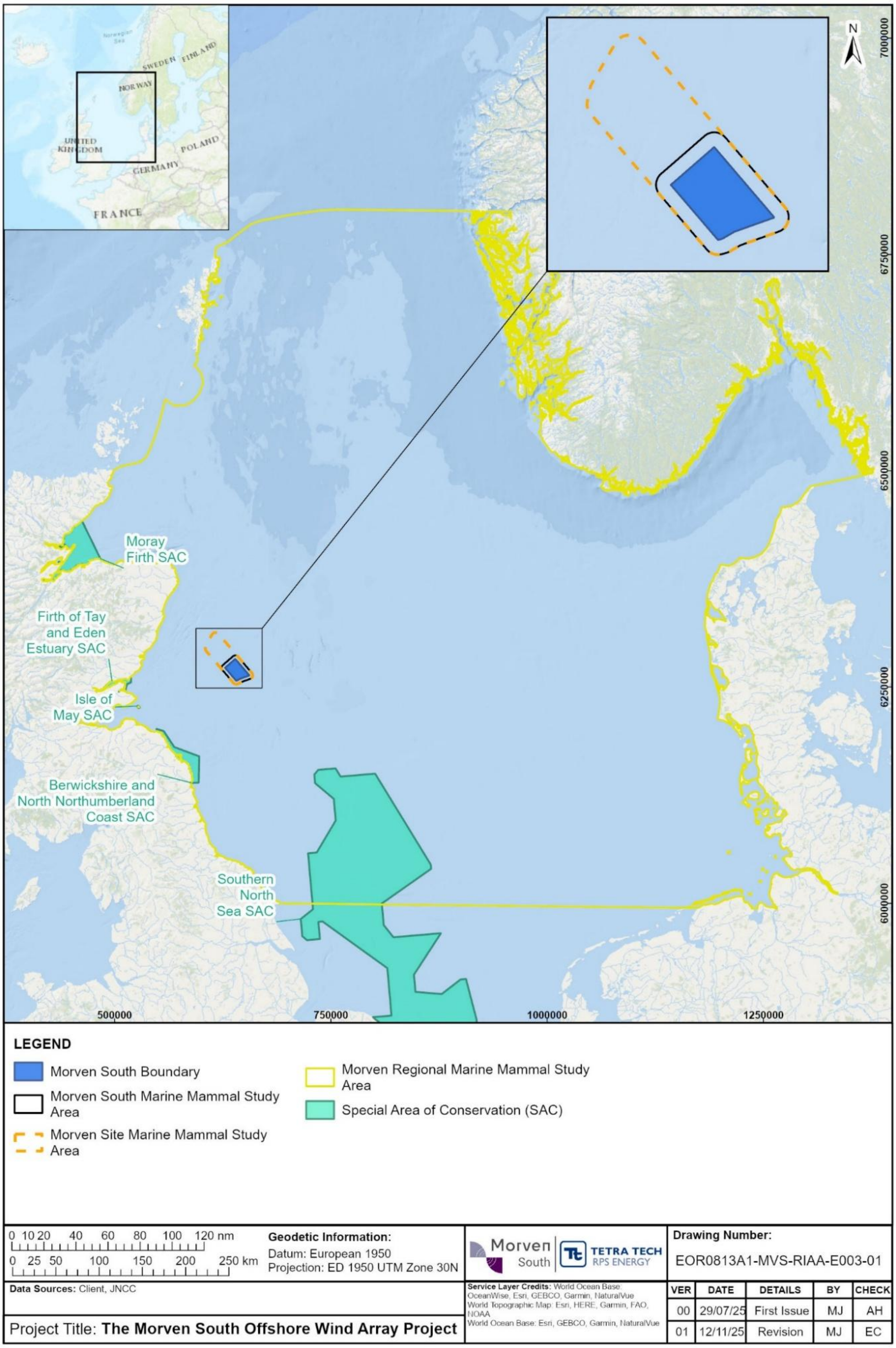

Figure 6.1: Location of European sites designated for Annex II marine mammals for which an Appropriate Assessment is required

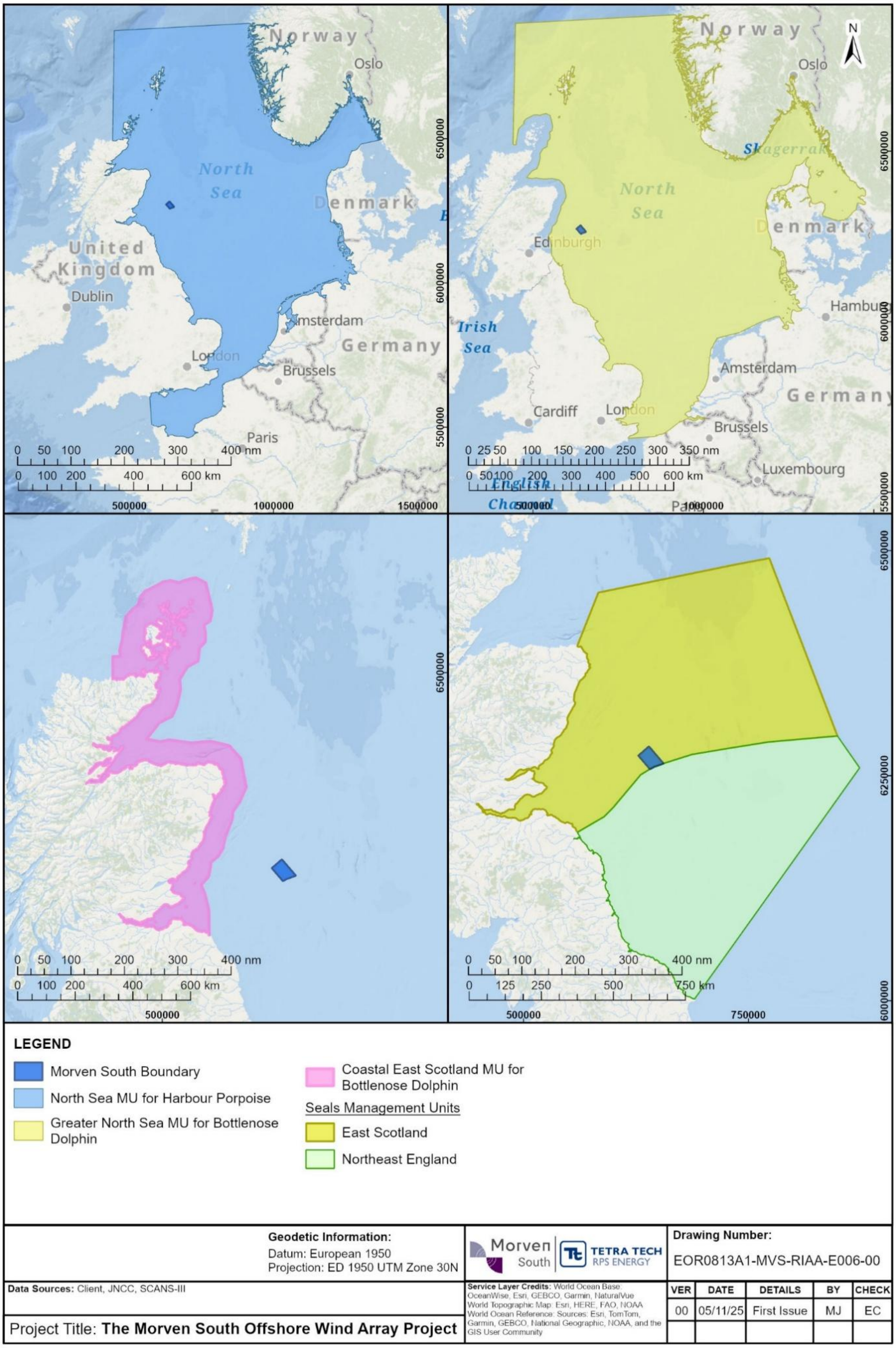

Figure 6.2: Marine Mammal Management Units relevant to the Appropriate Assessment for Morven South

6.1.1.3 The potential for LSE[2]s on the SACs presented in Table 6.1 were identified for potential impact pathways during construction, O&M and decommissioning phases of Morven South, which are outlined below in

6.1.1.4 Table 6.2, in line with the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 as discussed in Section 3.2.3. A range of designed-in measures have been committed to as part of Morven South, and these are presented, where relevant, in Section 6.3 per impact, as well as in Volume 3 Annex 6.4: EIA Commitments Register, of the EIA Report.

Table 6.2: Potential impacts to Annex II marine mammals of the European sites identified for Appropriate Assessment

Project phase	Potential Impact
Construction	Injury and disturbance from underwater sound generated from piling Injury and disturbance from underwater sound generation from UXO clearance Injury and disturbance to marine mammals from site investigation surveys Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities
O&M	Injury and disturbance to marine mammals from site investigation surveys Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities
Decommissioning	Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities

6.1.1.5 The Appropriate Assessment (considering effects of Morven South both alone and in-combination) for European sites designated for Annex II marine mammals are presented in Section 6.3 and 6.4 respectively. A summary of assessments undertaken within this RIAA Part 2 is provided in Section 7.

6.2 Baseline

6.2.1.1 Baseline information on the relevant Annex II marine mammal features screened in has been gathered through a comprehensive desktop study of existing datasets and materials and a site specific Digital Aerial Surveys (DAS; Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report, of the EIA Report). Full detail is provided in Volume 2, Chapter 10: Marine Mammals and Volume 3, Annex 10.1: Marine Mammals Shared Baseline Technical Report, of the EIA Report.

6.2.1.2 Within the EIA Report, three marine mammal study areas were defined for the purposes of the baseline characterisation and the same study areas have been applied within this RIAA Part 2:

- The Morven South Marine Mammal Study Area: an area encompassing the Morven South Boundary plus a 4km buffer.
- The Morven Site Marine Mammal Study Area includes the Morven Site plus a buffer extending 4km from this boundary). This area was covered by site specific DAS carried out between January 2021 and September 2023.
- The Morven South and Morven North Regional Marine Mammal Study Area (hereafter the Morven Regional Marine Mammal Study Area): an area encompassing the wider northern North

Sea to account for the highly mobile nature of marine mammals. The northern boundary coincides with the northern limit of the North Sea, and the southern boundary is located approximately 250km south of the Morven South Boundary, extending east from Flamborough Head (Yorkshire) to the German North Sea coast. The eastern extent reaches the Norwegian and Swedish coasts and is delineated by the southern limit of the Skaggerak (Figure 6.1).

6.2.2 Feature accounts for Annex II marine mammals

Grey seal

6.2.2.1 The grey seal is the larger of the two pinniped species that occurs around the British Isles, with males weighing up to 300kg and females up to 200kg (SCOS, 2022). The average lifespan is between 20 to 30 years, although females tend to live longer than males. Females reach sexual maturity at between three and five years old and males at around six years, although they are not thought to be socially mature until eight years old (Hall and Thompson, 2009).

6.2.2.2 Grey seals breed, rest, moult and engage in social activity when they gather in colonies on land (known as haul outs). Haul out events occur also at sea on exposed sandbanks, but their frequency is low, and their duration is on average shorter than events on land (Russell and Lonergan, 2012).

6.2.2.3 Female grey seals tend to exhibit natal fidelity in their pupping locations, which in the UK include remote, uninhabited islands or coasts and occasionally in caves, allowing females with young pups to move inland away from busy beaches and storm surges (SCOS, 2022). Grey seal may also breed on exposed, cliff-backed beaches but these locations limit the opportunity to avoid storm surges and may result in higher levels of pup mortality (SCOS, 2022). In the UK, grey seals begin breeding in the autumn months, with a clockwise cline in the mean birth date around the UK (SCOS, 2023). The majority of pups in southwest Britain are born between August and October; in north and west Scotland peak pupping occurs mainly between September and late November; in East Scotland between October and December and in eastern England pupping occurs mainly between early November to mid-December.

6.2.2.4 Grey seal give birth to a single, white-coated pup which is weaned over a period of 17 to 23 days (SCOS, 2022). Pups shed their white natal coat and develop their first adult coat at the time of weaning, after which pups remain at the breeding colony for up to three weeks. Following departure of pups, females come into oestrus and mating occurs before females return to sea to forage and build up fat reserves.

6.2.2.5 Grey seal along the Scottish coast exhibits a preference for offshore foraging, returning to land regularly to haul-out (Damseaux *et al*., 2021). Foraging trips can be wide-ranging, although tracking studies suggest that most foraging is likely to occur within 100km of a haul-out site (SCOS, 2022), and during the breeding season foraging may be restricted to approximately 20km from the breeding site.

6.2.2.6 Marine geomorphological features such as slopes, foot slopes and hollows attract grey seal as these features may support aggregations of prey, improving prey capture success (Wyles *et al*., 2022). Grey seal has a selective diet, which may comprise up to 50% plaice and sole (*Solea solea*), 46% sandeels (Ammodytidae) and some gadoids, with some seasonal and regional variation (Damseaux *et al*., 2021, Hammond *et al*., 2005). Seals in shallow waters may also show a preference for demersal and groundfish species such as cephalopods and flatfish, while seals foraging in deeper waters, over sandy substrates, will target pelagic and benthopelagic species such as blue whiting (*Micromesistius poutassou*) and sandeels (Gosch, 2017).

6.2.2.7 Globally, grey seal occurs in three regional concentrations: eastern Canada and the northeast USA, around the coast of the UK (especially in Scottish coastal waters), and the Baltic Sea. All populations are known to be increasing, however, numbers are still relatively low in the Baltic where the population has been reduced by pollution and historical human exploitation (Galatius *et al.*, 2020, SCOS, 2022). The UK total grey seal population size at the start of the 2022 breeding season was estimated to be 162,000 grey seals of which 129,100 (approximately 80%) were in Scotland (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report).

6.2.2.8 Movement data were also obtained from telemetry tags on 37 pups between 1990 and 2014, with all individuals tagged in the seal MUs of interest (see Section 6.2.3 and 6.2.4; Figure 6.3). It is important to note that pup and juvenile movements may not be representative of the typical movement patterns of adult grey seals, since recently weaned pups are known to disperse widely to haul-out locations far from their birth colony location (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report). Of these 37 grey seal pups, 13 (35%) were tracked within Morven Site Marine Mammal Study Area, 11 (30%) of which were also tracked within an SAC designated for grey seal, indicating some connectivity between the Morven Site Marine Mammal Study Area and grey seal SACs (see Sections 6.2.3 and 6.2.4 below).

6.2.2.9 The mean grey seal density of at sea usage within the Morven South Marine Mammal Study Area was estimated at 6.3 animals per 5km x 5km grid cell (Figure 4.25), equating to a density of 0.252 animals/km^2 (Carter *et al*., 2022). As discussed in Section 4.7 of Volume 3, Annex 10.1: Marine Mammal Shared Baseline Technical Report, of the EIA Report, although the density estimate was updated in Carter *et al*. (2025), that estimate is less robust and less conservative, so on a precautionary basis the Carter *et al*. (2022) density estimate for grey seal of 0.252 animals/km^2 has been taken forward in this RIAA Part 2 (as agreed with NatureScot and MD-LOT, see Table 2.1).

Harbour seal

6.2.2.10 Harbour seals typically weigh between 80kg to 100kg and are the smaller of the two species of pinniped that breed in the UK (SCOS, 2022). Males reach sexual maturity at four to six years, and females at three to five years (Lowry, 2016), with a life expectancy of between 20 and 30 years (SCOS, 2022).

6.2.2.11 Harbour seals are central place foragers and they come ashore in sheltered waters, often on sandbanks, in estuaries and rocky areas (SCOS, 2022). Haul-out sites are required for resting, moulting, and breeding, and individuals disperse from these sites to forage at sea. To reduce time and energy searching for prey, animals are likely to travel directly to areas of previously or predictably high foraging success (Bailey *et al.*, 2014) and tend to stay within 50km of the coast, although most foraging trips are over shorter ranges (Carter *et al.*, 2022, Russell and McConnell, 2014).

6.2.2.12 Harbour seal are generalist feeders, and their diet varies seasonally and regionally (Hammond *et al.*, 2005). The analysis of stable isotopic composition and concentration of mercury and selenium ions in blood of harbour seal in the North Sea demonstrated that harbour seal diet is comprised of 30% juvenile cod (*Gadus morhua*), 29% of plaice (*Pleuronectes platessa)* and 23% of monkfish (*Lophius piscatorius)*, as well as European hake (*Merluccius merluccius)* and haddock (*Melanogrammus aeglefinus*) (Damseaux *et al.*, 2021).

6.2.2.13 Harbour seal females give birth in small groups scattered along the coastline, with pups born in June and July having moulted their white coats prior to birth. During lactation, females spend much of their time in the water with their pups and, although they will forage during this period, individuals travel shorter distances than during other periods (Thompson *et al.*, 1994). In recent years, a small number of surveys have been carried out in Scottish waters during the breeding season, in areas designated as SACs for harbour seals (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report), although none were conducted in the East Scotland or Northeast England SMUs.

6.2.2.14 The harbour seal is found around the coasts of the North Atlantic and North Pacific from the subtropics to the Arctic (SCOS, 2022). The largest population in Europe is in the Wadden Sea, with approximately 32% found in the UK (SCOS, 2022). On the east coast of the UK the distribution of this species is more restricted with concentrations in the major estuaries of the Thames, The Wash, the Firths of Forth and Tay, and the Moray Firth. Major declines have been documented in several harbour seal populations along the east coast of England and around Scotland (SCOS, 2024), although the pattern of declines is not universal.

6.2.2.15 A tagging study undertaken between 2001 and 2013 provided information on movements of harbour seal in and around the Morven Site Marine Mammal Study Area. In total, 49 harbour seals were tracked within the East Scotland and Northeast England SMUs, and four of these animals showed connectivity with the Firth of Tay and Eden Estuary SAC (see Section 6.2.5; Figure 6.4; Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report). Three of these seals had clear connectivity with the Morven South Marine Mammal Study Area. None of the tagged individuals showed connectivity with harbour seal SACs outside of the East Scotland SMU (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report).

6.2.2.16 The annual moult of harbour seals in Scotland occurs in August, during which the greatest and most consistent abundance of hauled-out harbour seals occurs (SCOS, 2022). As such, the main harbour seal population surveys are carried out during this time.

6.2.2.17 The mean harbour seal at sea usage within the Morven South Marine Mammal Study Area is very low, with mean density of 3.00 x 10^{-6} animals per 5km x 5km grid cell, equating to a density of 1.20 x 10^{-7} animals/km^2 (Carter *et al*., 2022). Note that the most recent Carter *et al.* (2025) maps exclude animals tagged in the northeast of England and therefore are less conservative compared to the previous Carter *et al.* (2022) maps. As discussed in Section 4.8 of Volume 3, Annex 10.1: Marine Mammal Shared Baseline Technical Report, of the EIA Report, this density estimate was taken forward in this RIAA Part 2 as the most precautionary density estimate (as agreed with NatureScot and MD-LOT, see Table 2.1).

Harbour porpoise

6.2.2.18 The harbour porpoise is a small odontocete (toothed whale) which inhabits coastal temperate and boreal waters of the northern hemisphere. It reaches a maximum body length of 1.9m (Bjørge and Tolley, 2009), with females and males reaching an average length of 1.6m and 1.45m, respectively (Lockyer, 1995). The maximum recorded longevity is approximately 24 years, although most individuals do not live beyond 12 years (Lockyer, 2013). Sexual maturity in harbour porpoise is reached at three to four years and reproduction is strongly seasonal, with mating occurring between June and August (Lockyer, 1995). Gestation lasts 10 to 11 months and peak birth rate around the UK occurs during the months of June and July (Boyd *et al*., 1999).

6.2.2.19 Harbour porpoise is predominantly piscivorous, feeding mainly on small demersal or pelagic shoaling fish species (Santos and Pierce, 2003). Regional, seasonal and inter-annual variation in diet is driven by the availability of prey species as well as individual age, with younger animals targeting smaller individuals or smaller species (Santos and Pierce, 2003). Energy maps of harbour porpoise prey species suggest that the energetic value of prey in the North Sea is greatest in the summer, with diet largely comprising sandeels and whiting (*Merlangius merlangus*). During the winter European sprat (*Sprattus sprattus*) and Atlantic herring (*Clupea harengus*) also contribute to overall energy density (Ransijn *et al.*, 2019, Santos, 1998, Santos and Pierce, 2003).

6.2.2.20 Although harbour porpoise individuals generally hunt alone or in small groups, this species can be seen in larger aggregations of 50 or more individuals, either during seasonal migrations or associated with increased concentrations of prey. Within these aggregations, segregation may occur, with females travelling with their calves and yearlings, and immature animals of each sex segregating into groups.

6.2.2.21 The harbour porpoise is widespread throughout the cold and temperate Atlantic seas of Europe, including the North Sea, the Irish Sea, and the Baltic Sea (JNCC, 2023b). In the North Sea MU (IAMMWG, 2023) water depths and hydrodynamic variables appear to be the most important factors predicting the presence of harbour porpoise (Heinänen and Skov, 2015).

6.2.2.22 Amongst historical surveys undertaken to inform the regional baseline, and those for other offshore wind developments, harbour porpoise was the most commonly identified cetacean.

6.2.2.23 These include The Crown Estate aerial surveys (Grellier and Lacey, 2011), Berwick Bank aerial surveys (SSE Renewables, 2022c), Ossian OWF aerial surveys (Ossian OWFL, 2024b), SSE Regional Survey aerial surveys (HiDef, 2023) and boat-based surveys for Seagreen (Seagreen Wind Energy Limited, 2018, Sparling, 2012) and Neart na Gaoithe (Mainstream Renewable Power, 2019).

6.2.2.24 Harbour porpoise accounted for the highest number of sightings across all species in the DAS of the Morven Site Marine Mammal Study Area, with a total of 593 animals recorded across 29 months (comprising 33 months of survey, four of which contained no harbour porpoise sightings). No clear temporal or spatial patterns were observed in the distribution of harbour porpoise sightings within the Morven South Boundary, although notable concentrations of animals did occur in the north of the Morven Site Marine Mammal Study Area during May 2021 and May 2022 (see Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report, of the EIA Report).

6.2.2.25 Monthly predicted distribution maps of harbour porpoise from Waggitt *et al*. (2020) overlaid on the Morven South Marine Mammal Study Area indicate that harbour porpoise densities are higher throughout summer and autumn months. As discussed in Section 4.2 of Volume 3, Annex 10.1: Marine Mammal Shared Baseline Technical Report, of the EIA Report, while surface density estimates are available at a finer spatial resolution compared to the SCANS block data (Gilles *et al.*, 2025, Waggitt *et al.*, 2020) SCANS-IV block data (from 2022) are more conservative, and represent the most up-to-date density estimates for harbour porpoise. Therefore, the SCANS-IV density of 0.599 animals/km^2 (Gilles *et al.*, 2023) is considered the most appropriate to be taken forward in this RIAA Part 2 (as agreed with NatureScot and MD-LOT, see Table 2.1).

Bottlenose dolphin

6.2.2.26 Bottlenose dolphin is an odontocetes of the family Delphinidae, found in temperate and tropical waters worldwide. It is the largest of the beaked dolphins, ranging in length from 1.9m to 3.8m. Bottlenose dolphin live, on average, between 20 to 30 years, with males reaching sexual maturity at 10 to 12 years and females at five to 10 years. Mating occurs during the summer months, with gestation taking 12 months and calves suckling for 18 to 24 months. Females generally reproduce every three to six years (Mitcheson, 2008).

6.2.2.27 Bottlenose dolphin is more frequently seen in groups rather than individually, and group size in offshore populations may be larger than coastal populations, although relatively little is known about offshore populations (Rogan et al., 2018). For example, mean group size across the SCANS-III survey areas was estimated as 5.25 individuals (Hammond et al., 2021), while group sizes in the outer Moray Firth varied between two and 70 animals (Robinson et al., 2017).

6.2.2.28 The distribution of bottlenose dolphin is influenced by tidal state, weather conditions, resource availability, life cycle stage and seasonal factors and within-population variation in patterns of habitat use have been observed (Hastie et al., 2004). Typical prey items in Scottish waters include cod, saithe (*Pollachius virens*), Atlantic salmon, haddock and whiting (Santos et al., 2001).

6.2.2.29 Bottlenose dolphin is present within the northern North Sea and comprises discrete offshore and inshore (coastal) population ecotypes. Morven South is located in the offshore region and therefore predominantly overlaps with the offshore population represented by the Greater North Sea MU, with an estimated abundance of 2,022 individuals in the Greater North Sea MU (1,885 in the UK portion). However, only the coastal population, distributed within the 2m to 20m depth contour and approximately 2km from the shore, is well studied (Geelhoed *et al.*, 2022) and, with strong links to the Moray Firth SAC, this coastal population is described further below. It is the coastal population that is relevant in the context of this RIAA Part 2 and is used as the MU reference population.

6.2.2.30 The East Coast Marine Mammal Acoustic Study, which uses acoustic recorders, known as Cetacean Porpoise Detector (C-PODs), at locations in the Moray Firth, Firth of Tay, Firth of Forth and Aberdeenshire coast, to estimate the distribution of small cetaceans around the east coast of Scotland from detection of echolocation clicks, found that broadband acoustic occupancy rates throughout the survey were generally higher for C-PODs closer to the shoreline (Palmer *et al.*, 2019). This suggests that bottlenose dolphins are more likely to be observed in coastal waters, within 5km of shore and therefore are unlikely to be present in the offshore areas that may be exposed to significant construction noise from offshore wind farms. These results were corroborated by Quick *et al.* (2014) which reported that dolphins were mostly encountered in waters less than 30m deep, generally in waters between 2m and 20m and within 2km from the coast. Paxton *et al.* (2016) also describes the bottlenose dolphin distribution as coastal within the Morven Regional Marine Mammal Study Area.

6.2.2.31 As discussed in Section 4.2 of Volume 3, Annex 10.1: Marine Mammal Shared Baseline Technical Report, of the EIA Report, density estimates reported by Lacey *et al.* (2022) are considered the most appropriate to use to reflect densities of bottlenose dolphin in the offshore waters where the Morven South Boundary is located. Therefore, a density of 0.005 animals per km^2 was taken forward in this RIAA Part 2 as the most precautionary density estimate (as agreed with NatureScot and MD-LOT, see Table 2.1). There were no bottlenose dolphin recorded during site specific DAS for Morven South (Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report, of the EIA Report).

6.2.3 Berwickshire and North Northumberland Coast Special Area of Conservation

Site description

6.2.3.1 The Berwickshire and North Northumberland Coast SAC, at its closest point, is located 97.2km southwest from the Morven South Boundary. The Berwickshire and North Northumberland Coast SAC is one of the most varied coastlines in the UK, stretching from Alnmouth to north of St Abbs head and contains a complex mix of marine habitats, associated species and communities (Natural England, 2020). It covers an area of 652.3km^2 and the primary Annex II species the SAC is designated for is grey seal (JNCC, 2025i).

6.2.3.2 The SAC is an extensive and diverse stretch of coastline, which provide important breeding and haul-out habitats for grey seal, supporting approximately 3% of the British annual pup production (Natural England, 2020). Grey seals use areas within the SAC, such as Staple Island within the Farne Islands and Fast Castle, for breeding, hauling out and moulting (Natural England, 2020). The Farne Islands have been an important breeding site since the Middle Ages (SCOS, 2023), while Fast Castle is a recently established breeding site first colonised in the 1990s. The grey seal pup production at the Farne Islands and Fast Castle has shown a recent, rapid increase; from 2014 to 2019, the mean estimated increase in grey seal pup production at Farne Islands was 53% (SCOS, 2023). A large number of grey seal also haul out around Holy Island sands, Lindisfarne, however, no breeding has been recorded here to date (Natural England, 2020). The SAC represents the most south eastern grey seal breeding colonies in the UK, and it is the most southeasterly SAC designated for this species (JNCC, 2025i).

6.2.3.3 The Berwickshire and North Northumberland Coast SAC grey seal population is part of the East Scotland SMU in Scotland and the Northeast England SMU in England. The English Berwickshire and North Northumberland Coast SAC component represents more than 90% of the Northeast England SMU and so mirrors trends in the Northeast England SMU (SCOS, 2024). August grey seal counts took place in 2021 in both East Scotland and Northeast England SMU and resulted in a scaled August population estimates of 10,783 and 25,913 grey seals, respectively (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report).

6.2.3.4 Based on Carter *et al.* (2022) maps, mean grey seal at-sea usage within the Morven South Marine Mammal Study Area is low, as the hotspots are located closer to the shore and in the vicinity of the Berwickshire and North Northumberland Coast SAC, Firth of Forth, Tay and Eden Estuary and north of Aberdeen (Figure 6.3). Telemetry data demonstrated connectivity between the Berwickshire and North Northumberland Coast SAC and the Morven Site Marine Mammal Study Area with 14 adult individuals and five grey seal pups moving regularly between these areas (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report).

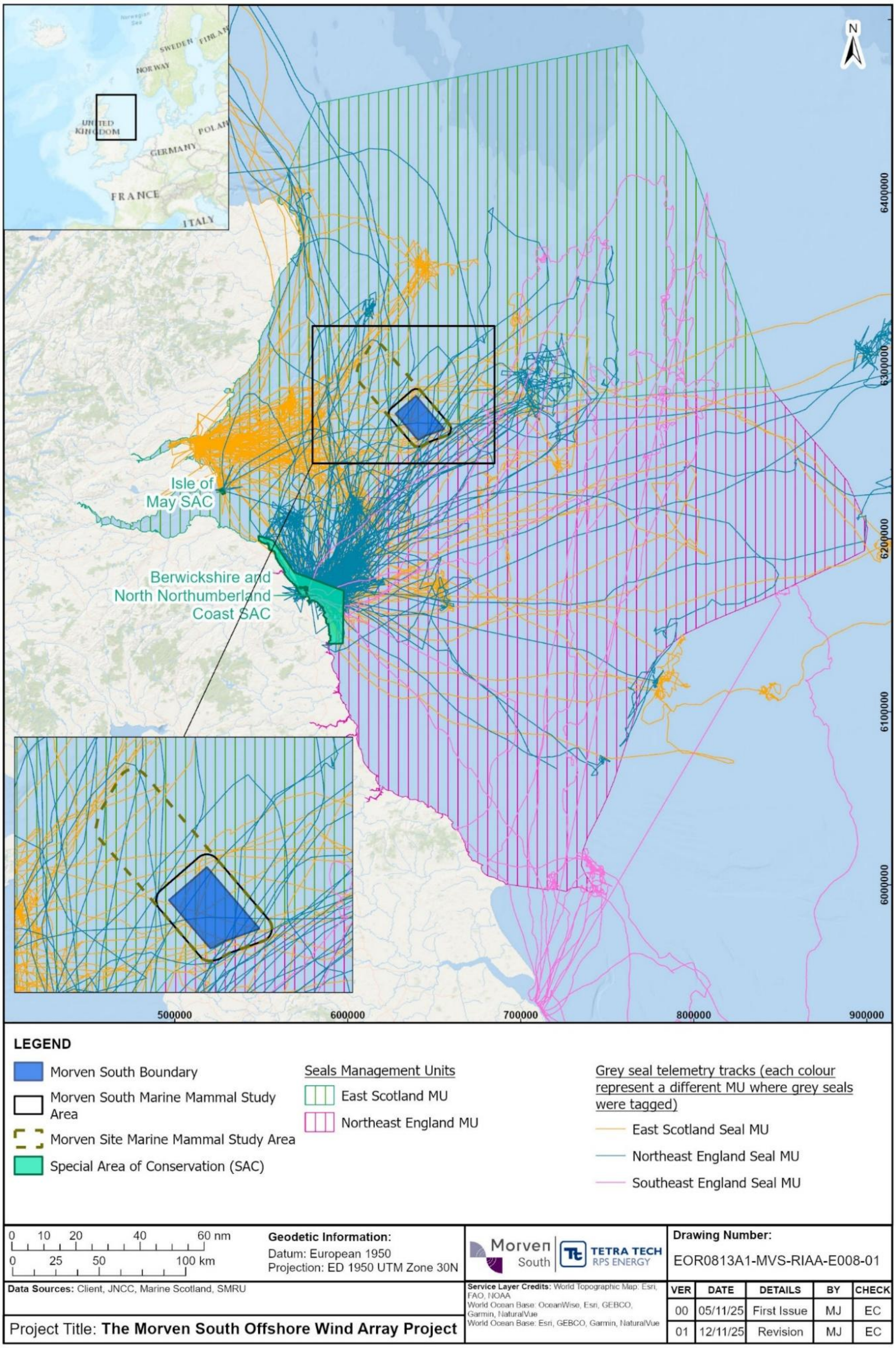

Figure 6.3: Telemetry tracks of adult grey seals with connectivity to the Morven South Marine Mammal Study Area and Special Areas of Conservation

Conservation objectives

6.2.3.5 The conservation objectives for Berwickshire and North Northumberland Coast SAC were jointly developed by NatureScot and Natural England (Natural England, 2020) and apply to the site and the individual species (e.g. grey seal) for which the site has been classified. High-level objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the FCS of its qualifying features, by maintaining or restoring:

- the extent and distribution of qualifying natural habitat and habitats of the qualifying species;
- the structure and function (including typical species) of qualifying natural habitats;
- the structure and function of the habitats of the qualifying species;
- the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely;
- the populations of each of the qualifying species;
- the distribution of qualifying species within the site.

6.2.3.6 The second conservation objective: 'the structure and function (including typical species) of qualifying natural habitats' is only relevant to the Annex I habitat features of the Berwickshire and North Northumberland Coast SAC and is therefore not included further in this assessment on Annex II marine mammals.

6.2.3.7 Supplementary advice on conservation objectives (published on 09 May 2023) (Natural England, 2023) provides the site specific attributes and targets specific to the grey seal feature of the SAC. Conservation targets for grey seal are summarised here:

- maintain the population size within the site;
- maintain the reproductive and recruitment capability of the species;
- maintain the presence and spatial distribution of the species and their ability to undertake key life cycle stages and behaviours;
- maintain connectivity of the habitat within sites and the wider environment to ensure recruitment, and/or to allow movement of migratory species;
- restrict the introduction and spread of INNS and pathogens, and their impacts;
- maintain the extent and spatial distribution of the following supporting habitats: haul out sites;
- maintain the cover and abundance of preferred food items required by the species;
- maintain the natural physico-chemical properties of the water;
- maintain all hydrodynamic and physical conditions such that natural water flow and sediment movement is not significantly altered or constrained;
- reduce aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the WFD, avoiding deterioration from existing levels;
- maintain water quality at mean winter dissolved inorganic nitrogen levels where biological indicators of eutrophication (opportunistic macroalgal and phytoplankton blooms) do not affect the integrity of the site and features;
- maintain natural levels of turbidity in areas where this species is, or could be, present.

Condition assessment

6.2.3.8 There was no condition assessment currently available on the Natural England Designated Sites Portal (Natural England, 2020), however, the condition of grey seal within the Berwickshire and North Northumberland Coast SAC was assessed by NatureScot in 2024 (NatureScot, 2025b) as:

- favourable – maintained.

6.2.4 Isle of May Special Area of Conservation

Site description

6.2.4.1 The Isle of May SAC, at its closest point, is located 108.6km southwest from the Morven South Boundary. The SAC extends over an area of 3.6km^2 and is primarily designated for Annex II grey seal (JNCC, 2025k). It supports the largest east coast breeding colony in Scotland (JNCC, 2025k).

6.2.4.2 The Isle of May SAC grey seal population forms part of the East Scotland SMU. Grey seal pup production at the Isle of May SAC increased at a rate of 9.9% per year since surveys began (1979), before reaching a peak of approximately 2,000 pups in the late 1990s (SCOS, 2023). Although prior to the 1990s the Isle of May SAC was the dominant location for grey seal pup production within the East Scotland MU, pup production is now considered to be stable or potentially declining (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report). Approximately 25% of the SMU pup production and 4.5% of annual UK pup production is supported by the Isle of May SAC (NatureScot, 2025a, SCOS, 2022).

6.2.4.3 As noted for the Berwickshire and North Northumberland Coast SAC (paragraph 6.2.3.4; Figure 6.3), mean grey seal at-sea usage within the Morven South Marine Mammal Study Area is low. Telemetry data demonstrated connectivity between the Isle of May SAC and the Morven Site Marine Mammal Study Area with two adult grey seals regularly moving between these areas, as well as four grey seal pups (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report).

Conservation objectives

6.2.4.4 Conservation objectives for the Isle of May SAC have been developed by NatureScot as part of the site CMA document (NatureScot, 2025a). The overarching conservation objectives for all features of the SAC are:

- to ensure that the qualifying features of Isle of May SAC are in favourable condition and make an appropriate contribution to achieving FCS;
- to ensure that the integrity of Isle of May SAC is maintained or restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature.

6.2.4.5 Specific conservation objectives for grey seal ensure that:

- 2a: grey seals are a viable component of the Isle of May SAC;
- 2b: the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals;
- 2c: the supporting habitats relevant to grey seal are maintained.

Condition assessment

6.2.4.6 The condition of grey seal within the Isle of May SAC was last assessed in 2024 (NatureScot, 2025b) as:

- favourable – maintained.

6.2.5 Firth of Tay and Eden Estuary Special Area of Conservation

Site description

6.2.5.1 The Firth of Tay and Eden Estuary SAC, at its closest point, is located 109.3km southwest from the Morven South Boundary. The Firth of Tay and Eden Estuary SAC covers an area of 154.4km^2 and harbour seal is the primary Annex II species for which the site is designated (JNCC, 2025m). The

Firth of Tay and Eden Estuary SAC provides protection to an excellent example of a northern North Sea estuary, which supports migratory fish species and mussel beds, both of which are important food sources for other species, including harbour seals (NatureScot, 2024).

6.2.5.2 The SAC also provides important habitat for harbour seal to moult and breed, namely the sandbanks of the estuary (JNCC, 2025m, NatureScot, 2024). Between 1990 and 2002, the majority of the East Scotland SMU harbour seal population was located in the Firth of Tay and Eden Estuary SAC. During this period, harbour seal counts in this SAC remained stable, representing approximately 85% of the East Scotland SMU count (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report). The population within the SAC then declined rapidly from 2002 to 2021 to a count of 41 individuals, representing an approximate 95% decline in the population. As such, the SAC now accounts for approximately 16% of the haul-out counts in the East Scotland SMU. There is, however, recent evidence that this decline may be slowing, with the current population estimate for harbour seal in the East Scotland SMU at 364 animals (Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report).

6.2.5.3 Based on Carter *et al.* (2022) maps, mean harbour seal at-sea usage within Morven South Marine Mammal Study Area is low, as the hotspots are located closer to the shore and in the vicinity of the Firth of Forth, Tay and Eden Estuary and north of Aberdeen. No harbour seals were recorded during the DAS (Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report, of the EIA Report). Telemetry data confirmed that harbour seal habitat usage within the Morven Site Marine Mammal Study Area is very limited. In total, 49 harbour seals were tracked within the East Scotland and Northeast England SMUs, and of these animals, three were recorded within the Morven South Marine Mammal Study Area (Figure 6.4; Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report) although noting one additional track was recorded to the north within the Morven Site Marine Mammal Study Area. All four of these individuals were tagged within the Firth of Tay and Eden Estuary SAC, and although this site lies approximately 100km from the Morven South Marine Mammal Study Area (i.e. beyond the typical 50km foraging range for harbour seal), the data suggests some degree of connectivity between the SAC and the Morven Site Marine Mammal Study Area.

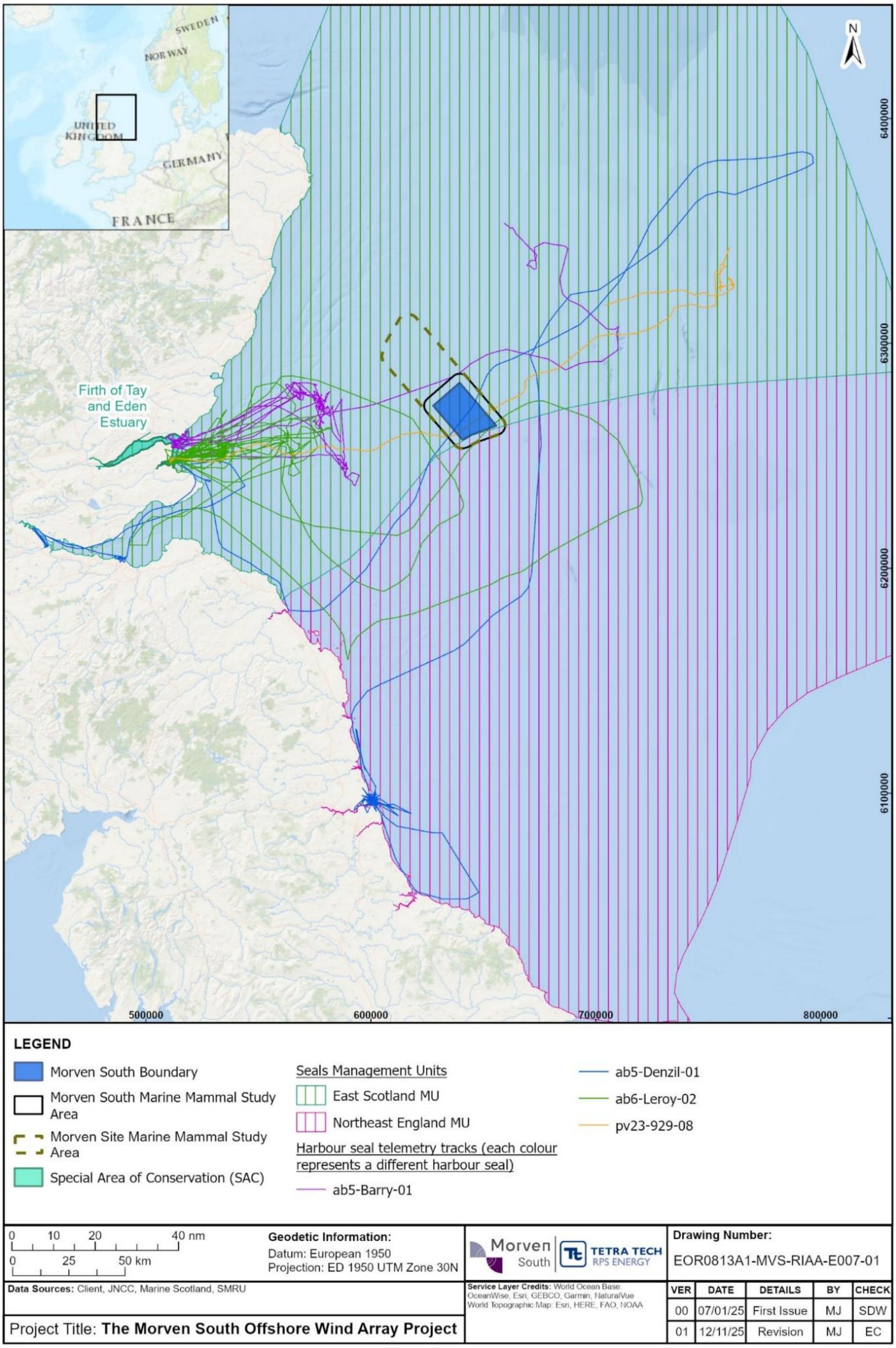

Figure 6.4: Telemetry tracks of harbour seals with connectivity to the Morven South Marine Mammal Study Area and Firth of Tay and Eden Estuary Special Area of Conservation

Conservation objectives

6.2.5.4 Conservation objectives for the Firth of Tay and Eden Estuary SAC have been developed by NatureScot as part of the site CMA document (NatureScot, 2024). The overarching conservation objectives for all features of the SAC are:

- to ensure that the qualifying features of Firth of Tay and Eden Estuary SAC are in favourable condition and make an appropriate contribution to achieving FCS;
- to ensure that the integrity of Firth of Tay and Eden Estuary SAC is maintained or restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature.

6.2.5.5 Specific conservation objectives for harbour seal ensure that:

- 2a: harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality;
- 2b: the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance;
- 2c: the supporting habitats and processes relevant to harbour seal are maintained.

Condition assessment

6.2.5.6 The condition of harbour seal within the Firth of Tay and Eden Estuary SAC was assessed in 2024 (NatureScot, 2025b) as:

- unfavourable – declining.

6.2.5.7 As the harbour seal feature is in unfavourable condition at Firth of Tay and Eden Estuary SAC, due the overall decline in the number of seals using the site since the 1990s (approximately 95%) (Morris *et al.*, 2021), NatureScot (2024) states that the conservation objectives seek to maintain the conditions in the SAC to support the recovery of the harbour seal. This is because reasons for the decline in the SAC are considered to be off-site factors such as predation, competition for prey, prey quality and availability, and toxin exposure from harmful algae (NatureScot, 2024).

6.2.6 Southern North Sea Special Area of Conservation

Site description

6.2.6.1 The Southern North Sea SAC, at its closest point, is located 135.1km southeast from the Morven South Boundary. The Southern North Sea SAC covers a fully marine area of 36,951km^2 and is designated solely for harbour porpoise (JNCC, 2023a, JNCC and Natural England, 2019). The site lies along the east coast of England, predominantly in the offshore waters of the central and southern North Sea, from north of Dogger Bank to the Straits of Dover in the south.

6.2.6.2 The Southern North Sea SAC is an area of importance for harbour porpoise: the northern part of the site (approximately two-thirds) is important for the species during the summer, while persistently high densities are supported by the southern part during the winter (JNCC, 2023a). The majority of this site lies offshore but does extend from the coastal areas of Norfolk and Suffolk out to the 12nm limit. The SAC is characterised predominantly by sandy, coarse sediments, which are thought to be preferred by harbour porpoise, likely due to availability of prey (JNCC, 2023a).

6.2.6.3 The Southern North Sea SAC is located within the North Sea MU for harbour porpoise and supports approximately 17.5% of the UK North Sea MU population. The latest population estimated of the North Sea MU was 346,601 individuals, of which 159,632 individuals comprise the UK portion (IAMMWG, 2023).

Conservation objectives

6.2.6.4 The conservation objectives for the Southern North Sea SAC were jointly developed by the JNCC and Natural England (2019). The conservation objectives for the site are to ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining FCS for harbour porpoise in UK waters. In the context of natural change, this will be achieved by ensuring that:

1. harbour porpoise are a viable component of the site;
2. there is no significant disturbance of the species;
3. the condition of supporting habitats and processes, and the availability of prey is maintained.

Condition assessment

6.2.6.5 The status of the harbour porpoise feature within the Southern North Sea SAC was last assessed as 'Favourable' in 2023 (JNCC, 2023a).

6.2.7 Moray Firth Special Area of Conservation

Site description

6.2.7.1 The Moray Firth SAC, at its closest point, is located 215.8km northwest of the Morven South Boundary. This SAC covers a fully marine area of 1,512.7km^2 and extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast (JNCC, 2025b). It is designated primarily for bottlenose dolphin, as this SAC supports the only known resident coastal population of bottlenose dolphin in the North Sea (JNCC, 2025b, NatureScot, 2025c). Based on data collected in 1980s and early 1990s, the Moray Firth SAC is thought to encompass the core area of occurrence of the resident, coastal population of bottlenose dolphins in the North Sea (i.e. the Coastal East Scotland MU). The resident population of bottlenose dolphin from the Moray Firth SAC is also now known to venture down the coast of East Scotland and England as far south as Scarborough, where there have been regular sightings in recent years (Hackett, 2022).

6.2.7.2 As the Coastal East Scotland MU is considered equivalent to the SAC population (NatureScot, 2025c), the SAC bottlenose dolphin population has an estimated abundance of 226 individuals based on the weight mean estimate between 2020 to 2022 (Cheney *et al.*, 2024). The Coastal East Scotland MU has been used as the reference population throughout this RIAA Part 2 (paragraph 6.2.2.29), rather than the Greater North Sea MU, which was used as the reference population in Volume 2, Chapter 10: Marine Mammals of the EIA Report. The boundary of the Coastal East Scotland MU is 64.4km from the Morven South Boundary.

6.2.7.3 Data from the site condition monitoring suggests that the proportion of population that use the SAC has declined, although the overall population along the coast is increasing (Cheney *et al.*, 2018, Cheney *et al.*, 2024), and it is thought that their range is extending (Arso Civil *et al.*, 2019, Arso Civil *et al.*, 2021, Cheney *et al.*, 2018, Cheney *et al.*, 2024, IAMMWG, 2023, Quick *et al.*, 2014). However, the SAC is still estimated to be used by 50% of the Coastal East Scotland MU population annually with bottlenose dolphins present in the SAC throughout the year.

Conservation objectives

6.2.7.4 Conservation objectives for the Moray Firth SAC have been developed by NatureScot as part of the site CMA document (NatureScot, 2025c). The overarching conservation objectives for all features of the SAC are:

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

- to ensure that the integrity of Moray Firth SAC is maintained or restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature.

6.2.7.5 Conservation objectives for bottlenose dolphin are as follows:

- 2a: the population of bottlenose dolphin is a viable component of the site;
- 2b: the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance;
- 2c: the supporting habitats and processes relevant to bottlenose dolphin and their prey/food resources for bottlenose dolphin are maintained.

Condition assessment

6.2.7.6 The condition of bottlenose dolphin within the Moray Firth SAC was assessed in 2024 (NatureScot, 2025b) as:

- favourable – maintained.

6.2.8 Marine mammals and underwater sound

6.2.8.1 Marine mammals, in particular cetaceans, are capable of generating and detecting sound and are dependent on sound for many aspects of their life, including prey identification, predator avoidance, communication and navigation (Bailey *et al.*, 2010). Increases in anthropogenic sound may consequently lead to a potential effect within the marine environment (Bailey *et al.*, 2010, Parsons *et al.*, 2008). Underwater sound influence may then subsequently affect marine mammals in a number of ways and vary with the distance from the sound source (Marine Mammal Commission, 2007). It can compete with important signals (masking) and alter behaviour (by inducing changes in foraging or habitat-use patterns, separation of mother-calf pairs). Underwater sound can also cause temporary hearing loss or, if the exposure is prolonged or intense, permanent hearing loss. It can also cause damage to tissues other than the ear if noise is sufficiently intense (Marine Mammal Commission, 2007).

6.2.8.2 Given that there is sparse scientific evidence to properly evaluate masking (e.g. no relevant threshold criteria to enable a quantitative assessment), the assessment of effects associated with underwater sound on marine mammals will consider auditory injury (temporary and permanent hearing loss) and behavioural response.

Injury

6.2.8.3 Auditory injury in marine mammals can be either temporary TTS, wherein an animal's auditory system recovers over time, or a Permanent Threshold Shift (PTS), whereby hearing does not recover. The 'onset' of non-trivial TTS corresponds to a 6dB shift in a hearing threshold, defined by the US National Marine Fisheries Service (NMFS, 2024) as "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".

6.2.8.4 The acoustic threshold that would result in PTS onset in marine mammals has not been directly measured (given the ethical implications of experimentally inducing permanent auditory injury) and must therefore be extrapolated from available TTS-onset measurements. The extrapolated PTS threshold of 40dB of TTS is conservatively thought to require a longer recovery time than smaller shifts (e.g. of 6dB), with a higher probability of irreversible damage (Southall *et al.*, 2007).

6.2.8.5 Whether such shifts in hearing would lead to loss of fitness will depend on several factors including the frequency range of the shift and the duration of impulsive sounds. If a shift occurs within a frequency band outside of the main hearing sensitivity of the receiving animal there may be a 'notch' in this band, but potentially no effect on the animal's ability to survive. Further discussion on the sensitivity of marine mammals to hearing shifts is presented later in this assessment. Potential auditory injury is assessed in terms of PTS given the irreversible nature of the effect. TTS is considered to be impairment rather than injury because an animal's auditory system can recover (Hastie *et al.*, 2019).

6.2.8.6 Auditory injury criteria are used to assess potential impacts to marine mammals. In an update to the previously applied Southall *et al.* (2019) criteria, NMFS (2024) has compiled, interpreted and synthesized the scientific literature to produce criteria for the onset of permanent auditory injury (expressed as 'AUG INJ'), which includes (but is not limited to) PTS. The new guidance also provides thresholds for the onset of temporary hearing damage (based on a TTS). This updated guidance is considered to reflect the current state of knowledge regarding the characteristics of sound exposure that has the potential to affect marine mammal hearing sensitivity. AUD INJ thresholds are based on both unweighted peak sound pressure levels (PK) and hearing-weighted cumulative sound exposure levels (SEL_{24h}) (NMFS, 2024;

6.2.8.7 Table 6.3). Weighting functions are defined using the frequency characteristics (bandwidth and sound level) for each hearing group within which acoustic signals can be perceived, and therefore, assumed to have potential auditory effects. The weighting functions used in sound modelling act as filters, to de-prioritise frequency content that is less relevant for the species group; for this RIAA Part 2 the relevant species groups are phocid pinnipeds (in water; i.e. grey seal and harbour seal) (PW), very high frequency (VHF) cetaceans (i.e. harbour porpoise) and high frequency (HF) cetaceans (i.e. bottlenose dolphin) as outlined in

6.2.8.8 Table 6.3. Underwater sound modelling also assumes continuous exposure during piling with animals moving away horizontally from the sound source at a steady speed (

6.2.8.9

6.2.8.10

6.2.8.11 Table 6.4). A degree of conservatism was built into the method in that this RIAA presumes receivers swim solely at the depth of the maximum sound level. This discounts the effect of animals coming up to the surface to breathe, where sound levels are demonstrably much lower.

Table 6.3: Summary of acoustic thresholds for auditory injury and Temporary Threshold Shift onset in relevant hearing groups

Hearing Group (NMFS, 2024)	Generalised hearing range	Indicative species	Sound characteristic	Acoustic threshold			
				PK (dB re 1μPa)		SEL_{24h} (dB re 1μPa^{2}s)	
				TTS	AUD INJ	TTS	AUD INJ
Phocid pinnipeds (in water) (PW)	40Hz to 90kHz	Grey seal; Harbour seal	Impulsive	217	223	168	183
			Non-impulsive	-	-	175	195
Very High Frequency (VHF) cetaceans	200Hz to 165kHz	Harbour porpoise	Impulsive	196	202	144	159
			Non-impulsive	-	-	160	181
High Frequency	150Hz to 160kHz	Bottlenose dolphin	Impulsive	224	230	178	193
			Non-impulsive	-	-	181	201

Hearing Group (NMFS, 2024)	Generalised hearing range	Indicative species	Sound characteristic	Acoustic threshold			
				PK (dB re 1μPa)		SEL_{24h} (dB re 1μPa²s)	
				TTS	AUD INJ	TTS	AUD INJ
(HF) cetaceans							

Table 6.4: Swim speeds used in the underwater sound modelling

Species	NMFS Hearing Group	Swim Speed (m/s)	Source Reference
Grey seal	PW	1.8	Thompson *et al.* (2015)
Harbour seal			
Harbour porpoise	VHF	1.5	Otani *et al.* (2000)
Bottlenose dolphin	HF	1.52	Bailey *et al.* (2010)

Disturbance

6.2.8.12 As sound intensity decreases beyond the injury threshold zone, sound levels have the potential to disrupt the behavioural patterns of marine mammals. Behavioural reactions can vary in severity, from sustained vigilance, to interruptions in foraging, to active avoidance or displacement (NRW, 2023b). Responses may not necessarily directly scale with received sound level (Gomez *et al.*, 2016). The reaction of a marine mammal to disturbance is dependent upon individual factors and contextual considerations (Southall *et al.*, 2021), with prior experience and acclimatisation playing crucial roles in determining whether an individual will manifest an aversive response to sound (Ellison *et al.*, 2012, Popper *et al.*, 2014), especially in regions characterised by elevated underwater sound levels associated with human activities.

6.2.8.13 Non-trivial disturbance may occur when there is a risk of animals incurring sustained or chronic disruption of behaviour. The determination of the likelihood and extent of disturbance is difficult. There are no agreed-upon disturbance criteria, primarily because there are no clear threshold criteria that can be used due to the variability of documented animal responses to similar levels of sound. The NMFS (2005) 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". This definition is similar to the JNCC (2010b) description of non-trivial (significant) disturbance. For impulsive sound the Level B harassment thresholds for all marine mammals is 160dB re 1μPa (rms) while for continuous sound the threshold is given as 120dB re 1μPa (rms). Considering the paucity and high-level variation of data relating to onset of behavioural effects due to continuous sound, any ranges predicted using this number are likely to be probabilistic and potentially over precautionary.

6.2.8.14 This NMFS (2005) guidance is based on thresholds above which disturbance could occur and has been widely applied to UK offshore wind farm assessments. Further, an unweighted sound threshold value of 143dB re 1μPa^{2}s SEL_{ss} based on the work by Tougaard (2021) was recently recommended in the position statement on assessing behavioural disturbance of harbour porpoise from impulsive underwater sound published by NRW (2023a). Such thresholds represent an area-based approach which assumes that all animals out to these thresholds could experience a disturbance effect. In the context of HRA, area-based thresholds are useful in understanding the potential for a significant disturbance where elevated subsea sound overlaps an SAC.

6.2.8.15 An alternative approach is to apply the concept of a dose response. There is empirical evidence from data gathered in the field during impact piling activity, which demonstrates a proportional disturbance response of animals corresponding to decreasing levels of received sound moving further away from the source (Brandt *et al.*, 2011, Graham *et al.*, 2019, Whyte *et al.*, 2020). Further detail on the dose response approach is provided in paragraph 6.2.8.18 *et seq*.

6.2.8.16 This RIAA Part 2 has applied several disturbance thresholds considered to be most appropriate relative to the noise generating activities assessed for Morven South (

6.2.8.17 Table 6.5). These thresholds vary depending on the species and activity. Specifically, for piling only, an second approach is applied to estimate the number of animals potentially disturbed using a dose response relationship, as supported in the Morven Site Scoping Opinion (MD-LOT, 2023). Further information is provided below.

Table 6.5: Summary of criteria used in the impact assessment of behavioural disturbance for different marine mammal species

Species	Impulsive source: piling	Intermittent (impulsive/non-impulsive) source: geophysical surveys	Impulsive source: UXO Clearance	Continuous source: Vessels
Grey seal, harbour seal	160dB re 1μPa SPL_{rms} (Dose response out to 145dB SEL_{ss})	160dB re 1μPa SPL_{rms}	TTS onset for PCW: PK 216dB re 1μPa; SEL 168dB re 1μPa^{2}s	120dB re 1μPa SPL_{rms}
Harbour porpoise	143dB re 1μPa^{2}s SEL_{ss} (Dose response out to 140dB SEL_{ss})	160dB re 1μPa SPL_{rms}	TTS onset for VHF: PK 196dB re 1 μPa; SEL 178dB re 1μPa^{2}s	120dB re 1μPa SPL_{rms}
Bottlenose dolphin	160dB re 1μPa SPL_{rms} (Dose response out to 140dB SEL_{ss})	160dB re 1μPa SPL_{rms}	TTS onset for HF: PK 224dB re 1μPa; SEL 178dB re 1μPa^{2}s	120dB re 1μPa SPL_{rms}

Dose Response

6.2.8.18 The application of a dose response function allows for a more realistic assessment of the risk of disturbance as this takes into account the likelihood of a response, in comparison to a fixed sound threshold, as this assumes all individuals within the fixed sound threshold respond, whereas outside the contour there is no response.

6.2.8.19 Southall *et al.* (2019) stated that "Apparent patterns in response as a function of received sound level (sound pressure level) highlighted a number of potential errors in using all or nothing "thresholds" to predict whether animals will respond. Tyack and Thomas (2019) subsequently and substantially expanded upon these observations. The clearly evident variability in response is likely attributable to a host of contextual factors, which emphasises the importance of estimating not only a dose response function but also characterising response variability at any dosage".

Approach for cetacean species

6.2.8.20 Current dose response functions used for assessment regarding cetacean disturbance are based on Graham *et al*. (2017) and were developed using monitoring data obtained in the Moray Firth as part of the Beatrice Offshore Wind Farm monitoring programme. These data have been regularly applied as industry standard across UK offshore wind farm marine mammal assessments. Graham et al. (2019) presented updated information gathered from further monitoring of piling in the Moray Firth. Analysis of the Passive Acoustic Monitoring (PAM) data showed a 50% probability of response to piling within 7.4km for the first location piled, which reduced to within 1.3km by the final piling location, suggesting that the use of the dose response functions from 2017 is precautionary.

6.2.8.21 The recent PrePARED paper (Thompson *et al*., 2025) highlights the over precaution relating to the use of the Graham *et al*. (2017) dose response functions. One issue is that received levels of sound may not be the key driver of disturbance. Further, the use of an unweighted metric may overestimate sound levels for harbour porpoises, because sound propagation with distance alters the frequency content due to quick attenuation of high frequency sound. This means for porpoise, a VHF cetacean, that the impact piling sound may not be audible at the further ranges covered by the dose response sound contours.

6.2.8.22 The case study presented in Thompson *et al*. (2025) stated that the monitoring data indicated that around 150 porpoises would have been at risk of disturbance by each piling event. When compared to the worst-case prediction (using the Graham *et al*. (2017) dose response functions) of 4,681 porpoises, the prediction is approximately 30 times more than the number estimated from monitoring information. Thompson *et al*. (2025) highlights that the potential for significant disturbance to occur in the far field are biologically implausible.

6.2.8.23 The emerging evidence strongly suggests that the use of the Graham *et al*. (2017) is highly over precautionary. In the absence of any alternative approach, this RIAA Part 2 has used the Graham *et al*. (2017) dose response functions, but caps the likely response at the 140dB SEL_{ss} contour (

6.2.8.24 Table 6.5) to derive an estimate of the number of animals at risk of disturbance (this approach was accepted by NatureScot, Table 2.1). The following was considered in order to define this approach:

- Graham *et al*. (2017) considered that harbour porpoise responded to piling when the proportional decrease in occurrence exceeded the threshold of 0.5, therefore, anything below a 50% chance was not considered to be a significant behavioural response.
- Graham *et al*. (2019) found that there was a greater than or equal to a 50% chance of porpoises responding in the 24-hour period after piling to an unweighted SEL of 144.3dB re $1mPa^2$ s (95% CI 142.1–146.8) at the first location piled.
- The 140dB SEL_{ss} aligns with (or is more conservative than) other published thresholds that have been used for impact piling assessment including 143dB SEL_{ss} (Tougaard, 2021); 145dB SEL_{ss} (Lucke *et al*., 2009); or 140dB SEL_{ss} (ASCOBANS, 2014).
- While fixed thresholds represent an all or nothing response areas and are therefore not necessarily equivalent to a dose response approach, the examples above are detailed for context as to sound levels considered to elicit a behavioural response.
- The dose response functions described in Graham *et al*. (2017) indicate that there is less than a 20% probability of a response at sound levels below 140dB SEL_{ss}. A 20% probability is not considered to be a significant behavioural response, together with the emerging data published in Thompson *et al*. (2025) suggests therefore that capping the Graham *et al*. (2017) dose

response curves at the 140dB SEL_{ss} contour will capture those individuals most at risk of non-trivial disturbance, while retaining sufficient precaution.

- In the absence of species-specific data for bottlenose dolphin, the same dose response curve was assumed to apply in this RIAA Part 2 and represents a precautionary approach to assessment as bottlenose dolphin are likely to be less sensitive than harbour porpoise to behavioural disturbance as noted in the literature (Tougaard, 2021).

Approach for seal species

6.2.8.25 Whyte *et al.* (2020) used tracking data from 24 harbour seal to estimate the effects of pile driving sounds on this species. The study used predictions of seal density during pile driving made by Russell *et al.* (2016). Predicted seal density significantly decreased within 25km or above 145dB re 1μPa^2 SEL_{ss} (averaged across depths and pile installations). Other studies have reported similar avoidance reactions for both grey seal and harbour seal to the same sound source (Aarts *et al.*, 2018, Götz and Janik, 2010) and therefore harbour seal dose response curve is considered as appropriate to be used as a proxy for grey seal. As such, the dose response curve derived from Whyte *et al.* (2020) was also applied to the grey seal assessment to determine the number of animals that may potentially respond behaviourally to received sound levels during piling (

6.2.8.26 Table 6.5).

Assumptions and limitations

6.2.8.27 By applying the fixed-threshold based and dose response criteria, the magnitude of impact can be quantified with respect to the spatial extent of disturbance, and subsequently the number of animals potentially disturbed based on available density information. However, Southall *et al*. (2021) noted that it is challenging to develop a comprehensive set of empirically derived criteria for such a diverse group of animals. The study identified data gaps and extrapolation from other species has been necessary. Since there are broad differences in hearing across the frequency spectrum for different marine mammal hearing groups, sounds that disturb one species may be irrelevant or inaudible to other species. Variance in responses even across individuals of the same species are well documented to be context and sound-type specific (Ellison *et al*., 2012). In addition, the potential interacting and additive effects of multiple stressors (e.g. reduction in prey, sound and disturbance, contamination, etc.) is likely to influence the severity of responses (Lacy *et al.*, 2017).

6.2.8.28 As such, the recent recommendations by Southall *et al*. (2021) steer away from a single overarching approach. Instead, the study proposes a framework for developing probabilistic response functions for future studies (Southall *et al*., 2021). The paper suggests different contexts for characterising marine mammal responses for both free-ranging and captive animals with distinctions made by sound sources (i.e. active sonar, seismic surveys, continuous/industrial sound and pile driving). Three parallel categories have been proposed within which a severity score from an acute (discrete) exposure can be allocated:

- survival – defence, resting, social interactions and navigation;
- reproduction – mating and parenting behaviours;
- foraging – search, pursuit, capture and consumption.

6.2.8.29 Although some studies have been able to assign responses to these categories based on acute exposure, there is still limited understanding of how longer-term (chronic) exposure could translate into population-level effects. The potential for behavioural disturbance to lead to population consequences has been considered for this RIAA Part 2 using the Interim Population Consequences of Disturbance (iPCoD) approach and is described in detail in Volume 2, Chapter 10: Marine Mammals and Volume 3, Annex 10.5: Marine Mammals Interim Population Consequences of Disturbance (iPCoD) Modelling Report, of the EIA Report.

6.2.8.30 Marine mammal ability to compensate for chronic exposure to sound will also depend on a range of ecological factors, including the relative importance of the disturbed area and prey availability within their wider home range, the distance to and quality of other suitable sites, the relative risk of predation or competition in other areas, individual exposure history, and the presence of concurrent disturbances in other areas of their range (Gill *et al.*, 2001). Animals may be able to compensate for short-term disturbances by feeding in other areas, for example, which would reduce the likelihood of longer-term population consequences. (Booth *et al.*, 2019) reported that although minimising the anthropogenic disturbance is an important factor to animal's health, if animals can find suitable high-energy-density prey they may be capable of recovering from some lost foraging opportunities. Odontocetes may be more vulnerable to whale-watching compared to mysticetes due to their more localised, and often, coastal home ranges. (Bejder *et al.*, 2006) documented a decrease in local abundance of bottlenose dolphin which was associated with an increase in whale-watching in a tourist area compared to a control area. Studies of changes in abundance as a result of disturbance should be considered in light of findings presented in Gill *et al*. (2001) who reported that if there is no suitable habitat nearby animals may be forced to remain in an area despite the disturbance, regardless of whether or not it could affect survival or reproductive success.

6.2.8.31 The marine mammal qualifying features considered in this RIAA Part 2 vary biologically and therefore have different ecological requirements that may affect their sensitivity to disturbance. Reproductive strategy can impact the energetic consequences of disturbance and cause variation in an individual's vulnerability to disturbance based on both its reproductive strategy and stage (Harwood *et al.*, 2020). Grey seals are capital breeders and store energy for reproduction and survival, while harbour seal, harbour porpoise and bottlenose dolphin are income breeders and they use energy that is acquired on a continual basis, including during the reproductive period (Stephens *et al.*, 2009).

6.2.8.32 Recognising the inherent uncertainty in the quantification of effects using threshold and dose response approaches, this RIAA Part 2 has adopted a precautionary approach at all stages of assessment, including additional conservative assumptions in the:

- marine mammal qualifying feature densities (e.g. use of seasonal density peaks for harbour porpoise densities);
- MDS for the project parameters (e.g. Table 6.19; use of high order UXO detonation as the MDS);
- underwater sound modelling (see paragraphs 6.3.1.10 to 6.3.1.16 for summary and Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report for more details).

6.2.8.33 These assumptions have been referred to throughout this RIAA Part 2, illustrating that the systematic incorporation of layers of conservatism is likely to result in a very precautionary assessment.

6.3 Assessment of the adverse effects of Morven South alone

6.3.1 Injury and disturbance from underwater sound generated from piling

6.3.1.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction phase, LSE[2] could not be ruled out for injury and disturbance from underwater sound generated from piling. This relates to all five SACs (Table 3.1) and relevant Annex II marine mammal features:

- Berwickshire and North Northumberland Coast SAC:
  - Grey seal.
- Isle of May SAC:
  - Grey seal.
- Firth of Tay and Eden Estuary SAC:
  - Harbour seal.
- Southern North Sea SAC:

    - Harbour porpoise.
- Moray Firth SAC:
    - Bottlenose dolphin.

6.3.1.2 The MDS and designed-in measures considered for the assessment of injury and disturbance from underwater sound generated from piling are shown in Table 6.6 and Table 6.7, respectively.

Table 6.6: Maximum Design Scenario considered for the assessment of potential impacts to Annex II marine mammals due to injury and disturbance from underwater sound generated from piling during the construction phase

Project phase	Maximum Design Scenario	Justification
Construction	***Spatial MDS*** Concurrent piling with up to two vessels, at a minimum distance of 1km and a maximum distance of 27.65km, piling at 73 foundations comprising: • 67 wind turbines: – 16m diameter monopiles; – Maximum hammer energy of 6,600kJ; – Maximum duration of 24h piling per monopile, with a maximum of two foundations per day (concurrently); – Total of 34 days of concurrent piling. • Four HVAC collector OSPs: – 16m diameter monopiles; – Maximum hammer energy of 6,600kJ; – Maximum duration of 24h piling per monopile, with a maximum of two foundations per day (concurrently); – Total of two days of concurrent piling. • One bridge-linked (=two foundations) HVDC converter OSP: – Two six-legged jacket foundations (bridge-linked); – 24 x 5m diameter pin piles (modelled as 5.3m), equals 48 pin piles for two bridge-linked foundations; – Maximum hammer energy of 4,000kJ; – Maximum duration of 9h piling per pin pile, with an average of four piles per day. – Total of 12 days of piling (based on four piles per day). Total duration of piling = 34 + 2 + 12 = 48 days	**Spatial MDS** The spatial MDS assumes that concurrent piling of the largest diameter monopiles (16m) using the greatest hammer energy (6,600kJ) would lead to the largest spatial extent of ensonification at any one time. The spatial MDS assumes the maximum number of piles would be installed per day. Minimum spacing between concurrent piling (1km) represents the highest risk of injury to animals as sound from adjacent foundations could combine to produce a greater radius of effect compared to a single piling event. Maximum spacing between concurrent piling (27.65km) represents the highest risk of behavioural effects to marine mammals as a larger area would be ensonified at any one time. **Temporal MDS** The temporal MDS assumes that the greatest number of piles (524) would be installed and that piling would be undertaken at only one location at a time. The temporal MDS assumes the minimum number of piles would be installed per day (one pile), leading to the greatest number of piling days.

Project phase	Maximum Design Scenario	Justification
	Temporal MDS Single-vessel piling at 101 foundations comprising: • 95 wind turbines: – 3.7m diameter pin piles per foundation = 380 piles; – Maximum hammer energy of 4,000kJ; – Maximum duration of 9h piling per pile, with a minimum of 2 piles per day; – Maximum of 190 days of piling. • Four HVAC collector OSPs: – 4.5m diameter pin piles (modelled as 5.3m) per foundation = 96 piles; – Maximum hammer energy of 4,000kJ; – Maximum duration of 9h piling per pile, with a minimum of 2 piles per day; – Maximum of 48 days of piling. • One bridge-linked (= two foundations) HVDC converter OSP: – Two six-legged jacket foundation; – 24 x 5m (modelled as 5.3m) diameter pin piles per foundation, equals 48 piles for two bridge-linked foundations; – Maximum hammer energy of 4,000kJ; – Maximum duration of 9h piling per pin pile, with a minimum of 2 piles per day. – Maximum of 24 days of piling. Total duration of piling = 190 + 48 + 24 = 262 days Piling phased over 12 months (start Q4 2034)	

Table 6.7: Designed-in measures considered for the assessment of potential impacts to Annex II marine mammals from injury and disturbance from underwater sound generated from piling during the construction phase

Reference number	Designed-in measure	Justification	Primary or tertiary
MM-8	Development of and adherence to a Marine Mammal Mitigation Protocol.	The Marine Mammal Mitigation Protocol (MMMP) will mitigate for risk of injury or disturbance to marine mammals during construction. This will include ensuring that animals are not observed within the marine mammal mitigation zone during piling. The MMMP may include using Marine Mammal Observer(s) (MMOb) and PAM to monitor the mitigation zone (as determined by the underwater sound modelling) to ensure that animals are not observed within the mitigation zone during piling. ADD may be used if required to deter animals from the Mitigation Zone.	Tertiary
MM-40	Development of and adherence to a piling strategy which will include a soft-start procedure (including low hammer initiation and ramp up) to be implemented for pile driving	To reduce the likelihood of injury from elevated underwater noise to marine receptors (i.e. marine mammals) in the immediate vicinity of piling operations as much as possible, allowing individuals to move away from the area before sound levels reach a level at which injury may occur.	Primary

Information to inform the assessment

Overview of underwater sound modelling for Morven South

Summary of piling scenarios

6.3.1.3 Piling during the construction phase of Morven South has the potential to result in higher levels of underwater sound when compared to background levels and could result in auditory injury and/or potential behavioural effects on Annex II marine mammal qualifying features.

6.3.1.4 The assessment of effects on Annex II marine mammals from piling considered a temporal MDS and a spatial MDS (Table 6.6). The temporal MDS, leading to the greatest number of days of piling, is based on single piling of pin piles for jacket foundations. The longest duration of piling and the greatest number of days over which piling could occur for the temporal scenario was 262 days (Table 6.6).

6.3.1.5 The spatial MDS assumes concurrent piling of 16m diameter monopile foundations (Table 6.6), leading to the largest area of effect at any one time, for which underwater sounds modelling was undertaken. The following assumptions were identified for concurrent piling (see Volume 2, Chapter 10: Marine Mammals and Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report):

- minimum separation distance of 1km between concurrent piling events as the MDS for potential injury (cumulative exposure metric);
- maximum separation distance of up to 27.65km as the MDS for potential disturbance and injury PK metric.

6.3.1.6 Note that due to the large number of options presented in the project description (Section 4 of RIAA Part 1) the underwater sound modelling selected three conservative pile types to represent the suite of different options available (Table 6.8).

Table 6.8: Details of hammer and helmet weights in the modelling and representations of different foundation types/hammer energies presented in this Report to Inform Appropriate Assessment Part 2

Pile	Hammer model	Hammer energy (kJ)	Foundation/ hammer Represented	Justification
3.7m pin pile	IHC S-4000	4,000	3.7m pin pile, 4,000kJ	Sensitivity testing was undertaken and demonstrated that the 3.7m pin pile could not be represented by the 5.3m diameter pin pile as some frequency components led to larger effect ranges than predicted for the 5.3m pin pile in the far field.
5.3m pin pile	IQIP IQ6	4,500	5.0m pin pile, 4,000 kJ 4.5m pin piles, 4,000kJ	The 5.3m pin pile was selected to capture the maximum ranges across all pin pile diameters in the project description including the 5.0m and 4.5m.
16m monopile	IQIP IQ6	6,600	16m monopile, 6,600kJ	16m monopile is the maximum adverse spatial for WTGs and HVAC collector OSPs

6.3.1.7 Model outputs were provided as BE and UB to represent the median and maximum geoacoustic profiles respectively. These are described in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report as realistic and conservative for the BE and UB respectively. Effect ranges were given as R_{max} and $R_{95\%}$. R_{max} corresponds to the maximum horizontal distance from the sound source to the given sound level, and is more suited to cases when sound propagation does not radiate in a uniform manner, typically due to interaction with bathymetric features. $R_{95\%}$ corresponds to the equivalent distance after the 5% farthest points have been excluded, and is more suited to cases when sound propagation radiates relatively uniformly in all directions from the source.

6.3.1.8 For the assessment of instantaneous injury (based on PK), the greatest predicted ranges, across all penetration depths, have carried forward from the underwater sound modelling (Volume 3, Annex 10.2 Underwater Sound Shared Technical Report, of the EIA Report) since these will underpin the mitigation zone and therefore should be inherently precautionary (

6.3.1.9 Table 6.9). These were found to be at penetration depth B and predicted using the BE and R_{max} in all cases. Contrary to expectations, it was the BE that produced larger ranges than the UB for the PK metric; most likely as a result of how seabed reflectivity couples with the geoacoustics in the nearfield where sound energy was more effectively transferred to the water column using the BE parameters compared to the UB parameters.

Table 6.9: Summary of metrics taken forward from the underwater sound modelling to the marine mammal assessment

Metric	Application	Values taken forward	Justification
Unweighted Peak pressure (PK)	Instantaneous auditory injury using AUD INJ criteria	Largest of Upper bound or Best Estimate, R_{max}	This is the absolute maximum which will determine the maximum injury range at any location and define the size of the mitigation zone.
M-weighted SEL_{24h}	Hearing weighted AUD INJ criteria for accumulated sound for different hearing groups	Best estimate, $R_{95\%}$	Modelling of cumulative SEL makes very conservative assumptions; here we take the realistic values to reduce the potential for overestimating the effect ranges.
Single strike SEL (SEL_{ss})	Unweighted SEL_{ss} to apply either a single threshold of 143dB (harbour porpoise)/ 140dB (all other species) or 5dB isopleths as per dose response to estimate behavioural effects*	Best estimate, $R_{95\%}$	Realistic values are taken as the results are used in population modelling. It is therefore more representative to understand the maximum averaged over all locations rather than the absolute maximum at a single location which is then assumed across all locations as this could lead to an overestimate.

*140/143dB is a fixed threshold compared to the dose response which assumes proportional disturbance relating to the level of sound received at different isopleths.

Conservatism in the underwater sound modelling

6.3.1.10 To ensure that the RIAA is precautionary, a number of conservative assumptions were adopted in the underwater sound model. These measures of conservatism are summarised in this section and highlight that auditory injury (and TTS onset ranges) predicted using the SEL_{24h} threshold (

6.3.1.11 Table 6.3) are likely to lead to overestimates in the ranges and therefore should be interpreted with caution. For more details refer to Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report.

6.3.1.12 The underwater sound modelling assumed that the maximum hammer energy would be reached and maintained at all locations, whereas this is unlikely to be the case based on examples from other offshore wind farms (e.g. Beatrice Offshore Wind Farm, where the mean actual hammer energy averages were considerably lower than the maximum assessed in the EIA Report and only 6 out of 86 asset locations reached maximum hammer energy (Beatrice OWF Limited, 2018)).

6.3.1.13 Additionally, the piling procedure simulated in the model did not allow for short pauses in piling (e.g. for realignment) and therefore the modelled SEL_{24h} is likely to be an overestimate since, in reality, these pauses would reduce the sound exposure that animals experience while moving away.

6.3.1.14 The underwater sound modelling assessment also assumed that animals swim directly away from the sound source at constant and conservative average speeds based on published values. While this buffers the uncertainty with respect to the directionality of their movement, it may lead to overestimates of the potential range of effect as animals are likely to exceed these speeds. For example, Otani *et al.* (2000) reported horizontal speed for harbour porpoise can be significantly faster than vertical speed and cite a maximum speed of 4.3m/s (compared to 1.5m/s used in the underwater sound model).

6.3.1.15 The underwater sound model accounts for the SEL_{24h} metric as an equal-energy rule, where exposures of equal-energy are assumed to produce the same sound-induced threshold shift regardless of how the energy is distributed over time. Since for intermittent sound (such as piling) the quiet periods between sound exposures will allow some recovery of hearing compared to continuous sound, the equal-energy rule is likely to overestimate the extent of impact. Additionally, modelling of concurrent piling assumed piling will occur at exactly the same time and strike piles simultaneously, whereas in reality this is highly unlikely and could lead to overestimates in the injury and/or disturbance ranges.

6.3.1.16 The impulsive sound is likely to undergo transition into non-impulsive sound at distance from the sound source due to a combination of factors (e.g. dispersion of the waveform, multiple reflections from sea surface and seafloor, and molecular absorption of high frequency energy). The empirical evidence suggest that such shifts in impulsivity could occur within 10km from the sound source (Hastie *et al.*, 2019). However, since the precise range at which this transition occurs is unknown, the underwater sound model adopted the impulsive thresholds at all ranges. This is likely to lead to an overly precautionary estimate of injury ranges at larger distances (tens of kilometres) from the sound source. The Offshore Renewables Joint Industry Programme (ORJIP) RaDIN study (ORJIP, 2024) concluded that "*there was a marked decrease in impulsiveness as sounds travel away from the source within 5km of the piling location*" and that, "*there is still insufficient evidence to establish a range of distances from which these sounds are no longer impulsive*".

Geographic Information System mapping for dose response

6.3.1.17 To obtain the numbers of animals (cetaceans and seals) potentially disturbed during piling, SEL_{ss} contours from underwater sound modelling were plotted by 5dB contours in GIS for all modelled locations. The areas within each contour were calculated from the spatial GIS map and a proportional expected response (derived from the dose response curve for each contour area) was used to calculate the number of animals potentially disturbed. These numbers were subsequently summed across all contours to estimate the total number of animals disturbed during piling at any given time. The number of animals predicted to respond are based on species-specific densities derived from site specific surveys and desktop data. For seal species animals were counted where >50% of each 5km x 5km grid cell fell within a 5 dB isopleth and the total number of animals were summed across all grid cells.

Summary of Interim Population Consequences of Disturbance modelling

6.3.1.18 There is limited understanding of how behavioural disturbance and auditory injury affect survival and reproduction in individual marine mammals and how subsequently this translates into effects at the population-level.

6.3.1.19 The iPCoD framework was developed by Sea Mammal Research Unit (SMRU) Consulting and the University of St Andrews using a process of expert elicitation (Booth and Heinis, 2018, Booth *et al.*, 2019) to determine how physiological and behavioural changes affect individual vital rates (i.e. the components of individual fitness that affect the probability of survival, production of offspring, growth rate and offspring survival).

6.3.1.20 The iPCoD framework applies simulated changes in vital rates to infer the number of animals that may be affected by disturbance as a means to iteratively project the size of the population. The expert elicitation process (Booth and Heinis, 2018, Booth *et al.*, 2019) was undertaken for the four Annex II marine mammals:

- grey seal;
- harbour seal;
- harbour porpoise;
- bottlenose dolphin.

6.3.1.21 Relevant MU and associated reference populations for modelling were informed by the SAC CMA documents (Sections 6.2.3to 6.2.7); for further detail see Volume 3, Annex 10.1: Marine Mammal Shared Baseline Technical Report, of the EIA Report.

6.3.1.22 The Morven South Boundary coincides with the boundary between two SMUs, so for grey seal and harbour seal, the reference population comprises the sum of the East Scotland SMU and the Northeast England SMU (SCOS, 2022). For harbour porpoise only one MU, the North Sea MU, occurs in the vicinity of the Morven South Marine Mammal Study Area (IAMMWG, 2023), and the population estimates for this MU have been used for iPCoD modelling.

6.3.1.23 It should be noted that for this RIAA, the populations of the SMUs and harbour porpoise MU used in the iPCoD modelling cannot be directly attributed or allocated to the specific populations within the SACs being assessed. However, the results of the iPCoD modelling still provide important context at a population-level which aids the overall assessment.

6.3.1.24 With respect to bottlenose dolphin, the coastal ecotype discussed in paragraph 6.2.2.29 is incorporated within the Coastal East Scotland MU population and the population of relevance to the Moray Firth SAC (226 dolphins, (Cheney *et al.*, 2024) (Section 6.2.7). However, due to the offshore location of Morven South the reference population considered was the Greater North Sea MU, and in this case the UK population (1,885 dolphins, IAMMWG, 2023) was taken forward as a more conservative value to account for higher densities (with a lower coefficient of variation) within UK waters compared to the wider MU which extends across to European waters (Gilles *et al.*, 2025). As modelled underwater sound contours did not overlap with the Coastal East Scotland MU, the iPCoD modelling for bottlenose dolphin has not been utilised in this RIAA Part 2 for Morven South alone impacts.

6.3.1.25 The population estimates used to parameterise iPCoD models were taken from IAMMWG (2023) for harbour porpoise (346,601 individuals in the North Sea MU) and from Volume 3, Annex 10.4: Marine Mammals Shared Seal Telemetry and Haul-out Data Study Technical Report, of the EIA Report for seals (488 harbour seals and 36,696 grey seals), alongside vital rates taken from Sinclair *et al.* (2020), presented in Table 6.10.

Table 6.10: Marine mammal vital rates used to parameterise the Interim Population Consequences of Disturbance models for Morven South

Species	Calf/pup survival	Juvenile survival	Adult survival	Fertility	Age of independence (years)	Age of first birth (years)
Grey seal	0.222	0.94	0.940	0.84	1	6
Harbour seal	0.400	0.78	0.920	0.85	1	4
Harbour porpoise	0.846	0.85	0.925	0.34	1	5

6.3.1.26 Estimates of the number of animals of each species that may experience auditory injury considered the hearing group-specific frequency-weighted injury ranges derived from underwater sound modelling (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report) to calculate, using dose response, the maximum numbers of animals predicted to experience auditory injury (based on the PK and SEL_{24h} metrics). As detailed in paragraph 6.2.8.18, use of dose response numbers allows for a more realistic assessment of the risk of disturbance which takes into account the likelihood of a response, rather than a fixed threshold approach. As described in paragraph 6.2.8.23, the dose response contour was capped at the 140dB SEL_{ss} contour.

6.3.1.27 This RIAA Part 2 aligns with the dual metric approach applied in underwater sound modelling, whereas the mitigation zone for the implementation of standard industry measures, including the use of MMObs, PAM and ADD has been informed only by the PK metric (as per NatureScot's advice, see Table 2.1).

6.3.1.28 Note that the use of ADD is a standard industry measure; however, the exact device type and duration will be determined post-consent once the final project parameters have been determined. The assessment therefore provides the effect ranges with and without an ADD (using a standard 30 minutes of activation) for the purpose of demonstrating the efficacy of using this tool as a mitigation measure. For the purpose of this RIAA Part 2, calculation of the residual number of animals that may experience auditory injury has assumed a 30-minute implementation of an ADD, as use of an ADD is standard industry practice, and any residual numbers were also included in the iPCoD modelling.

6.3.1.29 iPCoD models were parameterised to simulate both the temporal MDS (i.e. the single piling scenario with fewer animals impacted per day, but over more days) and the spatial MDS (i.e. the concurrent piling scenario with more animals impacted per day, but over fewer days).

6.3.1.30 Results of iPCoD modelling are presented in full in Volume 3, Annex 10.5: Marine Mammals Interim Population Consequences of Disturbance (iPCoD) Modelling Report, of the EIA Report, and summarised in the relevant SAC sections below.

Construction phase

<u>Injury</u>

Single piling

6.3.1.31 The impact ranges presented in this RIAA Part 2 are based on the NMFS (2024) thresholds for AUD INJ only (Table 6.3). The potential marine mammal injury ranges for single installation of monopile foundations, based on the PK and SEL_{24h} metrics (Table 6.3), as well as the functional hearing group-specific AUD INJ thresholds, are summarised in Table 6.11.

6.3.1.32 For single piling of monopile foundations (i.e. piling undertaken by one vessel at one location on any given day) the maximum predicted instantaneous injury risk range based on the PK metric is 950m for harbour porpoise (VHF functional hearing group) (Table 6.11). The impact ranges for seals (PW functional hearing group) and bottlenose dolphin (HF function hearing group) were not exceeded (Table 6.11). The ranges for pin pile foundations were less than those for monopiles (Table 6.11).

6.3.1.33 It is assumed that an ADD will be activated for 30 minutes prior to the commencement of piling. The distance swum by marine mammals during ADD activation has been calculated based upon the conservative swim speeds in Table 6.4, and are summarised in Table 6.12. With 30 minutes of ADD applied, based on the PK metric, all species are predicted to be able to swim beyond the respective injury ranges. This falls within the range over which MMObs would be effective and therefore it is anticipated that the risk of injury can be fully mitigated with standard industry mitigation applied. For the SEL_{24h} metric the modelling predicted that there would be no exceedance of the injury threshold for any marine mammal hearing groups with or without an ADD.

Table 6.11: Potential marine mammal injury ranges for single installation of monopile foundations, based on the NMFS (2024) PK metric (N/E denotes Auditory Injury threshold not exceeded)

Hearing Group	Species	AUD INJ Threshold, PK (dB re 1µPa)	Maximum Range (m)		
			Monopile No ADD	5.3m Pin Pile No ADD	3.7m Pin Pile No ADD
PW	Grey seal Harbour seal	223	N/E	N/E	N/E
VHF	Harbour porpoise	202	950	570	770
HF	Bottlenose dolphin	230	N/E	N/E	N/E

Table 6.12: Distances swum during 30 minutes of Acoustic Deterrent Device activation by each hearing group

Species	Hearing group	Swim speed (m/s)	Distance swum (m) in 30 minutes	Clear of injury range?
Grey seal Harbour seal	PW	1.8	3,240	Y
Harbour porpoise	VHF	1.5	2,700	Y
Bottlenose dolphin	HF	1.52	2,736	Y

6.3.1.34 The estimated numbers of animals potentially experiencing auditory injury from single piling, with and without ADD activation is summarised in Table 6.13. Numbers have been presented for the monopile scenario only as this represents the largest spatial extent.

6.3.1.35 For harbour seal and grey seal, in the absence of ADD, the potential instantaneous auditory injury (PK metric) threshold is not exceeded and therefore zero animals are potentially injured (Table 6.13).

6.3.1.36 For harbour porpoise, in the absence of ADD, potential instantaneous auditory injury (PK metric) is predicted for up to two animals (0.001% of both the full and the UK portion of the North Sea MU) (Table 6.13). With 30 minutes of ADD activation, harbour porpoise can clear the injury range (Table 6.12) and this is expected to reduce to zero animals injured.

6.3.1.37 For bottlenose dolphin, in the absence of ADD, using the PK, the threshold is not exceeded and therefore zero animals are potentially injured (Table 6.13). With 30 minutes of ADD activation, injury ranges are likely to reduce further.

6.3.1.38 Using the SEL_{24h} metric, for grey seal, harbour seal, harbour porpoise and bottlenose dolphin, the AUD INJ threshold is not exceeded both with and without ADD activation, and therefore zero animals are potentially injured.

Table 6.13: Numbers of animals at risk of auditory injury from single piling based on monopiles, using the PK metric, and equivalent percentage of the Management Unit population potentially affected (N/E denotes Auditory Injury threshold not exceeded)

Hearing group	Species	Density (animals/ km^2)	Ensonified area (km^2) PK metric	Number of animals		Percentage of MU (UK portion)	
				No ADD	30 min ADD	No ADD	30 min ADD
PW	Grey seal	0.252	N/E	-	-	-	-
	Harbour seal	1.20×10^{-7}	N/E	-	-	-	-
VHF	Harbour porpoise	0.599	2.835	2	0	0.001 (0.001)	0
HF	Bottlenose dolphin	0.005	N/E	-	-	-	-

Concurrent piling

6.3.1.39 For the spatial MDS (Table 6.6), represented by concurrent piling of monopile foundations (i.e. piling undertaken by two vessels at two locations on any given day), the greatest impact for auditory injury based on the PK metric was from two widely-spaced monopiles, compared to two monopiles spaced close together (1km apart; see Table 6.27 in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report of the EIA Report). However, considering cumulative exposure, a larger range of effect would be for two closely-spaced concurrent piling events (Tables 5.37 and 5.39 in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report of the EIA Report). The maximum modelled distances in each case have been brought through to this assessment.

6.3.1.40 The results are presented as a maximum ensonified area for PK and maximum range for SEL_{24h} metrics (Table 6.14). As detailed in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report, PK sound fields are taken as the maximum over the two fields (from each concurrent pile). Therefore, the maximum distance to any threshold remains the same as the maximum from the single pile case (Table 6.11). In these cases, for PK, it is the ensonified area to a threshold sound level that is presented instead of the maximum distance.

6.3.1.41 For the PK metric, for the PW functional hearing group (grey seal and harbour seal) the threshold is not exceeded (Table 6.14). For VHF cetaceans (harbour porpoise), using the PK metric, the area in which a risk of instantaneous injury is predicted is 5.67km^2 (Table 6.14). With 30 minutes of ADD applied, based on conservative swim speeds in Table 6.4, animals would be able clear the area (Table 6.12). For HF cetaceans (bottlenose dolphin) the AUD INJ threshold (PK metric) is not exceeded.

6.3.1.42 For the SEL_{24h} metric, the AUD INJ threshold was not exceeded for any species during concurrent piling.

Table 6.14: Ensonified area for potential marine mammal injury based on the NMFS (2024) PK metric from concurrent installation of monopile foundations (N/E denotes Auditory Injury threshold not exceeded)

Hearing Group	Species	AUD INJ Threshold, PK (dB re 1µPa)	Ensonified area to level (km²)		
			Monopile No ADD	5.3m Pin Pile No ADD	3.7m Pin Pile No ADD
PW	Grey seal Harbour seal	223	N/E	N/E	N/E
VHF	Harbour porpoise	202	5.67	1.66	2.42
HF	Bottlenose dolphin	230	N/E	N/E	N/E

6.3.1.43 The estimated numbers of animals potentially experiencing AUD INJ from concurrent piling, with and without ADD activation is summarised in Table 6.15, based on the PK metric. The number of animals at risk of AUD INJ from concurrent piling is estimated by combining the impact area with the species-specific density. For the PK metric the magnitude of the impact for concurrent piling was available as a specific area.

6.3.1.44 For grey seal and harbour seal, in the absence of ADD the threshold for instantaneous auditory injury (PK metric) is not exceeded and therefore zero animals are potentially at risk of injury (Table 6.15).

6.3.1.45 In the absence of ADD, potential instantaneous auditory injury (PK metric) is predicted for up to four harbour porpoises (0.001% of the full North Sea MU; 0.003% of the UK portion of the North Sea MU).

With 30 minutes of ADD activation, harbour porpoise can clear the injury range (Table 6.12) and this is expected to reduce to zero animals injured.

6.3.1.46 For bottlenose dolphin, in the absence of ADD and with ADD, using the PK metric, the threshold is not exceeded and therefore zero animals are potentially at risk of injury (Table 6.15).

6.3.1.47 Auditory injury resulting from accumulated sound (the SEL_{24h} metric), for grey seal harbour seal and bottlenose dolphin, both in the absence of ADD and with ADD, the threshold is not exceeded and therefore zero animals are potentially injured.

6.3.1.48 Auditory injury resulting from accumulated sound (the SEL_{24h} metric) for harbour porpoise with ADD, less than one animal is predicted to experience auditory injury (0.0003% of the full North Sea MU; 0.0006% of the UK portion of the North Sea MU). In the absence of ADD the threshold is not exceeded and therefore zero animals are potentially injured.

6.3.1.49 For all assessed qualifying species, due to the calculation that no or less than one individual would be affected with the application of ADD, the impact is predicted to be of highly localised spatial extent, short-term duration, intermittent, and with high reversibility (as qualifying features are expected to recover within hours/day).

Table 6.15: Numbers of animals at risk of auditory injury from concurrent piling, using the PK metric, and equivalent percentage of the Management Unit population potentially affected (N/E denotes Auditory Injury threshold not exceeded)

Hearing Group	Species	Density (animals/ km^2)	Ensonified area (km^2) PK metric	Number of animals		Percentage of MU (UK portion)	
				No ADD	30 min ADD	No ADD	30 min ADD
PW	Grey seal	0.252	N/E	-	-	-	-
	Harbour seal	1.20×10^{-7}	N/E	-	-	-	-
VHF	Harbour porpoise	0.599	5.64	4	0	0.001 (0.003)	0
HF	Bottlenose dolphin	0.005	N/E	-	-	-	-

6.3.1.50 PTS is a permanent and irreversible shift in hearing causing hearing impairment with the potential to affect key life functions such as mating, maternal fitness, communication, foraging, predator detection and mortality. The result of these effects could drive chronic (i.e. long-term and persistent) changes in animal health or acute (i.e. short-term and temporary) changes in vital rates (Costa, 2012, Erbe *et al.*, 2018).

6.3.1.51 Scientific understanding of the biological impact of auditory threshold shifts is limited to the results of controlled exposure studies on small numbers of captive animals (Finneran, 2015) where TTS was experimentally induced (given it is unethical to induce auditory injury in animals) and thresholds for AUD INJ were extrapolated using TTS growth rates. Kastelein *et al.* (2013b) demonstrated that hearing impairment as a result of exposure to piling noise is likely to only occur where the source frequencies overlap the range of peak sensitivity for the receptor species, rather than across the whole frequency hearing spectrum. The study demonstrated that for simulated piling noise (broadband spectrum), harbour porpoise hearing around 125kHz (the key frequency for echolocation) was not affected. Rather, a measurable, but relatively small, threshold shift in hearing was observed at frequencies of 4kHz to 8kHz, as most of the energy from the simulated piling occurred in the lower frequencies (Kastelein *et al.*, 2013a, Kastelein *et al.*, 2013b).

6.3.1.52 The periodicity of underwater sound is also likely to affect the magnitude of a hearing shift, whereby hearing may recover to some extent during inter-pulse intervals (Kastelein *et al.*, 2014), with the suggestion that audible and visual cues may allow animals to predict when injurious sounds will occur (Kastelein *et al.*, 2020). Other studies reported that while a threshold shift may accumulate across multiple exposures, the resulting shift will be less than the shift from a single, continuous exposure with the same total SEL (Kastelein *et al.*, 2014, Reichmuth *et al.*, 2019).

6.3.1.53 In response to exposure to underwater sound, marine mammals may exhibit behaviours that allow avoidance or a reduction in direct exposure. For instance, the animal may change the orientation of its head so that sound levels reaching the ears are reduced, and some cetacean species may modulate hearing sensitivity by one or more neurophysiological control mechanisms in the middle ear, inner ear, and/or central nervous system (Kastelein *et al.*, 2020). Kastelein *et al.* (2020) demonstrated this self-mitigation in harbour porpoise whereby an animal exposed to repeated airgun noises, did not consistently experience TTS. Pinnipeds may also simply lift their head above the water to avoid exposure to underwater sound.

6.3.1.54 In comparison to cetaceans, seals are less dependent on hearing for foraging, but may rely on sound for communication and predator avoidance (Deecke *et al.*, 2002). Seals can detect swimming fish with their vibrissae (Schulte-Pelkum *et al.*, 2007) and, in certain conditions, may also use the vocalisations of fish to hunt. The ecological consequences of sound-induced threshold shift in seals may be a reduction in fitness, reproductive output and longevity (Kastelein *et al.*, 2018).

6.3.1.55 One study reported that, based on calculations of SEL during the construction of the Lincs Offshore Wind Farm (Greater Wash, UK), at least half of the tagged harbour seals would have received sound levels from pile driving that exceeded AUD INJ thresholds (PTS) for pinnipeds (Hastie *et al.*, 2015). Nevertheless, population estimates indicated that the trajectory was increasing and, although numerous other ecological factors may influence population health, this study predicted that PTS would not affect a sufficient number of individuals to cause a decline in population trajectory (Hastie *et al.*, 2015). Hastie *et al.* (2015) noted, however, that the paucity of data around the effects of underwater sound on seal hearing required that the exposure criteria applied as per Southall *et al.* (2007) are intentionally conservative and consequently predicted numbers of individuals likely to experience auditory injury would also have been highly conservative.

6.3.1.56 Despite the uncertainty in the ecological effects of auditory injury on seals, the effect is unlikely to cause a change in either reproduction or survival rates. In addition, seals may be able to self-mitigate (i.e. reduce their hearing sensitivity in the presence of loud noises in order to reduce their perceived noise level) (Kastelein *et al.*, 2025).

6.3.1.57 Booth and Heinis (2018) presents the conclusions from the expert elicitation workshop on the effects of an auditory injury on vital rates in marine mammal species. The aim of the workshop was to update the relevant parameters for the iPCoD model and was focused on the potential for auditory injury from low frequency broadband noise (i.e. pile driving). Key conclusions were that individuals predicted to be at risk of exceeding the AUD INJ thresholds did not mean the animals were deaf, but that there could be a reduction in hearing sensitivity within a specific hearing range.

6.3.1.58 Conclusions were that effects on vital rates were lowest on harbour porpoise (VHF), harbour and grey seals (PW). Effects are thought to be slightly larger for bottlenose dolphins (HF), because dolphins use lower frequencies for communication, rather than they were more sensitive. However, for all hearing groups, the conclusions were that auditory injury was unlikely to result in an impact to either survival or reproductive rates.

6.3.1.59 All species are therefore considered to be able to avoid or adapt behaviour (adaptability) and have some tolerance (resilience) but with limited ability to recover from any impact as auditory injury is permanent.

<u>Disturbance</u>

6.3.1.60 Acoustic disturbance to marine mammals may lead to the interruption of normal behaviours (such as feeding or breeding) and avoidance, leading to displacement and exclusion from critical habitats (Castellote *et al.*, 2010, Castellote *et al.*, 2012, Goold, 1996, Weller *et al.*, 2002). Elevated underwater sound may also cause stress, which in turn can lead to a depressed immune function and reduced reproductive success (Anderson *et al.*, 2011, De Soto *et al.*, 2013). The extent to which an animal will be behaviourally affected, however, is very much context-dependent and varies both inter- and intra-specifically as described previously for auditory injury (PTS).

6.3.1.61 As discussed in paragraphs 6.2.8.12 to 6.2.8.16, behavioural disturbance has been assessed using two approaches: a dose response approach (applying the Graham *et al.* (2017) and Whyte *et al.* (2020) response functions to cetaceans and pinnipeds, respectively), and by applying an area-based threshold based on the 143db contour for harbour porpoise (Tougaard, 2021) and the 160db contour associated with “strong disturbance” (NMFS, 2005) for all other species (Table 6.5).

6.3.1.62 Estimates for the numbers of animals are derived from the dose response approach, and the percentage of each species' reference population, potentially experiencing behavioural disturbance are presented in Table 6.16 for the temporal MDS and in Table 6.17 for the spatial MDS. These numbers are carried forward into iPCoD modelling while the area-based thresholds are used to assess any impact on the species-specific SACs. As there is no overlap with the Coastal East Scotland MU and no iPCoD modelling was undertaken using the parameters of this MU (paragraph 6.3.1.24), the portion of this MU was not calculated.

6.3.1.63 The number of animals potentially experiencing behavioural disturbance for the spatial MDS (Table 6.17) was at least double that estimated for the temporal MDS (Table 6.16). However, the timescale for piling for the temporal MDS was more than five times longer than for the spatial MDS. This would mean that although fewer animals would be affected per day, disturbance from piling would be experienced for a longer period.

Table 6.16: Maximum estimate of the number of animals potentially experiencing disturbance from the temporal Maximum Design Scenario, calculated for dose response (Graham *et al*., 2017; Whyte *et al*., 2020)

Species	Number of animals	Percentage of reference population (UK portion)
Grey seal	161	0.44
Harbour seal	<1	0.20
Harbour porpoise	866	0.25 (0.54)
Bottlenose dolphin	8	-

Table 6.17: Maximum estimate of the number of animals potentially experiencing disturbance from the spatial Maximum Design Scenario, calculated for dose response (Graham *et al*., 2017; Whyte *et al*., 2020)

Species	Number of animals	Percentage of reference population (UK portion)
Grey seal	408	1.11
Harbour seal	<1	0.20
Harbour porpoise	1,739	0.50 (1.09)
Bottlenose dolphin	15	-

Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation

Grey seal

Injury

6.3.1.64 Modelling of both the single installation of monopile foundations (Table 6.11) and the concurrent installation of monopile foundations (Table 6.14) indicated that the AUD INJ threshold for grey seal was not exceeded, based on either the PK metric or the SEL_{24h} metric. There is no potential for spatial overlap with the two SACs, as the Berwickshire and North Northumberland Coast SAC is located 97.2km southwest of the Morven South Boundary and Isle of May SAC is located 108.6km southwest. Therefore, there is no risk of auditory injury for grey seals connected to either the Berwickshire and North Northumberland Coast SAC or the Isle of May SAC. As such, there will be no adverse effect on the grey seal population of the Berwickshire and North Northumberland Coast SAC or the viability of the grey seal feature of the Isle of May SAC, as there will be no significant mortality or injury.

Disturbance

6.3.1.65 There are still limited data on grey seal behavioural responses to pile driving. Experimental *ex situ* observations suggest that grey seal foraging success depends on both the perceived risk from anthropogenic sounds (silence, piling or tidal turbines), and prey patch quality (low or high density) and foraging context. During the trials, foraging success was found to be highest in silent control periods, and reduced in the presence of anthropogenic noise (piling and tidal turbine sounds), especially when prey density was low, suggesting seals balance risk against foraging profit (Hastie *et al.*, 2021). Importantly, animals showed an initial aversive response to the pile driving playbacks (with a lower proportion of dives spent foraging) but this diminished during each trial.

6.3.1.66 Twenty grey seals tracked during pile driving at the Luchterduinen and Gemini wind farms exhibited varied responses, including altered diving and swimming behaviours and no changes in behaviour or movement at all (Aarts *et al.*, 2018). The most common reactions were declines in descent speed (observed up to 36km) and reduction in bottom time, and on average grey seal within 33km were more likely to swim away from piling. Response distances varied significantly, however, similar to the risk/profit conclusions presented by Hastie *et al.* (2021), some seals exposed to pile driving at less than 30km returned to the disturbed areas on subsequent trips, indicating that the attraction to the area may outweigh the deterrent effect of noise.

6.3.1.67 Behavioural changes and barrier effects may impact seals' ability to build necessary energy reserves before reproduction and lactation - critical for capital breeders like grey seal which rely on stored energy for offspring survival (Sparling *et al.*, 2006). Female grey seals are particularly vulnerable during late pregnancy, needing extensive foraging to accumulate energy reserves for milk production (Hall and Thompson, 2009). However, during an expert elicitation workshop in 2018 (Booth *et al.*, 2019), it was concluded that grey seal have a reasonable ability to compensate for lost foraging opportunities due to their generalist diet, mobility, life history and adequate fat stores. Instead, survival of 'weaned of the year' animals and fertility were determined to be the most sensitive parameters to disturbance. Experts agreed grey seal would be more robust to the effects of disturbance, due being capital breeders and more generalist adaptable foraging strategy, than harbour seal. Grey seals are also highly adaptable to environmental changes, capable of adjusting their metabolic rates and foraging strategies to balance varying energy demands and availability (Beck *et al.*, 2003, Sparling *et al.*, 2006) and show wide foraging ranges between haul out and multiple foraging regions (Russell and McConnell, 2014) (e.g. 448km for grey seal in Carter *et al.* (2022)). Therefore, they are unlikely to be highly sensitive to displacement or barrier effects from foraging grounds during piling and while mild disturbances may elicit behavioural changes in seals (such as altered swimming speed or direction) these are unlikely to lead to population level effects.

6.3.1.68 However, Figure 6.5 illustrates that there is no potential for underwater sound generated by the single or concurrent piling of 16m monopiles to affect the Berwickshire and North Northumberland Coast SAC and Isle of May SAC. In particular, the area-based threshold of 160dB SPL_{rms} for concurrent piling shown in Figure 6.5 lies a distance of 85.5km and 92.5km from the Berwickshire and North Northumberland Coast SAC and Isle of May SAC respectively and therefore does not overlap these sites.

6.3.1.69 Based upon a density of 0.252 animals/km^2, for the temporal MDS up to 161 grey seals (equivalent to 0.44% of the combined East Scotland and Northeast England SMUs; Table 6.16) were estimated to have the potential to experience disturbance, when calculated using the dose response methodology for seals (Whyte *et al*., 2020).

6.3.1.70 For the spatial MDS up to 408 animals (equivalent to 1.11% of the combined East Scotland and Northeast England SMUs; Table 6.17) were estimated to have the potential to experience disturbance, when calculated using the dose response methodology for seals (Whyte *et al*., 2020).

6.3.1.71 While the populations of the SMUs cannot be directly attributed or allocated to the specific population within the Berwickshire and North Northumberland Coast SAC and Isle of May SAC, results still provide an important context at a population-level to help inform the overall assessment. Results of the iPCoD modelling for grey seal against the combined population of the East Scotland and Northeast England SMUs (36,696 individuals) for both the temporal MDS and spatial MDS showed that the median counterfactual of population size was 1.000 throughout the 25-year model run, indicating that there is predicted to be no significant difference between the population trajectories for the impacted population when compared to the un-impacted population (see Volume 3, Annex 10.5: Marine Mammals Interim Population Consequences of Disturbance (iPCoD) Modelling Report, of the EIA Report). This indicates that there would be no significant difference between the population trajectories for the un-impacted (baseline) grey seal population and the impacted population.

6.3.1.72 After 25 years from the start of piling there was no difference in the number of animals in the impacted population when compared to the un-impacted population. It is therefore considered that there would be no potential long-term effects on the grey seal population of these SMUs resulting from elevated underwater sound generated during piling. As such, there will be no adverse effect on the population, nor significant disturbance, of the grey seal feature of the Berwickshire and North Northumberland Coast SAC and/or the Isle of May SAC.

Conclusion

6.3.1.73 Adverse effects on the grey seal qualifying feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SACs will not occur as a result of injury and disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.18.

6.3.1.74 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result of injury and disturbance from underwater sound generated during piling with respect to the construction phase of Morven South.

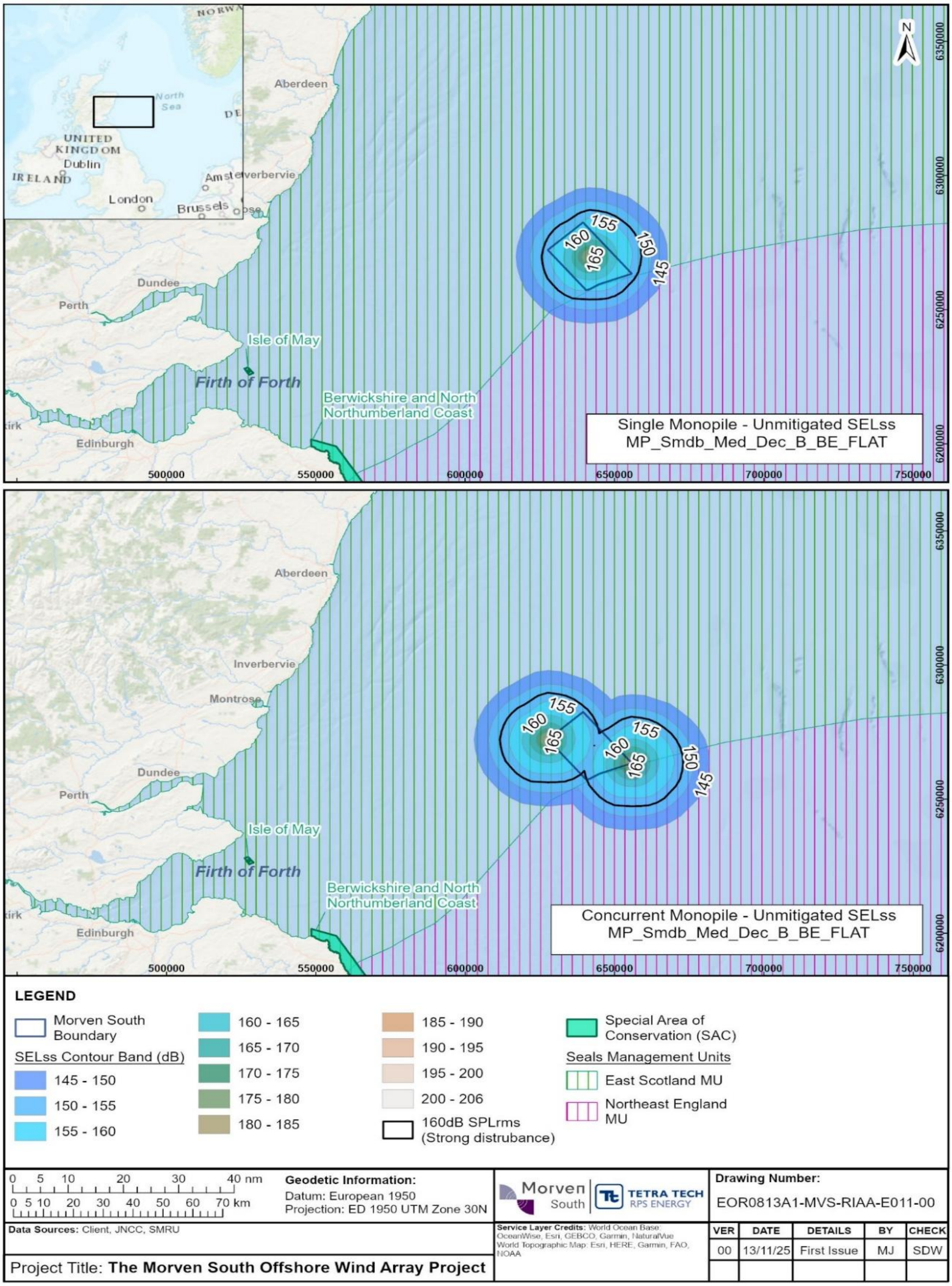

Figure 6.5: Unweighted single strike sound exposure level contours and NMFS (2005) sound pressure level (root mean square) strong disturbance thresholds associated with single (top) and concurrent (bottom) piling of 16m monopiles, in relation to Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

Injury

6.3.1.75 Modelling of both the single installation of monopile foundations (Table 6.11) and the concurrent installation of monopile foundations (Table 6.14) indicated that the AUD INJ threshold for harbour seal was not exceeded, based on either the PK metric or the SEL_{24h} metric. There is no potential for spatial overlap with the SAC itself, as the Firth of Tay and Eden Estuary SAC is located 109.3km southwest of the Morven South Boundary. Therefore, there is no risk of auditory injury for harbour seals, considering, Russell *et al.* (2016) found that harbour seals avoided the area during the piling activity. Harbour seals connected to Firth of Tay and Eden Estuary SAC within the SAC are therefore, not at risk from injury or mortality from underwater sound generated from piling.

Disturbance

6.3.1.76 Mild disturbances in harbour seals may elicit behavioural changes, such as altered swimming speed or direction, similar to grey seals, but these are unlikely to impact populations significantly.

6.3.1.77 Empirical evidence from a telemetry study on harbour seal at the Lincs Offshore Wind Farm showed harbour seals significantly avoided piling activities within a 25km radius (predicted received levels of between 166 and 178dB re $1lPa_{(p-p)}$), with a notable decrease in seal presence during piling but this was limited to piling activity only. Seal distribution returned to baseline levels less than two hours after piling ceased (Russell *et al.*, 2016), Harbour seals store energy in thick blubber, allowing them to tolerate short-term fasting while hauled out during rest, breeding, or moulting. As a result, they are less likely to be significantly affected by brief disruptions to foraging caused by piling activity (Whyte *et al.*, 2020). However, the reproductive strategy of harbour seals is considered to be an intermediate between capital and income breeding (Harwood *et al.*, 2023), because females start foraging before the end of lactation, and income breeders must feed much more continuously to support themselves and their pups, and therefore may be more susceptible to disturbance than grey seal. In an expert elicitation workshop (Booth, 2019) experts agreed the most likely outcome of a six-hour period without energy intake, due disturbance from low-frequency broadband pulsed noise (e.g. impact piling, airgun pulses) would be a short-term disruption to feeding behaviour. It was agreed that harbour seals were considered to have a reasonable ability to compensate for lost foraging opportunities due to their generalist diet, mobility, life history and adequate fat stores. Foraging ranges are smaller than for grey seal, with harbour seals are generally considered to be coastal foragers (Booth, 2019, Vance *et al.*, 2021) (though often journey much further from haul out sites, e.g. 273km in Carter *et al.* (2022)).

6.3.1.78 Figure 6.6 illustrates that there is no potential for underwater sound generated by the single or concurrent piling of 16m monopiles to affect the Firth of Tay and Eden Estuary SAC. In particular, the area-based threshold of 160dB SPL_{rms} for concurrent piling shown in Figure 6.6 lies a distance of 93.4km from the Firth of Tay and Eden Estuary SAC and therefore does not overlap this site. The spatial effects for the 5.3m and 3.7m pin piles are less than those for the monopiles and therefore not illustrated in Figure 6.6.

6.3.1.79 Based upon a density of <0.001 animals/km^2, for the temporal MDS up to one harbour seal (equivalent to 0.21% of the combined East Scotland and Northeast England SMUs[5]; Table 6.16) were estimated to have the potential to experience disturbance, when calculated using the dose response methodology for seals (Whyte *et al.*, 2020).

6.3.1.80 For the spatial MDS up to one animal (equivalent to 0.21% of the combined East Scotland and Northeast England SMUs[5]; Table 6.17) was estimated to have the potential to experience disturbance, when calculated using the dose response methodology for seals (Whyte *et al.*, 2020).

6.3.1.81 While the populations of the SMUs cannot be directly attributed or allocated to the specific population within the Firth of Tay and Eden Estuary SAC, results still provide an important context at a population-level to help inform the overall assessment. Results of the iPCoD modelling for harbour seal against the combined population of the East Scotland and Northeast England SMUs (488 individuals) for both the temporal MDS and spatial MDS showed that the median and mean counterfactual of population size was 1.000 throughout the 25-year model run, indicating that there is predicted to be no significant difference between the population trajectories for the impacted population when compared to the un-impacted population (see Volume 3, Annex 10.5: Marine Mammals Interim Population Consequences of Disturbance (iPCoD) Modelling Report, of the EIA Report). This indicates that there would be no significant difference between the population trajectories for the un-impacted (baseline) harbour seal population and the impacted population.

6.3.1.82 After 25 years from the start of piling there was no difference in the number of animals in the impacted population when compared to the un-impacted population. It is therefore considered that there would be no potential long-term effects on the harbour seal population of these SMUs resulting from elevated underwater sound generate during piling. While there may be some measurable changes to individuals that are disturbed (i.e. interruption of feeding or breeding and/or displacement to alternative areas), only a small proportion of the reference population is predicted to be impacted (0.20%). As such, there will be no adverse effect on the population, nor significant disturbance, of harbour seal throughout the Firth of Tay and Eden Estuary SAC.

Conclusion

6.3.1.83 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.18.

6.3.1.84 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of injury and disturbance from underwater sound generated during piling with respect to the construction phase of Morven South.

[5] While it is recognised that the Firth of Tay and Eden Estuary is associated with the population of the East Scotland SMU (paragraph 6.2.5.2), the combined East Scotland and Northeast England SMUs population was used as the reference population to account for the fact that it is unlikely that all disturbed seals will belong to the East Scotland SMU and thus, the Firth of Tay and Eden Estuary. This is the same for all disturbance impacts.

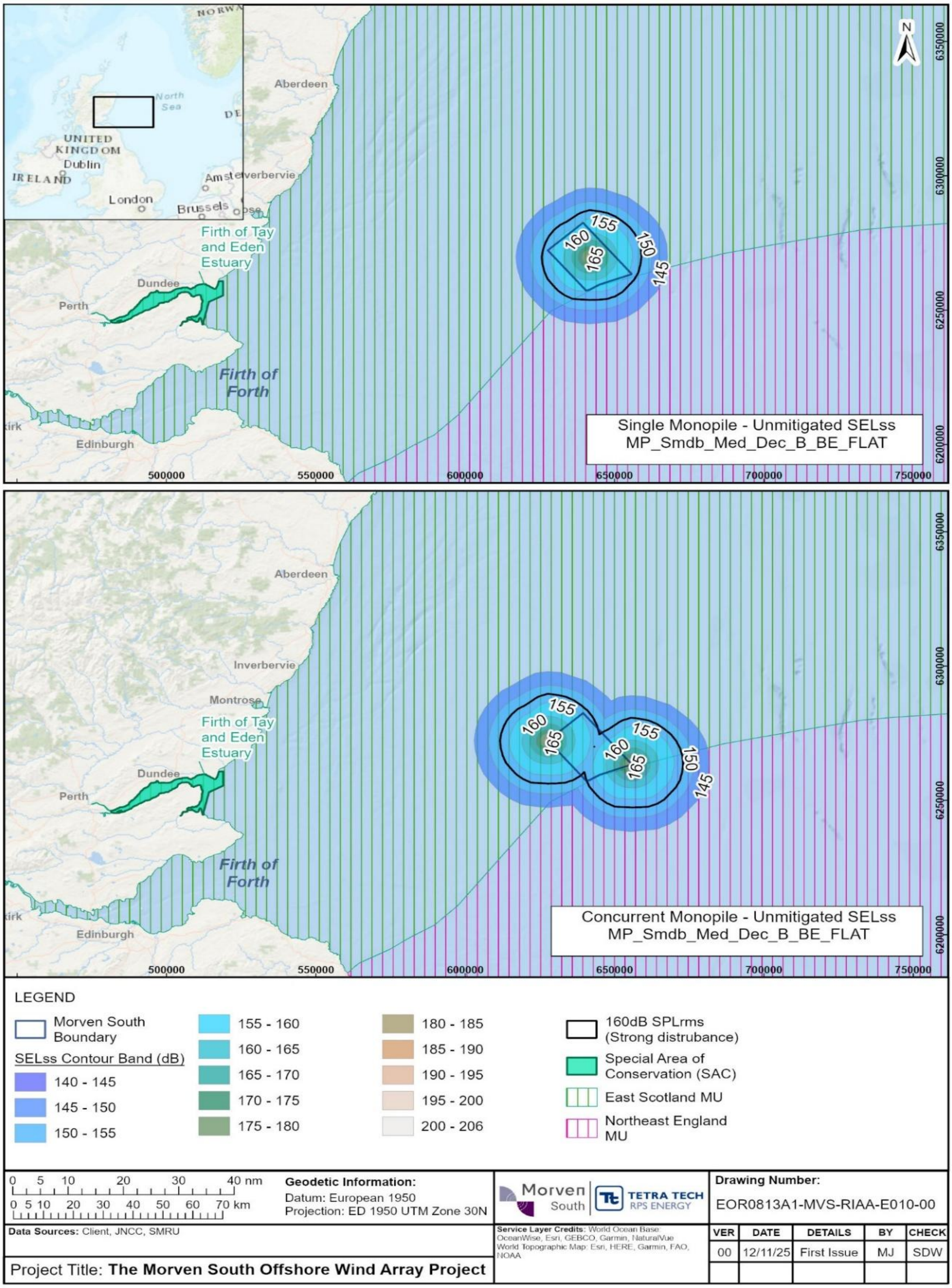

Figure 6.6: Unweighted single strike sound exposure level contours NMFS (2005) sound pressure level (root mean square) strong disturbance thresholds associated with single (top) and concurrent (bottom) piling of 16m monopiles, in relation to the Firth of Tay and Eden Estuary Special Area of Conservation

Southern North Sea Special Area of Conservation

Harbour porpoise

Injury

6.3.1.85 Based on the PK metric, the maximum range for injury to harbour porpoise was estimated as 950m during the single installation of monopile foundations (Table 6.11), while the maximum ensonified area for potential marine mammal injury from concurrent installation of monopile foundations was 5.67km^2 (Table 6.14). Applying a density value of 0.599 animals per km^2, two animals would be at risk of experiencing auditory injury during the single installation (Table 6.13) and four animals would be at risk during the concurrent installation of monopile foundations (Table 6.15). However, with designed-in measures applied (30-minutes of ADD; Table 6.7), it is predicted that no animals would be affected by peak pressure as they would be able to flee the potential injury range within the 30 minute period of ADD activation (Table 6.12).

6.3.1.86 Given that the auditory injury range is less than 1km, this will be localised to within the Morven South Marine Mammal Study Area and there is no potential for spatial overlap with the SAC itself, as the Southern North Sea SAC is located 135.1km southeast of the Morven South Boundary. Therefore, there is no risk of auditory injury for harbour porpoise connected to the SAC, and as such, there will be no adverse effect on the viability of the harbour porpoise feature of the Southern North Sea SAC.

Disturbance

6.3.1.87 As a small cetacean species, harbour porpoise is vulnerable to heat loss, and with a high metabolic requirement, needs to forage frequently (between 4% and 9.5% of their body weight in fish was required per day (Kastelein *et al.*, 1997)) to lay down sufficient fat reserves for insulation. Wild porpoises forage almost continuously day and night to obtain their required calorific intake, so they are vulnerable to starvation if foraging is interrupted (Wisniewska *et al.*, 2016). Harbour porpoise was recorded year-round in the Morven South Marine Mammal Study Area and therefore could be vulnerable to piling at any time of year (Volume 3, Annex 10.3: Marine Mammals Shared Digital Aerial Survey Report, of the EIA Report).

6.3.1.88 Variation in behavioural responses to increased underwater sound is context-specific and factors such as the activity state of the receiving animal, the nature and novelty of the sound (i.e. previous exposure history), and the distance between sound source and receiving animals are important in determining the likelihood of a behavioural response (Ellison *et al.*, 2012). Empirical evidence from monitoring during construction of offshore wind farms indicates that piling is unlikely to lead to 100% avoidance in all individuals exposed, and that there will be a proportional decrease in avoidance at greater distances from the piling source (Brandt *et al.*, 2011). At Horns Rev Offshore Wind Farm, 100% avoidance was observed in harbour porpoises at up to 4.8km from the piles, while at distances beyond 10km this proportion reduced to less than 50% (Brandt *et al.*, 2011).

6.3.1.89 More recently Benhemma-Le Gall *et al.* (2021) studied responses of harbour porpoise to piling at the Beatrice Offshore Wind Farm and suggested that harbour porpoise may adapt to increased noise disturbance over the course of the piling phase, thereby showing a degree of tolerance and behavioural adaptation. The probability of occurrence (measured as porpoise-positive minutes) also demonstrated an exponential increase relative to distance from the noise source (Graham *et al.*, 2019). For example, Brandt *et al.* (2018) demonstrated at offshore wind farms in the German Bight that at maximum effect distances (between 17km and 33km for installation of foundations comprising monopiles, tripiles, tripod foundations and jacket foundations) avoidance occurred only during the hours of piling, when detections were found at sound levels exceeding 143dB re 1μPa^{2}s. However, within the vicinity (<2km) of piling, porpoise detections declined several hours before the start of piling (likely due to increased shipping traffic in combination with calm weather conditions) and were reduced for one to two days post piling (Brandt *et al.*, 2018). Brandt *et al.* (2018)

considered that this gradient is a result of more animals reacting, or animals responding more strongly, or quickly, to noise when it is louder and/or when the noise source is closer.

6.3.1.90 Although harbour porpoise may be able to avoid the disturbed area and forage elsewhere, there may be a potential effect on reproductive success of some individuals. As mentioned in paragraph 6.3.1.89, it is anticipated that there would be some adaptability to the elevated sound levels from piling and therefore survival rates are not likely to be affected.

6.3.1.91 However, Figure 6.7 illustrates that there is no potential for underwater sound generated by the single or concurrent piling of 16m monopiles to affect the Southern North Sea SAC. In particular, the area-based threshold of 143dB SEL_{ss} for concurrent piling shown in Figure 6.7, lies a distance of 107.9km from the Southern North Sea SAC and therefore does not overlap with this site.

6.3.1.92 Based upon a density of 0.599 animals/km^2, for the temporal MDS up to 866 animals (equivalent to 0.25% of the full North Sea MU and 0.54% of the UK portion of the MU; Table 6.16) were estimated to have the potential to experience disturbance, when calculated using the dose response methodology for cetaceans (Graham *et al.*, 2017) capped at 140db SEL_{ss}.

6.3.1.93 For the spatial MDS up to 1,739 animals (equivalent to 0.50% of the full North Sea MU and 1.09% of the UK portion of the MU; Table 6.17) were estimated to have the potential to experience disturbance, when calculated using the 140db SEL_{ss}-capped dose response methodology for cetaceans (Graham *et al.*, 2017).

6.3.1.94 While the populations of the SMUs cannot be directly attributed or allocated to the specific population within the Southern North Sea, results still provide an important context at a population-level to help inform the overall assessment. Results of the iPCoD modelling for harbour porpoise against the North Sea MU population (346,601 individuals) for both the temporal MDS and spatial showed that the median counterfactual of population size was 1.000 throughout the 25-year model run, indicating that there is predicted to be no significant difference between the population trajectories for the impacted population when compared to the un-impacted population (see Volume 3, Annex 10.5: Marine Mammals Interim Population Consequences of Disturbance (iPCoD) Modelling Report, of the EIA Report).

6.3.1.95 After 25 years from the start of piling there was no difference in the number of animals in the impacted population when compared to the un-impacted population. It is therefore considered that there would be no potential long-term effects on the harbour porpoise population of this MUs resulting from elevated underwater sound generate during piling. As such, there will be no adverse effect on the population, nor significant disturbance, of the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.3.1.96 Adverse effects on the harbour porpoise qualifying feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.18.

6.3.1.97 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of injury and disturbance from underwater sound generated from piling with respect to the construction phase of Morven South.

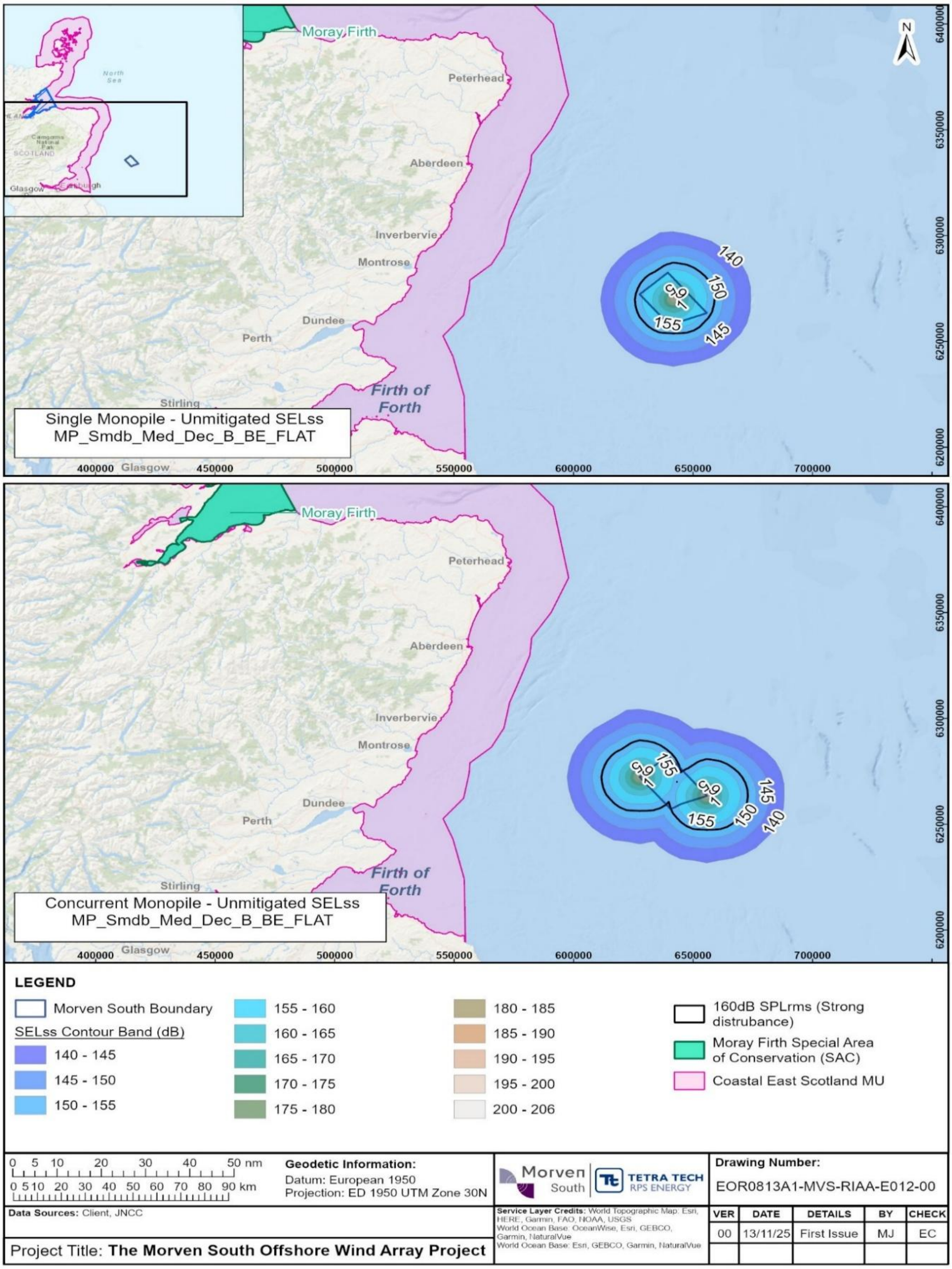

Figure 6.7: Unweighted single strike sound exposure level contours associated with single (top) and concurrent (bottom) piling of 16m monopiles and 143dB single strike sound exposure level area-based threshold contour, in relation to the Southern North Sea Special Area of Conservation (inset)

Moray Firth Special Area of Conservation

Bottlenose dolphin

Injury

6.3.1.98 Modelling of both the single installation of monopile foundations (Table 6.11) and the concurrent installation of monopile foundations (Table 6.14) indicated that the AUD INJ threshold for bottlenose dolphin was not exceeded, based on either the PK metric or the SEL_{24h} metric. There is no potential for spatial overlap with the Moray Firth SAC as the SAC is located 215.8km northwest of the Morven South Boundary, nor the Coastal East Scotland MU (paragraph 6.2.7.2). Therefore, there is no risk of auditory injury for bottlenose dolphin connected to Moray Firth SAC, and so there will be no adverse effect on the population of the bottlenose dolphin feature of the Moray Firth SAC.

Disturbance

6.3.1.99 Bottlenose dolphins are considered less vulnerable to disturbance compared to harbour porpoises due to their larger body sizes, lower metabolic rates, and less frequent foraging needs. Bottlenose dolphins are predominantly distributed in coastal habitats and tend to be more abundant during spring and summer months. Across 33 months of site specific surveys in the Morven South Marine Mammal Study Area, no bottlenose dolphins were observed.

6.3.1.100 There is limited information on how bottlenose dolphins respond to piling noise disturbances, as most research has focused on harbour porpoises. A study at the Nigg Energy Park in northeast Scotland found that bottlenose dolphins showed a weak but measurable response to piling activities, spending less time near the construction site (Graham *et al.*, 2017). During offshore wind farm construction in the Moray Firth increased dolphin detections were observed on days when piling occurred, suggesting that behavioural changes like increased vocalisations occurred rather than displacement (Fernandez-Betelu *et al.*, 2021).

6.3.1.101 The behavioural response severity spectrum developed by Southall *et al*. (2007, 2021) suggests that strong disturbance near the noise source could lead to displacement, while mild disturbance further away would cause less severe behavioural effects. Bottlenose dolphins are likely capable of avoiding disturbed areas, and while there may be some reproductive impacts close to the source of strong disturbance, survival rates are unlikely to be affected. It is expected that these animals will build some tolerance to the noise over time and resume normal activities once piling ceases.

6.3.1.102 However, as illustrated by Figure 6.8, there is no potential for underwater sound generated by the single or concurrent piling of 16m monopiles to affect the Moray Firth SAC. Similarly, the underwater sound contour for the NMFS (2005) 160db rms (strong disturbance) is not predicted to overlap with the Coastal East Scotland MU (paragraph 6.2.7.2). In particular, the area-based threshold of 160dB SPL_{rms} metric for concurrent piling shown in Figure 6.8 lies a distance of 203.7km from the Moray Firth SAC and therefore does not overlap this site. Therefore, based on the assumption that any bottlenose dolphins disturbed would not belong to the Coastal East Scotland MU population, and thus the Moray Firth SAC population, there is no impact pathway for disturbance to bottlenose dolphins within the SAC population. As such, underwater sound generated by piling would not lead to significant disturbance to the bottlenose dolphin feature of the Moray Firth SAC and thus no adverse effect on the SAC population.

Conclusion

6.3.1.103 Adverse effects on the bottlenose dolphin qualifying feature of the Moray Firth SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.7.5) is presented in Table 6.18.

6.3.1.104 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Moray Firth SAC as a result of injury and disturbance from underwater sound generated during piling with respect to the construction phase of Morven South.

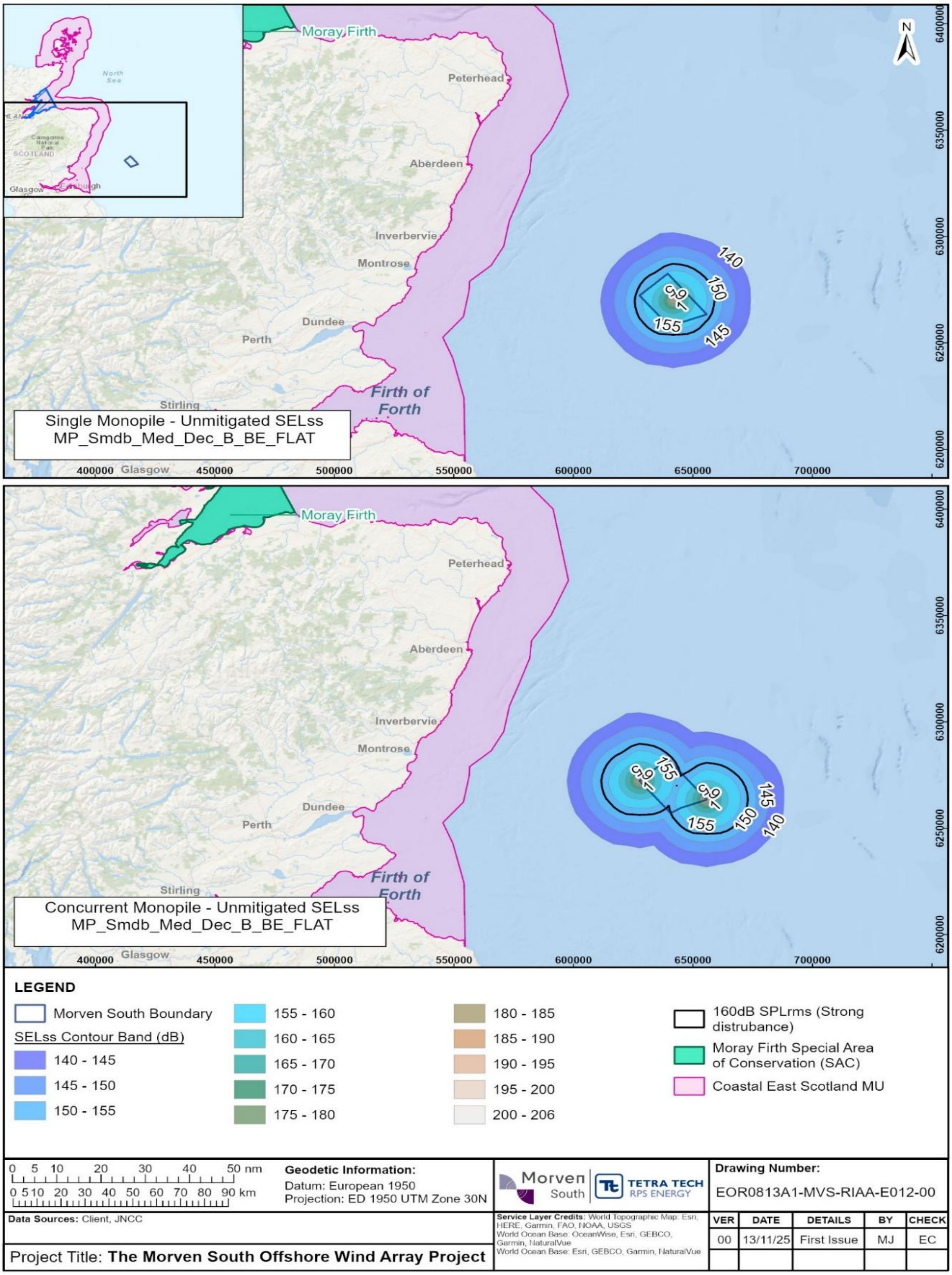

Figure 6.8: Unweighted single strike sound exposure level contours and NMFS (2005) sound pressure level (root mean square) strong disturbance thresholds associated with single (top) and concurrent (bottom) piling of 16m monopiles, in relation to the Moray Firth Special Area of Conservation (inset)

Table 6.18: Conclusions against the conservation objectives of the Special Areas of Conservation designated for marine mammals from injury and disturbance from underwater sound generated during piling with respect to the construction phase

SAC	Feature	Conservation objective	Conclusion
Berwickshire and North Northumberland Coast SAC	Grey seal	The extent and distribution of qualifying natural habitats and habitats of the qualifying species are maintained.	There is no impact pathway between underwater sound generated during piling and the extent, distribution, structure, and function of the habitats and supporting processes of grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Supplementary advice (Natural England, 2023) refers to maintaining spatial extent and distribution of supporting habitats including haul-out sites and the assessment found that there was no overlap with the SAC and the sound contours did not reach the coastal area where key haul outs are located. Furthermore, the ensonified area would not impede connectivity between the site and the wider environment as grey seal are able to forage widely and disturbance during piling would only occur as short-term reversible events after which animals would return to baseline levels. Therefore, the presence, abundance, condition and diversity of habitats and species required to support grey seal will not be adversely affected and will be maintained.
		The structure and function of the habitats of the qualifying species are maintained.	
		The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely are maintained.	
		The populations of each of the qualifying species are maintained	As described in paragraphs 6.3.1.64 to 6.3.1.72, piling during the construction phase is unlikely to lead to injury or significant disturbance of grey seals as there is no overlap of the ensonified area with the SAC. In addition, population modelling has demonstrated that there are no long-term population-level effects on this species as a result of potential disturbance during piling and therefore with respect to the supplementary advice the reproductive and recruitment capability of the species would be maintained (Natural England, 2023). Therefore, the population and distribution of grey seal within the SAC will not be adversely affected and so will be maintained.
		The distribution of qualifying species within the site are maintained.	
Isle of May SAC	Grey seal	2a. ensure grey seals are a viable component of the Isle of May SAC.	As described in paragraphs 6.3.1.64 to 6.3.1.72, piling during the construction phase is unlikely to lead to injury or strong behavioural disturbance of grey seals. There is no impact pathway for injury

SAC	Feature	Conservation objective	Conclusion
			during piling in the construction phase, as the AUD INJ threshold for grey seal was not exceeded. Similarly, grey seal would not be disturbed within the site as the ensonified area does not overlap the SAC, ensuring grey seals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2025a). Importantly, this means that there is no effect on reproductive capability of grey seal during the breeding season and pup production would not be expected to decline as a result of this impact, ensuring stable or increasing grey seal numbers are maintained. Therefore, grey seals will remain a viable component of the SAC.
		2b. ensure the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals.	This conservation objective refers to potential for long-term declines in the use of the site, changes in the distribution of the species on a sustained basis or changes in their behaviour such that it reduces the ability of the species to survive, breed or rear young (NatureScot, 2025a). As described in paragraphs 6.3.1.65 to 6.3.1.72, significant disturbance of grey seals from piling throughout the site during the construction phase will be avoided as the area ensonified does not overlap the SAC. Furthermore, modelling demonstrated there would be no population-level effect on the species and therefore no effect of underwater sound during piling on the survival of this species or their ability to use and access all areas within the SAC used for pupping and nursing. Therefore, the distribution of grey seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats relevant to grey seal are maintained.	The focus of this conservation objective is on maintaining the extent, quality, and distribution of the supporting habitats required by breeding grey seals (NatureScot, 2025a). The assessment found that there is no impact pathway between underwater sound generated during piling and the supporting habitats relevant to grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Thus, there is unlikely to be any effect at key times of year when seals, which rely on these habitats, may be resting or foraging within or

SAC	Feature	Conservation objective	Conclusion
			close to the SAC. Therefore, the habitats required to support grey seal will not be adversely affected and will be maintained.
Firth of Tay and Eden Estuary SAC	Harbour seal	2a. ensure harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality.	As described in paragraphs 6.3.1.75, piling during the construction phase is unlikely to lead to injury (and therefore mortality) of harbour seals as the AUD INJ threshold for harbour seal was not exceeded. This ensures that the recovery of harbour seal at a population level (noting that the condition of harbour seal within the SAC was last assessed as unfavourable – declining; see paragraph 6.2.5.7) is not impeded and animals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2024). Therefore, harbour seals within the SAC will not be at significant risk of injury or mortality and will not be adversely affected.
		2b. ensure the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.1.76 to 6.3.1.82, significant disturbance of harbour seals throughout the site from piling during the construction phase will not occur as the area ensonified does not overlap the SAC. Even outwith the SAC the number of harbour seal disturbed is very low and there are no population-level effects in relation to the relevant SMUs. This ensures harbour seals will continue to have access to, and can utilise, all habitats suitable for haul-outs and breeding associated within the site (NatureScot, 2024). Therefore, the distribution of harbour seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to harbour seal are maintained.	The focus of this conservation objective is on maintaining habitats within the SAC to support recovery of the species due to its declining status (NatureScot, 2024). The assessment found that there is no impact pathway between underwater sound generated during piling and the supporting habitats and processes relevant to harbour seal (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour seal will not be adversely affected and will be maintained.

SAC	Feature	Conservation objective	Conclusion
Southern North Sea SAC	Harbour porpoise	1. harbour porpoise are a viable component of the site.	As described in paragraphs 6.3.1.85 to 6.3.1.95, piling during the construction phase is unlikely to lead to injury or strong behavioural disturbance of harbour porpoises. The range of effect for injury is out to a maximum of 950m and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. Similarly, harbour porpoise would not be disturbed within the site as the ensonified area does not overlap the SAC. Furthermore, modelling demonstrated there would be no population-level effect on the species. As such, there is no restriction on the survivability and reproductive potential of harbour porpoise using the site (JNCC and Natural England, 2019) from underwater sound during piling. Therefore, harbour porpoise will remain a viable component of the SAC.
		2. there is no significant disturbance of the species.	This conservation objective considers disturbance significant if it leads to the exclusion of harbour porpoise from a significant portion of the site (JNCC and Natural England, 2019). As described in paragraphs 6.3.1.87 to 6.3.1.95, significant disturbance of harbour porpoise from piling during the construction phase will be avoided as the area ensonified does not overlap the SAC. There will be no displacement of harbour porpoise from the site from underwater sound during piling. Therefore, the SAC population will not be adversely affected.
		3. the condition of supporting habitats and processes, and the availability of prey is maintained.	This conservation objective (JNCC and Natural England, 2019) refers to the maintenance of supporting habitats (i.e. characteristics of the seabed and water column) and processes (i.e. movements and physical properties of the habitat) contributing to ensuring that prey is maintained within the site and is available to harbour porpoises. As the assessment found that there was no overlap with the area of significant disturbance with the SAC, there is no impact pathway between underwater sound generated during piling and the supporting habitats and processes relevant to harbour porpoise. With respect to the availability of prey, no adverse effects were predicted

SAC	Feature	Conservation objective	Conclusion
			on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support harbour porpoise will not be adversely affected and will be maintained.
Moray Firth SAC	Bottlenose dolphin	2a. ensure the population of bottlenose dolphin is a viable component of the site.	As described in paragraphs 6.3.1.98 to 6.3.1.102, there is no impact pathway for injury during piling in the construction phase, as the AUD INJ threshold for bottlenose dolphin was not exceeded and there is no overlap with the SAC nor the functionally linked Coastal East Scotland MU (NatureScot, 2025c). As such, there is no risk of injury or mortality to bottlenose dolphin from underwater sound from piling during the construction phase. Therefore, bottlenose dolphin will remain a viable component of the SAC.
		2b. ensure the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.1.99 to 6.3.1.102, significant disturbance of bottlenose dolphin throughout the site from piling during the construction phase will be avoided as the area ensonified does not overlap the SAC nor the functionally linked Coastal East Scotland MU (NatureScot, 2025c). As there is no impact pathway from disturbance, bottlenose dolphin will continue to use and have access to all areas of the site. Therefore, the distribution of bottlenose dolphin within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to bottlenose dolphin and their prey/food resources for bottlenose dolphins are maintained.	The focus of this conservation objective is on maintaining sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site (NatureScot, 2025c). The assessment found that there is no impact pathway between underwater sound generated during piling and the supporting habitats and processes relevant to bottlenose dolphin (i.e. no overlap with the area of significant disturbance with the SAC nor functionally linked Coastal East Scotland MU). With respect to the availability of prey, no adverse effects were predicted

SAC	Feature	Conservation objective	Conclusion
			on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support bottlenose dolphin will not be adversely affected and will be maintained.

6.3.2 Injury and disturbance from underwater sound generation from Unexploded Ordnance clearance

6.3.2.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction phase, LSE[2] could not be ruled out for injury and disturbance from underwater sound generation from UXO clearance. This relates to all five SACs (Table 3.1) and relevant Annex II marine mammal features:

- Berwickshire and North Northumberland Coast SAC:
  - Grey seal.
- Isle of May SAC:
  - Grey seal.
- Firth of Tay and Eden Estuary SAC:
  - Harbour seal.
- Southern North Sea SAC:
  - Harbour porpoise.
- Moray Firth SAC:
  - Bottlenose dolphin.

6.3.2.2 The MDS and designed-in measures considered for the assessment of injury and disturbance from underwater sound generation from UXO clearance are shown in Table 6.19 and Table 6.20, respectively.

Table 6.19: Maximum Design Scenario considered for the assessment of potential impacts to Annex II marine mammals due to injury and disturbance from underwater sound generation from Unexploded Ordnance clearance during the construction phases

Project phase	Maximum Design Scenario	Justification
Construction	**Construction Phase** • Clearance of up to 15 UXOs within the Morven South Boundary; • maximum charge weight of 554kg NEQ; • most likely charge weight of 132kg NEQ; • maximum donor charge of 10kg (2 x 5kg); • maximum of one detonation within 24 hours; • total duration of UXO clearance campaign 15 days (excluding downtime for e.g. weather); • clearance during daylight hours only.	Maximum number and maximum realistic size of UXOs encountered is based on the UXO Hazard Assessment undertaken for Morven South (MvOWL, 2023).

Table 6.20: Designed-in measures considered for the assessment of potential impacts to Annex II marine mammals from injury and disturbance from underwater sound generation from Unexploded Ordnance clearance during the construction phases

Reference number	Designed-in measures	Justification	Primary or tertiary
MM-8	Development of and adherence to a Marine Mammal Mitigation Protocol.	The MMMP will mitigate for risk of injury or disturbance to marine mammals during construction. The MMMP may include standard industry measures such as MMObs, PAM and ADD activation prior to UXO clearance.	Tertiary
MM-16	UXO clearance using low order disposal techniques where technically feasible.	Where reasonably practical, low order techniques will be adopted as mitigation to reduce sound levels and thereby reduce injury and disturbance to sound-sensitive receptors (i.e. marine mammals) during UXO clearance.	Primary

Information to inform the assessment

6.3.2.3 The Applicant is applying for UXO licence separately; however, potential UXO impacts are still assessed as a more holistic approach.

6.3.2.4 Pre-construction clearance of UXOs could lead to effects from high order detonation of UXO. This activity has the capacity to produce some of the most elevated peak sound pressures among all human-made underwater sound sources and is recognised as a high-energy, impulsive sound source (von Benda-Beckmann *et al.*, 2015). The effects of this impact will vary based on the characteristics of the sound source, the species affected, proximity to the source and the degree of attenuation within the surrounding environment.

6.3.2.5 Further detail on underwater sound modelling of UXO clearance is provided in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report. In the case of high order detonation, acoustic modelling was conducted following the empirical exponentially decaying model for an underwater blast outlined in Gaspin (1983) and Richardson *et al.* (1995), as well as contributions from subsequent bubble expansion-contraction cycles.

6.3.2.6 Low order deflagration yields a considerably lower amplitude of peak sound pressure compared to high order detonations (Robinson *et al.*, 2020). Low order clearance techniques offer a substantial reduction in acoustic output over traditional high order methods, with the PK and SEL_{24h} observed being typically more than 20dB lower for the deflagration of the same sized munition. In this case, the radiated sound corresponds with the donor charge weight rather than the UXO itself. Therefore, underwater sound modelling for low order clearance has been based on the same methodology as for high order detonation, but with a smaller donor charge size.

6.3.2.7 Underwater sound modelling (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report) presents two distances relative to the source (e.g. the site of UXO clearance) for each sound level: R_{max} and $R_{95\%}$ (see paragraph 6.3.1.7).

6.3.2.8 For the purpose of defining the mitigation zone, and based on the PK metric, this RIAA Part 2 has adopted the modelled output for R_{max} as this is the most conservative approach. For SEL_{24h} and disturbance associated with UXO clearance the distances related to $R_{95\%}$ have been applied, as the bathymetry in this region is unlikely to cause underwater sound to propagate irregularly, and the sound source (UXO detonation) is not expected to be directional.

6.3.2.9 The sound from both low order and high order detonation is unlikely to remain impulsive in character at distances beyond a few kilometres (as per paragraph 6.3.1.16; see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report for more details). Predicted injury ranges should therefore be interpreted with caution, as those in the order of tens of kilometres are likely to be considerably lower.

6.3.2.10 In line with stakeholder advice (Table 2.1 and Volume 2, Chapter 10: Marine Mammals, of the EIA Report) the assessment with respect to auditory injury from UXO clearance was based on both the unweighted PK and marine mammal hearing weighted SEL metrics. The impulsive sound thresholds for AUD INJ for explosives are the same as those defined for piling (NMFS, 2024;

6.3.2.11 Table 6.3). The assessment of effect assumes designed in measures (i.e. MMObs, PAM and 30 minutes of ADD activation prior to clearance; Table 6.20) and the outline Marine Mammal Mitigation Protocol (MMMP) (Volume 4, Annex 2: Outline Marine Mammal Mitigation Protocol, of the EIA Report) will be developed in line with the latest statutory guidance (JNCC, 2025f).

Construction phase

Injury

6.3.2.12 Potential impacts of underwater sound resulting from UXO clearance on marine mammals could include mortality, physical injury or auditory injury. The assessment focuses on auditory injury as this represents the largest potential effect range that should be mitigated. The duration of impact (elevated noise) for each UXO detonation is very short (seconds) therefore behavioural effects are considered to be negligible in this context. As such, TTS represents a temporary auditory injury but can be also considered as a threshold for strong behavioural disturbance (for the onset of a fleeing response). A detailed underwater sound modelling assessment was carried out to investigate the potential PTS and TTS to occur, using the latest assessment criteria (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report). A project-specific outline MMMP (Volume 4, Annex 2: Outline Marine Mammal Mitigation Protocol, of the EIA Report) will be developed to mitigate the potential for injury (Table 6.20).

6.3.2.13 It is anticipated that up to 15 UXOs within the Morven South Boundary may require clearance. The maximum UXO size is assumed to be 554kg NEQ and the most realistic maximum size is 132kg NEQ (Table 6.19). A low order clearance donor charge of 0.25kg NEQ is assumed for each clearance event. The clearance activities will be tide and weather dependent. The aim is to enable clearance of at least one UXO per 24 hours, during daylight hours and good visibility only.

6.3.2.14 Therefore, while the Applicant has committed to low order clearance, to adopt a precautionary approach the RIAA has also considered high order detonation. High order detonation would only be required as a last resort in the event that low order clearance is unsuccessful following three attempts (JNCC, 2025f). Recent evidence from UXO clearance in the Moray Firth, however, provides high confidence that low order clearance will be successful (Ocean Winds, 2024) and therefore it is anticipated that high order detonation will not be required.

6.3.2.15 AUD INJ ranges for low order clearance donor charge (0.25kg), and for high order detonation (554kg and 132kg), are presented in Table 6.21 for both the PK (dB re 1μPa) and SEL (dB re 1μPa^{2}s) metrics (NMFS, 2024). Injury ranges based on the PK metric were greatest for harbour porpoise (VHF cetacean), and those based on the SEL metric were greatest for harbour seal and grey seal (PW).

Table 6.21: Auditory injury thresholds for unweighted peak sound pressure levels and hearing weighted sound exposure level and maximum potential auditory injury ranges (R_{max} and $R_{95\%}$) for low order and high order Unexploded Ordnance clearance/detonation (N/E denotes Auditory Injury threshold not exceeded)

Species	Metric	Auditory threshold	Maximum horizontal distance (m) to threshold		
			0.25kg	132kg	554kg
Grey seal Harbour seal	PK (dB re 1μPa)	222	30	1,930	2,790
	SEL(dB re 1μPa^{2}s)	183	30	1,750	2,810
Harbour porpoise	PK (dB re 1μPa)	202	560	9,310	16,300
	SEL(dB re 1μPa^{2}s)	159	20	870	1,640
Bottlenose dolphin	PK (dB re 1μPa)	230	N/E	690	1,680
	SEL(dB re 1μPa^{2}s)	193	N/E	N/E	30

6.3.2.16 The maximum number of animals predicted to experience auditory injury due to low order and high order detonation (in the absence of mitigation) is presented in Table 6.22. These were calculated from the absolute density estimates (see Section 6.2.2) and injury ranges summarised in Table 6.21.

6.3.2.17 The risk of injury to marine mammals from low order clearance was very low with no more than one animal potentially injured for all species, and for bottlenose dolphin the injury threshold was not exceeded (Table 6.22). For high order clearance, harbour porpoise was the species at greatest risk (see discussion in paragraph 6.3.2.50).

Table 6.22: Maximum number of animals potentially injured due to low order and high order Unexploded Ordnance clearance/detonation (N/A denotes Not Applicable)

Species	Density (animals/km^2)	Hearing group	Metric	Number of animals			Percentage of MU population (UK population) for 554kg clearance
				0.25kg	132kg	554kg	
Grey seal	0.252	PW	PK	<1	3	7	0.02
			SEL	<1	3	7	0.02
Harbour seal	1.20 x 10^{-7}	PW	PK	<1	<1	<1	0.20
			SEL	<1	<1	<1	0.20
Harbour porpoise	0.599	VHF	PK	1	164	500	0.14 (0.31)
			SEL	<1	2	6	0.002 (0.004)
Bottlenose dolphin	0.005	HF	PK	N/A	<1	1	N/A
			SEL	N/A	N/A	<1	N/A

6.3.2.18 The maximum injury ranges for high order detonations presented in Table 6.21 are larger than the standard 1,000m mitigation zone recommended for UXO clearance (JNCC, 2010a). There may however be difficulties in detecting marine mammals over large ranges in excess of 1,000m (McGarry *et al.*, 2017) with a significant decline in visual detection rate with increasing sea state (Embling *et al.*, 2010, Leaper *et al.*, 2015), particularly for smaller species like harbour porpoise.

6.3.2.19 Mitigation set out in the outline MMMP (Volume 4, Annex 2: Outline Marine Mammal Mitigation Protocol, of the EIA Report) will therefore also include the use of ADDs (up to 30 minutes) to deter animals from the injury zone (Table 6.20). The efficacy of such deterrence will depend upon the device selected and reported ranges of effective deterrence vary. The reported effective deterrence range for harbour porpoise using an ADD varies from 2.5km out to 12km (Brandt *et al.*, 2013, Dähne *et al.*, 2017, Kyhn *et al.*, 2015, Olesiuk *et al.*, 2002). A review of available devices is given in Phillips *et al.* (2025) and will provide guidance on the most suitable device for Morven South.

6.3.2.20 Table 6.23 presents indicative displacement distances per species, based upon conservative swim speeds presented in Table 6.4. With 30 minutes of ADD, all species except for harbour porpoise will be deterred beyond the maximum instantaneous injury zone (PK metric).

Table 6.23: Indicative displacement distances using 30 minutes of Acoustic Deterrent Device activation for Annex II marine mammals, assuming conservative swim speeds

Parameter	Potential Displacement Distance (m)		
	Grey seal*	Harbour porpoise	Bottlenose dolphin
Maximum PK injury zone (554kg NEQ)	2,790	16,300	1,680
Swim speed (m/s)	1.8	1.5	1.52
30mins ADD	3,240	2,700	2,736
Move away beyond the maximum auditory injury range?	Yes	No	Yes

*grey seal swim speed used as a proxy for harbour seal, as agreed with MD-LOT and NatureScot.

6.3.2.21 The main characteristic of the acoustic properties of explosives is a short shock wave, comprising a sharp rise in pressure followed by an exponential decay with a time constant of a few hundred microseconds (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report). In shallow water, interactions between the shock and acoustic waves create a complex pattern (von Benda-Beckmann *et al.*, 2015).

6.3.2.22 Sensitivity of Annex II marine mammals to auditory injury from an impulsive underwater sound has been described previously in detail for piling (Section 6.3.1) and, while the threshold shifts are related to the frequency characteristics of the sound source, the overall sensitivity (i.e. animals' responses to a hearing loss within their auditory range) may be similar regardless of the source.

6.3.2.23 With industry standard measures applied, including the use of an ADD, which has been provided for in the outline MMMP (Volume 4, Annex 2: Outline Marine Mammal Mitigation Protocol, of the EIA Report), it is anticipated that all species except harbour porpoise would be deterred from the zone of impact (Table 6.23). There may be a residual risk of injury to harbour porpoise from high order detonation since the effect range is beyond the distance that can be fully mitigated with an ADD. However, the potential for auditory injury and population-level effects to occur at a scale that would affect the integrity of SACs for any Annex II marine mammal is not expected(see discussion per SAC below and Table 6.26).

Disturbance

6.3.2.24 While underwater sound as a result of UXO clearance has the potential to produce behavioural disturbance, there are no agreed thresholds for the onset of a behavioural response. Suggested thresholds for the onset of behavioural disturbance from explosive detonation do exist (Finneran and Jenkins, 2012), but these are intended for repeated detonations over a 24-hour period. For single detonations, behavioural disturbance is likely to be limited to 'a short-lived startle reaction' (Finneran and Jenkins, 2012) and therefore specific behavioural disturbance thresholds may not be relevant for marine mammals exposed to single explosive events.

6.3.2.25 For single pulses such as UXO detonation the use of TTS onset as an auditory effect has been recommended (Southall *et al.*, 2007). Given that a maximum of one UXO clearance will occur per 24-hour period, the RIAA therefore uses the onset of TTS as a proxy for strong behavioural disturbance.

6.3.2.26 Strong disturbance ranges for low order clearance donor charge (0.25kg), and for high order detonation (554kg and 132kg), are presented in Table 6.24 for both the PK (dB re 1µPa) and SEL (dB re 1µPa^{2}s) metrics (NMFS, 2024). As for auditory injury (see paragraph 6.3.2.14) strong disturbance ranges based on the PK metric were greatest for harbour porpoise (VHF cetacean), and those based on the SEL metric were greatest for harbour seal and grey seal (PW).

Table 6.24: Temporary Threshold Shift thresholds (unweighted peak sound pressure levels and hearing weighted sound exposure levels) and maximum potential ranges ($R_{95\%}$) for strong behavioural disturbance from low order and high order Unexploded Ordnance clearance/detonation (N/E denotes threshold not exceeded)

Species	Metric	Auditory threshold	Maximum horizontal distance (m) to threshold[2]		
			0.25kg	132kg	554kg
Grey seal Harbour seal	PK (dB re 1µPa)	217	90	2,650	4,120
	SEL(dB re 1µPa²s)	168	310	6,740	9,530
Harbour porpoise	PK (dB re 1µPa)	196	1,250	14,900	22,300
	SEL(dB re 1µPa²s)	144	200	4,090	5,900
Bottlenose dolphin	PK (dB re 1µPa)	224	30	1,590	2,480
	SEL(dB re 1µPa²s)	178	N/E	200	290

6.3.2.27 The maximum number of animals predicted to experience strong behavioural disturbance due to low order clearance donor charge and high order detonation is presented in Table 6.25. These were calculated from the absolute density estimates (see Section 6.2.2) and strong disturbance ranges summarised in Table 6.24. No percentage of the Coastal East Scotland MU population for bottlenose dolphin was calculated due to the distance of Morven South from the MU boundary (paragraph 6.3.2.68).

6.3.2.28 Low numbers of animals were predicted to experience strong behavioural disturbance as a result of detonation of UXO. The greatest numbers of animals predicted were harbour porpoise, with up to 418 animals potentially injured by high order detonation of a 132kg UXO, and up to 936 animals potentially injured by high order detonation of a 554kg UXO (both for the PK metric; Table 6.25). Up to 66 harbour porpoise and 72 grey seals were predicted to experience strong behavioural disturbance, using the SEL metric (Table 6.25). For all species a small proportion of the relevant MUs is predicted to be affected by behavioural disturbance, with the greatest number of animals predicted for harbour porpoise reflecting only 0.59% of the UK population of the relevant MU for 554kg clearance (Table 6.25).

Table 6.25: Maximum number of animals potentially experiencing strong behavioural disturbance due to low order and high order Unexploded Ordnance disposal (N/A denotes Not Applicable)

Species	Density (animals/km²)	Hearing group	Metric	Number of animals			Percentage of MU population (UK population) for 554kg clearance
				0.25kg	132kg	554kg	
Grey seal	0.252	PW	PK	<1	6	14	0.04
			SEL	<1	36	72	0.20
Harbour seal	1.20×10^{-7}	PW	PK	<1	<1	<1	0.20
			SEL	<1	<1	<1	0.20
Harbour porpoise	0.599	VHF	PK	3	418	936	0.27 (0.59)
			SEL	<1	32	66	0.02 (0.04)
Bottlenose dolphin	0.005	HF	PK	<1	<1	<1	N/A
			SEL	N/A	<1	<1	N/A

6.3.2.29 TTS is a reversible hearing impairment in animals, with recovery expected once they move beyond the injury zone. While the ecological effects of TTS-induced displacement are not fully understood, these temporary hearing losses may cause short-term disruptions to vital life functions, similar to PTS, but with less likelihood of acute effects. The impact depends on the severity of the hearing shift and the sound characteristics, with recovery speed and completeness varying accordingly. TTS onset triggers a fleeing response, marking the boundary between behavioural disturbance and physical auditory injury. Although TTS may temporarily inhibit some ecological functions, it is reversible and unlikely to cause long-term effects on individuals.

6.3.2.30 Any behavioural effects are reversible and animals are anticipated to fully recover following cessation of the activity. It is, however, recognised that where designed-in mitigation applies to reduce the risk of auditory injury, the deterrence measures (i.e. ADD) by their nature would contribute to, rather than reduce, the moving away response. Thus, as part of this assessment it has been assumed that disturbance (leading to displacement) would occur during the 30-minute ADD activation period plus the 1 second UXO clearance event. This relates to high order detonation only as no ADD is required in respect of low order clearance.

6.3.2.31 Scientific understanding of the biological effects of TTS on marine mammals is limited to the results of controlled exposure studies on small numbers of captive animals. Given the difference with the natural environment, and the inability of these small sample sizes to capture intra- and interspecific differences, extrapolating controlled-exposure results to free-living animals should be undertaken with caution. The most likely response to a loud blast would be immediate displacement of animals from the ensonified area and changes in behaviour, for example the interruption of food intake (Siebert *et al.*, 2022). From the limited data available, the evidence points to a rapid recovery following exposure to loud impulsive sounds similar to those expected during high order UXO clearance.

6.3.2.32 The impact of the high order detonation (554kg NEQ) is predicted to be of regional spatial extent, very short-term duration (a 30-minute ADD activation period plus the 1 second UXO clearance event), intermittent and both the impact itself (i.e. the elevation in underwater sound during detonation event) and effect of disturbance is reversible (TTS represents a non-trivial disturbance but not permanent injury). Therefore, due to the very temporary nature of the disturbance event, and the small proportions of the respective MUs impacted any effects may be at an individual level, these are not predicted to be at a scale that would lead to any population-level effects, and so would not affect the integrity of any SAC (see discussion per SAC below and Table 6.26).

<u>Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation</u>

Grey seal

Injury

6.3.2.33 As presented in Table 6.21, the maximum injury range for grey seal was 2,810m, using the SEL metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 1,930m, using the PK metric, for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 30m (both metrics; Table 6.21). The number of individuals that could be potentially injured was estimated at up to seven animals within the maximum injury ranges using either metric for both high order and low order UXO clearance (Table 6.22). The maximum auditory injury range for grey seal (2,810m) does not overlap with either SAC, as the Berwickshire and North Northumberland Coast SAC is located 97.2km southwest of the Morven South Boundary and Isle of May SAC is located 108.6km southwest.

6.3.2.34 Based on the maximum auditory injury range (estimated using either metric) this potential impact would be localised within 3km of the detonation. UXO clearance would occur intermittently throughout the construction phase of Morven South and be very short-term. Although the potential impact itself is reversible (i.e. the elevation in underwater sound only occurs during the detonation event), the effect of auditory injury on grey seal is permanent. However, only 0.02% of the combined East Scotland and Northeast England SMUs would be at risk of auditory injury (Table 6.22). The use of an ADD would, however, deter grey seals beyond the maximum injury range (Table 6.23). The successful clearance of UXOs using low order techniques and industry standard measures, included as designed-in measures (Table 6.20), would reduce the likelihood of auditory injury. Therefore, there will be no adverse effect on the grey seal population of the Berwickshire and North Northumberland Coast SAC or the Isle of May SAC.

Disturbance

6.3.2.35 As presented in Table 6.24, the largest range of strong behavioural disturbance (using TTS as a proxy) to grey seal was 9,530m, using the SEL metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 6,740m for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 310m (Table 6.24). It should be noted that impulsive noise thresholds (TTS onset) were used in the underwater sound modelling for strong behavioural disturbance as a result of UXO clearance. However, as previously described in paragraphs 6.3.1.16, the sound is unlikely to be impulsive in character once it has propagated more than a few kilometres (Hastie *et al.*, 2019, NMFS, 2018) and therefore, the predicted ranges are likely to be conservative.

6.3.2.36 The number of individuals that could potentially experience strong behavioural disturbance was estimated as 72 grey seals, using the SEL metric for the maximum high order clearance of a 554kg NEQ UXO size (Table 6.25).

6.3.2.37 Table 6.25). The maximum TTS range for grey seal (9,530m) does not overlap with either SAC, as the Berwickshire and North Northumberland Coast SAC is located 97.2km southwest of the Morven South Boundary and Isle of May SAC is located 108.6km southwest.

6.3.2.38 As discussed for harbour seal (paragraphs 6.3.2.45 and 6.3.2.46), grey seal are likely to be able to tolerate the effect without any impact on either reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased. Only a small proportion (0.20%) of the combined East Scotland and Northeast England SMUs is predicted to be affected by strong behavioural disturbance (Table 6.25), therefore, there will be no adverse effect on the grey seal population of the Berwickshire and North Northumberland Coast SAC or the viability of the grey seal feature of the Isle of May SAC from disturbance. There will be no significant disturbance to the grey seal feature of either SAC.

Conclusion

6.3.2.39 Adverse effects on the grey seal qualifying feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SAC will not occur as a result of injury and disturbance from underwater sound generation from UXO clearance during the construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.26.

6.3.2.40 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result of injury and disturbance from underwater sound generation from UXO clearance with respect to the construction phase of Morven South.

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

Injury

6.3.2.41 As presented in Table 6.21, the maximum injury range for harbour seal was 2,810m, using the SEL metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 1,930m, using the PK metric, for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 30m (both metrics; Table 6.21). The number of individuals that could be potentially injured was estimated as no more than one animal within the maximum injury ranges using either metric for both high order and low order UXO clearance (Table 6.22). The maximum auditory injury range for harbour seal (2,810m) does not overlap with the Firth of Tay and Eden Estuary SAC, which is located 109.3km southwest of the Morven South Boundary.

6.3.2.42 Based on the maximum auditory injury range (estimated using either metric) this potential impact would be localised within 3km of the detonation. UXO clearance would occur intermittently throughout the construction phase of Morven South and be very short-term. Although the potential impact itself is reversible (i.e. the elevation in underwater sound only occurs during the detonation event), the effect of auditory injury on harbour seal is permanent. However, only 0.21% of the combined East Scotland and Northeast England SMUs[5] would be at risk of auditory injury (Table 6.22). The use of an ADD would, however, deter harbour seals beyond the maximum injury range (Table 6.23). The successful clearance of UXOs using low order techniques and industry standard measures, included as designed-in measures (Table 6.20), would reduce the likelihood of auditory injury. Therefore, there will be no adverse effects on the population of the SAC and harbour seals within the Firth of Tay and Eden Estuary SAC are not at risk from injury or mortality.

Disturbance

6.3.2.43 As presented in Table 6.24, the largest range of strong behavioural disturbance (using TTS as a proxy) to harbour seal was 9,530m, using the SEL metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 6,740m for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 310m (Table 6.24). It should be noted that impulsive sound thresholds (TTS onset) were used in the underwater sound modelling for strong behavioural disturbance as a result of UXO clearance. However, as previously described in paragraph 6.3.1.16, the sound is unlikely to be impulsive in character once it has propagated more than a few kilometres (Hastie *et al.*, 2019, NMFS, 2018) and therefore, the predicted ranges are likely to be conservative.

6.3.2.44 The number of individuals that could potentially experience strong behavioural disturbance was estimated as no more than one animal within the maximum injury ranges using either metric for both high order and low order UXO clearance (Table 6.25). The maximum TTS range for harbour seal (9,530m) does not overlap with the Firth of Tay and Eden Estuary SAC, which is located 109.3km southwest of the Morven South Boundary.

6.3.2.45 Kastelein *et al.* (2018) measured recovery rates of harbour seal following exposure to a sound source of 193dB re $1\mu Pa^2s$ (SEL_{cum}) over 360 minutes and found that recovery from TTS to the pre-exposure baseline was estimated to be complete within 72 minutes following exposure. To note, this is a significantly longer exposure than would be expected from a UXO clearance event, which typically involves 1 second exposure. These are in line with findings reported in SEAMARCO (2011), which showed that for small TTS values, recovery in seal species was very fast (around 30 minutes). Ketten (1995) also reported relatively fast recovery, with full hearing recovery within two hours following exposure.

6.3.2.46 Considering the above, in most cases, impaired hearing for a short time is anticipated to have little effect on the total foraging period of a seal. Nevertheless, the findings of studies presented in this section indicate that seal species are less vulnerable to TTS than harbour porpoise for the sound bands tested.

6.3.2.47 The RIAA considered that harbour seals are likely to be able to tolerate the effect without any potential impact on either reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased. As only a small proportion (0.20%) of the combined East Scotland and Northeast England SMUs[5] is predicted to be affected by strong behavioural disturbance (Table 6.25), the impact is unlikely to be at a scale that would lead adverse effects on the population of the SAC. Therefore, significant disturbance to harbour seal throughout the Firth of Tay and Eden Estuary SAC will be avoided.

Conclusion

6.3.2.48 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from underwater sound generation from UXO clearance during the construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.26.

6.3.2.49 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of injury and disturbance from underwater sound generation from UXO clearance with respect to the construction phase of Morven South.

Southern North Sea Special Area of Conservation

Harbour porpoise

Injury

6.3.2.50 von Benda-Beckmann *et al.* (2015) studied the range of effects of explosives on harbour porpoise in the southern North Sea. In-situ noise measurements were taken at distances up to 2km from the high order clearance of seven UXOs located at approximately 26m to 28m depth on a sandy substrate, with charge weights of up to 263kg. Von Benda-Beckmann *et al.* (2015) investigated the potential for noise-induced auditory injury to occur based on Lucke *et al.* (2009) threshold criteria of 190dB re 1μPa^{2}s ('very likely to occur') and of 179dB re 1μPa^{2}s (SEL) ('increasingly likely to occur'). Beyond 2km range that was monitored during the study noise induced injury was 'very likely to occur' since the SEL recorded at this distance was 191dB re 1μPa^{2}s (i.e. just breaching the 190dB re. 1μPa^{2}s threshold).

6.3.2.51 The same study also modelled possible effect ranges for 210 explosions (of up to 1,000kg charge mass) logged by the Royal Netherlands Navy and the Royal Netherlands Meteorological Institute over a two-year period (2010 and 2011). The authors validated the model using empirical measurements out to 2km and found that the effect distances ranged between hundreds of metres to just over 10km.

6.3.2.52 More recently, sound measurements collected near two detonations of UXO (with charge masses of 325kg and 140kg) indicated an auditory injury effect distance in the range 2.5km to 4km (Salomons *et al.*, 2021), using the weighted SEL values and threshold levels for PTS from Southall *et al.* (2019). When comparing the experimental data and model predictions presented by von Benda-Beckmann *et al.* (2015), Salomons *et al.* (2021) concluded that harbour porpoise may be at risk of permanent hearing loss at distances of several kilometres, i.e. distance between 2km and 6km based on 140kg and 325kg charge masses, respectively.

6.3.2.53 Post-mortem examination of 24 harbour porpoise found that in ten cases the cause of death was associated with a blast injury. The injured harbour porpoises showed signs of internal bleeding around their lower jaw and head, and damage to the small bones in their ears (Siebert *et al.*, 2022). The charge masses of the explosives in this study were not known, however an overpressure level of 172kPa (equivalent to 190dB re 1μPa) may be sufficient to cause shock wave-induced ear trauma (von Benda-Beckmann *et al.*, 2015).

6.3.2.54 Harbour porpoises rely heavily on sound underwater, using echolocation to find food, navigate, and avoid hazards (e.g. fishing nets, vessels). When auditory injury occurs, they can become disoriented. In the study, one porpoise got caught in a fishing net, and another had bruising on one side of its body, possibly because they couldn't detect hazards due to hearing loss. Beyond direct physical trauma, secondary effects of explosions may include displacement, interruption of feeding, chronic stress, and immune suppression. Porpoises may suffer TTS or PTS in orientation and obstacle detection, increasing the risk of bycatch (Siebert *et al.*, 2022).

6.3.2.55 As presented in Table 6.21, the maximum injury range for harbour porpoise was 16,300m, using the PK metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 9,310m for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 560m (Table 6.21). The number of individuals that could be potentially injured was estimated at up to 164 animals for the realistic high order scenario detonation of a132kg NEQ UXO, and up to 500 animals for the high order clearance of the maximum 554kg NEQ UXO (both for the PK metric;

6.3.2.56 Table 6.22). The maximum AUD INJ range for harbour porpoise (16,300m) does not overlap with the Southern North Sea SAC, which is located 135.1km southeast of the Morven South Boundary.

6.3.2.57 UXO clearance would occur intermittently throughout the construction phase of Morven South and be very short-term. Although the potential impact itself is reversible (i.e. the elevation in underwater sound only occurs during the detonation event), the effect of auditory injury on harbour porpoises is permanent. As shown in Table 6.23 harbour porpoise may not be deterred from the zone of impact and may be at risk of injury from high order detonation at an individual level. However, as only 0.14%of the North Sea MU (0.31% of the UK portion) could be injured with no mitigation (Table 6.22), it is considered unlikely that there is a population-level effect on the UK North Sea MU. Therefore, there will be no adverse effect on the population of the harbour porpoise feature of the Southern North Sea SAC.

Disturbance

6.3.2.58 Recovery rates of harbour porpoise were measured following exposure to a piling playback sound source of 175dB re 1μPa^{2}s (SEL) over 120 minutes. Recovery to the pre-exposure threshold was estimated to occur within 48 minutes following exposure, and the higher the hearing threshold shift, the longer the recovery (SEAMARCO, 2011).

6.3.2.59 Kastelein *et al.* (2021) found that the susceptibility to TTS depends on the frequency of the fatiguing sound causing the shift and the greatest TTS depends on the SPL (and related SEL). In a series of studies reviewed in Finneran (2015), which measured TTS occurrence in harbour porpoise, a range of frequencies typical of high-amplitude anthropogenic sounds, the greatest shift in mean TTS occurred at 0.5kHz with hearing recovery within 60 minutes after the fatiguing sound stopped.

6.3.2.60 As presented in Table 6.24, the largest range of strong behavioural disturbance (using TTS as a proxy) to harbour porpoise was 22,300m, using the PK metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 14,900m for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 1,250m (Table 6.24). It should be noted that impulsive noise thresholds (TTS onset) were used in the underwater sound modelling for strong behavioural disturbance as a result of UXO clearance. However, as previously described in paragraphs 6.3.1.16, the sound is unlikely to be impulsive in character once it has propagated more than a few kilometres (Hastie *et al.*, 2019, NMFS, 2018) and therefore, the predicted ranges are likely to be conservative. The maximum TTS range for harbour porpoise (22,300m) does not overlap with the Southern North Sea SAC, which is located 135.1km southeast of the Morven South Boundary.

6.3.2.61 The number of individuals that could potentially experience strong behavioural disturbance was estimated as 936 harbour porpoise, using the PK metric for the maximum high order clearance of a 554kg NEQ UXO size (Table 6.25). As only a small proportion (0.27% (0.59% of the UK portion)) of the North Sea MU is predicted to be affected by strong behavioural disturbance (Table 6.25), the impact is unlikely to be at a scale that would lead adverse effects on the population associated with the Southern North Sea SAC. As such, there will be no adverse effect on the viability, nor significant disturbance to, the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.3.2.62 Adverse effects on the harbour porpoise qualifying feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from underwater sound generation from UXO clearance during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.26.

6.3.2.63 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of injury and disturbance from underwater sound generation from UXO clearance with respect to the construction phase of Morven South.

<u>Moray Firth SAC</u>

Bottlenose dolphin

Injury

6.3.2.64 The sensitivity of bottlenose dolphin to UXO clearance is less well-studied than for harbour porpoise. During clearance of a 35kg charge at an important feeding area for a resident bottlenose dolphin population in Portugal, no adverse effects were recorded in their behaviour or appearance (dos Santos *et al.*, 2010). Acoustic pressure levels greater than 170dB re 1μPa were measured, with pressure levels 60dB higher than ambient noise (see paragraph 6.2.8.4). Nonetheless, external injuries consistent with inner ear damage have been found in dolphins near to UXO clearance, with little change in surface animal behaviour. This suggest that while surface behaviour might not show any visible change, internal injuries can still occur (Ketten *et al.*, 1993).

6.3.2.65 As presented in Table 6.21, the maximum injury range for bottlenose dolphin was 1,680m, using the PK metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 690m for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the AUD INJ acoustic threshold was not exceeded (Table 6.21). The number of individuals that could be potentially injured was estimated at up to one animal within the maximum injury ranges using the PK metric for high order UXO clearance (Table 6.22). The maximum auditory injury range for bottlenose dolphin (1,680m) does not overlap the Moray Firth SAC, which is located 251.8km northwest of the Morven South Boundary.

6.3.2.66 Based on the maximum auditory injury range (estimated using the PK metric) this potential impact would be localised within several kilometres of the detonation. Therefore, as there is also no overlap with the Coastal East Scotland MU, which is the MU associated with the Moray Firth SAC (paragraph 6.2.7.2), it is unlikely that the one bottlenose dolphin with the potential to experience auditory injury will be from the SAC population. As such, there is unlikely to be an impact pathway to the bottlenose dolphin feature of the SAC. Therefore, there will be no adverse effect on the population of the bottlenose dolphin of the Moray Firth SAC.

Disturbance

6.3.2.67 Experimental exposure of two captive bottlenose dolphins to sounds simulating distant underwater explosions indicated no TTS greater than 6dB at sound levels up to 221dB re 1μPa (Finneran *et al.*, 2000). Behavioural changes, such as delaying approach and avoiding certain areas, were observed at lower sound levels (196dB and 209dB re 1μPa) and persisted at higher levels. However, the use of distant, masked signals and trained animals conditioned to tolerate high noise levels, may suggest that behavioural disruptions could occur at lower levels in untrained free-living animals (Nowacek *et al.*, 2007).

6.3.2.68 As presented in Table 6.24, the largest range of strong behavioural disturbance (using TTS as a proxy) to bottlenose dolphin was 2,480m, using the PK metric for the high order clearance of maximum UXO size (554kg NEQ). However, this was reduced to 1,590m for the realistic high order scenario (132kg NEQ). For the low order clearance charge (0.25kg) the injury range was considerably lower: 30m (Table 6.24). As with the maximum auditory injury ranges, the maximum TTS range for bottlenose dolphin (2,480m) does not overlap with the Coastal East Scotland MU nor the Moray Firth SAC (paragraph 6.2.7.2). Therefore, based on the assumption that any bottlenose dolphins disturbed would not belong to the Coastal East Scotland MU population, and thus the Moray Firth SAC population, there is no impact pathway for disturbance to bottlenose dolphins within the SAC population. As such, underwater sound generated from UXO clearance would not lead to significant disturbance to the bottlenose dolphin feature of the Moray Firth SAC and thus no adverse effect on the SAC population.

Conclusion

6.3.2.69 Adverse effects on the bottlenose dolphin qualifying feature of the Moray Firth SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from underwater sound generation from UXO clearance during the construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.7.5) is presented in Table 6.26.

6.3.2.70 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Moray Firth SAC as a result of injury and disturbance from underwater sound generation from UXO clearance with respect to the construction phase of Morven South.

Table 6.26: Conclusions against the conservation objectives of the Special Areas of Conservation designated for marine mammals from underwater sound generation from Unexploded Ordnance clearance during the construction phase

SAC	Feature	Conservation objective	Conclusion
Berwickshire and North Northumberland Coast SAC	Grey seal	The extent and distribution of qualifying natural habitats and habitats of the qualifying species are maintained.	There is no impact pathway between underwater sound generation from UXO clearance (high or low order) and the extent, distribution, structure, and function of the habitats and supporting processes of grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Supplementary advice (Natural England, 2023) refers to maintaining spatial extent and distribution of supporting habitats including haul-out sites and the assessment found that there was no overlap with the SAC and the sound contours did not reach the coastal area where key haul outs are located. Furthermore, the ensonified area would not impede connectivity between the site and the wider environment as grey seal are able to forage widely and disturbance from low order or high order clearance would only occur as short-term reversible events after which animals would return to baseline levels. Therefore, the presence, abundance, condition and diversity of habitats and species required to support grey seal will not be adversely affected and will be maintained.
		The structure and function of the habitats of the qualifying species are maintained.	
		The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely are maintained.	
		The populations of each of the qualifying species are maintained	As described in paragraphs 6.3.2.33 to 6.3.2.38, underwater sound generation from UXO clearance during the construction phase is unlikely to lead to injury or significant disturbance of grey seals as there is no overlap of the ensonified area with the SAC. Only a small proportion (0.20%) of the relevant SMUs would potentially be impacted by strong behavioural disturbance and therefore with respect to the supplementary advice the reproductive and recruitment capability of the species would be maintained (Natural England, 2023). Therefore, the population and distribution of grey seal within the SAC will not be adversely affected and so will be maintained.
		The distribution of qualifying species within the site are maintained.	
Isle of May SAC	Grey seal	2a. ensure grey seals are a viable component of the Isle of May SAC.	As described in paragraphs 6.3.2.33 to 6.3.2.38, underwater sound generation from UXO clearance during the construction phase is

SAC	Feature	Conservation objective	Conclusion
			unlikely to lead to injury or strong behavioural disturbance of grey seals. The auditory injury range is out to a maximum of 30m (low order) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. Even in the unlikely event of a high order clearance the range is out to 2.8km and can be mitigated with standard measures including the use of an ADD. Similarly, grey seal would not be disturbed within the site as the ensonified area does not overlap the SAC either from low order or high order clearance, ensuring grey seals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2025a). Importantly, this means that there is no effect on reproductive capability of grey seal during the breeding season and pup production would not be expected to decline as a result of this impact, ensuring stable or increasing grey seal numbers are maintained. Therefore, grey seals will remain a viable component of the SAC.
		2b. ensure the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals.	This conservation objective refers to potential for long-term declines in the use of the site, changes in the distribution of the species on a sustained basis or changes in their behaviour such that it reduces the ability of the species to survive, breed or rear young (NatureScot, 2025a). As described in paragraphs 6.3.2.33 to 6.3.2.38, significant disturbance of grey seals from underwater sound generation from UXO clearance (high or low order) throughout the site during the construction phase will be avoided as the ensonified area does not overlap the SAC. Only a small proportion (0.20%) of the relevant SMUs would potentially be impacted by strong behavioural disturbance, which would not lead to changes in behaviour that would reduce the ability of seals to survive, breed or rear young Therefore, the distribution of grey seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats relevant to grey seal are maintained.	The focus of this conservation objective is on maintaining the extent, quality, and distribution of the supporting habitats required by

SAC	Feature	Conservation objective	Conclusion
			breeding grey seals (NatureScot, 2025a). The assessment found that there is no impact pathway between underwater sound generation from UXO clearance (high or low order) and the supporting habitats relevant to grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Thus, there is unlikely to be any effect at key times of year when seals, which rely on these habitats, may be resting or foraging within or close to the SAC. Therefore, the habitats required to support grey seal will not be adversely affected and will be maintained.
Firth of Tay and Eden Estuary SAC	Harbour seal	2a. ensure harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality.	As described in paragraphs 6.3.2.41 to 6.3.2.42, underwater sound generation from UXO clearance during the construction phase is unlikely to lead to injury (and therefore mortality) of harbour seals as the auditory injury range is out to a maximum of 30m (low order) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. Even in the unlikely event of a high order clearance the range is out to 2.8km and can be mitigated with standard measures including the use of an ADD. This ensures that the recovery of harbour seal at a population level is not impeded (noting that the condition of harbour seal within the SAC was last assessed as unfavourable – declining; see paragraph 6.2.5.7) and animals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2024).Therefore, harbour seals within the SAC will not be at significant risk of injury or mortality and will not be adversely affected.
		2b. ensure the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.2.43 to 6.3.2.47, significant disturbance of harbour seals throughout the site from underwater sound generation from UXO clearance during the construction phase will be avoided. Disturbance would occur as a very short-term event, which would be reversible and the area ensonified would not overlap the SAC either from low order or high order clearance. This ensures harbour seals continue to have access to, and can utilise, all habitats suitable for haul-outs and breeding associated within the site

SAC	Feature	Conservation objective	Conclusion
			(NatureScot, 2024). Therefore, the distribution of harbour seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to harbour seal are maintained.	The focus of this conservation objective is on maintaining habitats within the SAC to support recovery of the species due to its declining status (NatureScot, 2024). The assessment found that there is no impact pathway between underwater sound generation from UXO clearance (high or low order) and the supporting habitats and processes relevant to harbour seal (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour seal will not be adversely affected and will be maintained.
Southern North Sea SAC	Harbour porpoise	1. harbour porpoise are a viable component of the site.	As described in paragraphs 6.3.2.50 to 6.3.2.61, underwater sound generation from UXO clearance during the construction phase is unlikely to lead to injury or strong behavioural disturbance of harbour porpoises. The auditory injury range is out to a maximum of 560m (low order) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. Although there may be residual risk of auditory injury out to 16.3km for high order clearance with ADD for harbour porpoise it is anticipated that following receipt of more detail regarding size and number of UXO (and tailoring of secondary mitigation measures), the risk of injury to harbour porpoise from the highly unlikely high order detonation will be reduced such that there would be no residual adverse effects In addition, harbour porpoise would not be disturbed within the site as the ensonified area does not overlap the SAC. Only a small proportion (0.27%) of the North Sea MU would potentially be impacted by strong behavioural disturbance, so there is no restriction on the survivability and reproductive potential of harbour porpoise using the site (JNCC and Natural England, 2019) from underwater sound generation from UXO clearance. Therefore, harbour porpoise will remain a viable component of the SAC.

SAC	Feature	Conservation objective	Conclusion
		2. there is no significant disturbance of the species.	This conservation objective considers disturbance significant if it leads to the exclusion of harbour porpoise from a significant portion of the site (JNCC and Natural England, 2019). As described in paragraphs 6.3.2.58 to 6.3.2.61, significant disturbance of harbour porpoise from underwater sound generation from UXO clearance (high or low order) during the construction phase will be avoided as the area ensonified does not overlap the SAC. There will be no displacement of harbour porpoise from the site from underwater sound from UXO clearance (high or low order). Therefore, the SAC population will not be adversely affected.
		3. the condition of supporting habitats and processes, and the availability of prey is maintained.	This conservation objective (JNCC and Natural England, 2019) refers to the maintenance of supporting habitats (i.e. characteristics of the seabed and water column) and processes (i.e. movements and physical properties of the habitat) contributing to ensuring that prey is maintained within the site and is available to harbour porpoises. As the assessment found that there was no overlap with the area of significant disturbance with the SAC, there is no impact pathway between underwater sound generation from UXO clearance and the supporting habitats and processes relevant to harbour porpoise. With respect to the availability of prey, no adverse effects were predicted on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support harbour porpoise will not be adversely affected and will be maintained.
Moray Firth SAC	Bottlenose dolphin	2a. ensure the population of bottlenose dolphin is a viable component of the site.	As described in paragraphs 6.3.2.64 to 6.3.2.68, underwater sound generation from UXO clearance during the construction phase is unlikely to lead to injury of bottlenose dolphin. The AUD INJ acoustic threshold was not exceeded for low order clearance. In the unlikely event of a high order clearance the range is out to 1.7km and can be mitigated with standard measures including the use of an ADD. As such, there is no risk of injury or mortality to bottlenose dolphin

SAC	Feature	Conservation objective	Conclusion
			(NatureScot, 2025c) from underwater sound generation from high or low order UXO clearance during the construction phase. Therefore, bottlenose dolphin will remain a viable component of the SAC.
		2b. ensure the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.2.64 to 6.3.2.68, significant disturbance of bottlenose dolphin throughout the site from underwater sound generation from UXO clearance during the construction phase will be avoided as the ensonified area does not overlap the SAC nor the functionally linked Coastal East Scotland MU (NatureScot, 2025c). Bottlenose dolphin will continue to use and have access to all areas of the site and therefore, the distribution of bottlenose dolphin within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to bottlenose dolphin and their prey/food resources for bottlenose dolphins are maintained.	The focus of this conservation objective is on maintaining sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site (NatureScot, 2025c). The assessment found that there is no impact pathway between underwater sound generation from UXO clearance and the supporting habitats and processes relevant to bottlenose dolphin (i.e. no overlap with the area of significant disturbance with the SAC nor functionally linked Coastal East Scotland MU). With respect to the availability of prey, no adverse effects were predicted on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support bottlenose dolphin will not be adversely affected and will be maintained.

6.3.3 Injury and disturbance to marine mammals from site investigation surveys

6.3.3.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction and O&M phases, LSE[2] could not be ruled out for disturbance to marine mammals from site investigation surveys. This relates to all five SACs (Table 3.1) and relevant Annex II marine mammal features:

- Berwickshire and North Northumberland Coast SAC:
  - Grey seal.
- Isle of May SAC:
  - Grey seal.
- Firth of Tay and Eden Estuary SAC:
  - Harbour seal.
- Southern North Sea SAC:
  - Harbour porpoise.
- Moray Firth SAC:
  - Bottlenose dolphin.

6.3.3.2 The MDS and designed-in measures considered for the assessment of disturbance to marine mammals from site investigation surveys are shown in Table 6.27 and Table 6.28, respectively. The assessment combined the construction and O&M phase as the equipment parameters remain the same.

Table 6.27: Maximum Design Scenario considered for the assessment of potential impacts to Annex II marine mammals due to disturbance to marine mammals from site investigation surveys during the construction and operation and maintenance phases

Project phase	Maximum Design Scenario	Justification
Construction and O&M phases (combined assessed)	**Construction phase** Geophysical surveying is expected to include the following equipment, operating within the following indicative frequency range and source levels: • Multi-Beam Echo-Sounder (MBES) – 200-500kHz, 180-240dB re 1μPa re 1m (rms); • Side Scan Sonar (SSS) – 200-700kHz, 216-228dB re 1μPa re 1m (rms); • Single Beam Echosounder (SBES) – 120-400kHz, 180-240dB re 1μPa re 1m (rms); • Sub-Bottom Profilers (SBP) – 0.2-14kHz chirp, 200-240dB re 1μPa re 1m (rms). – 2-7 kHz pinger, 200-235dB re 1μPa re 1m (rms); • Ultra High Resolution Seismic (UHRS) – 0.05-4kHz, 182dB re 1μPa re 1m (rms). Geotechnical surveys will include: • boreholes; • cone penetration tests; • seismic cone penetration tests; • vibrocores Geophysical and geotechnical surveys will involve the use of up to 2 vessels on site at any one time, with up to 156 survey vessel movements in total. **O&M phase**	The range of geophysical and geotechnical survey activities likely to be undertaken, using equipment and parameters typically employed for these types of surveys, will result in the greatest potential impact.

Project phase	Maximum Design Scenario	Justification
	The type of site investigation surveys, and the corresponding indicative frequencies and source levels, are assumed to be the same as for the construction phase. Routine geophysical surveys would typically be undertaken every three years except for the inter-array cables and interconnectors where surveys would occur annually for the first five years, and every four years thereafter. Up to four survey vessels will be on site at any one time, involving 60 vessel return trips per year. There would be no geotechnical surveys undertaken post-construction.	

Table 6.28: Designed-in measures considered for the assessment of potential impacts to Annex II marine mammals from disturbance to marine mammals from site investigation surveys during the construction phase

Reference number	Designed-in measures	Justification	Primary or tertiary
MM-8	Development of and adherence to a Marine Mammal Mitigation Protocol.	The MMMP will mitigate for risk of injury or disturbance to marine mammals during construction. The MMMP may include using MMObs and PAM as per the standard JNCC (2017) mitigation for geophysical surveys.	Tertiary

Information to inform the assessment

6.3.3.3 Geophysical and geotechnical site investigation surveys during the construction and O&M phases have the potential to cause disturbance on Annex II marine mammals (Table 6.27). A detailed underwater sound modelling assessment has been carried out to investigate the potential for behavioural effects on marine mammals as a result of those activities identified as having the potential to cause an acoustic impact (primarily geophysical surveys), using the latest criteria (Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report). This Stage 2 assessment considers several sonar-like sources will be used for the geophysical surveys, including Multibeam Echo Sounder (MBES), Side Scan Sonar (SSS), Sub-Bottom Profiler (SBP (CHIRP 2kHz and 3.5kHz)), Single-Beam Echo-Sounder (SBES) and Ultra High-Resolution Seismic (UHRS). The equipment likely to be used, can typically work at a range of signal frequencies depending on the distance to the seabed and the required resolution. For sonar-like sources the signal is highly directional, acts like a beam and is emitted in pulses. Sonar-based sources are considered by NMFS (2018) as intermittent (non-impulsive) because they generally comprise a single (or multiple discrete) frequency. Unlike the sonar-like survey sources, the UHRS is likely to utilise a sparker, which produces an impulsive, broadband source signal. The survey parameters, such as source sound levels used in the underwater sound modelling are presented in detail in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report.

6.3.3.4 The site investigation surveys will take place during the pre-construction period (considered part of the construction phase), involving up to two vessels on site at any one time. A maximum of up to 156 vessel movements (return trips) will take place in total across all geophysical and geotechnical site investigation surveys.

6.3.3.5 The MDS comprises routine geophysical surveys such as MBES and SBES that will also take place during the O&M phase. There will be no geotechnical surveys undertaken post-construction. Routine geophysical surveys will typically be undertaken every three years except for the inter-array cables and interconnectors where surveys will occur annually for the first five years, and every four years thereafter. Up to four survey vessels will be on site at any one time, involving 60 vessel return trips per year.

Construction and operation and maintenance phases

Injury

6.3.3.6 The underwater sound modelling of geophysical equipment applied the impulsive source thresholds when evaluating peak sound levels as per NMFS (2024) (Table 6.3). This precautionary approach was advised by Scottish Ministers, in line with the NatureScot representation during EIA Scoping (Morven Site Scoping Opinion (MD-LOT, 2023)).

6.3.3.7 Auditory injury ranges estimated across all geophysical survey equipment, based on SEL_{24h}, are presented in Table 6.29. For PW (grey seal and harbour seal) and HF cetaceans (bottlenose dolphin) the 3.5kHz CHIRP SBP had the maximum distance with potential for auditory injury, while for VHF cetaceans (harbour porpoise) the MBES had the maximum distance with potential for auditory injury. However, it should be noted that as sonar-like sources have very strong directivity, there is only potential for auditory injury when a marine mammal is directly underneath the noise source. Once the animal moves outside of the main beam, there is no potential for auditory injury.

6.3.3.8 The number of marine mammals potentially experiencing auditory injury within the modelled auditory injury ranges were estimated using species-specific density estimates (see Section 6.2.2). Given that the potential auditory injury ranges are small, no more than one animal of each species is deemed to be at risk of experiencing auditory injury across all types of geophysical surveys (Table 6.30).

Table 6.29: Maximum horizontal distances in kilometres from the geophysical sources to maximum-over-depth peak and maximum-over-depth sound exposure level impact thresholds for marine mammals from NMFS (2024) (N/E denotes Auditory Injury threshold not exceeded)

Species	Metric	Maximum horizontal distance to threshold (km)							
		Auditory threshold*	Non-impulsive					Auditory threshold	Impulsive
			MBES	SSS	SBES	SBP CHIRP 2.0kHz	SBP CHIRP 3.5kHz		Sparker
Grey seal Harbour seal	PK	223	0.014	0.004	0.005	N/E	0.006	223	N/E
	SEL	195	0.058	-	0.005	0.003	0.091	183	0.004
Harbour porpoise	PK	202	0.105	0.032	0.007	0.006	0.064	202	0.009
	SEL	181	0.181	0.036	0.007	N/E	0.114	159	N/E
Bottlenose dolphin	PK	230	0.007	0.002	0.002	N/E	0.003	230	N/E
	SEL	201	0.016	0.002	0.003	N/E	0.039	193	N/E

*As there are no PK thresholds for continuous sources, the underwater sound modelling in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report of the EIA Report applied the impulsive source thresholds as per the recommendation from NatureScot.

Table 6.30: Estimated number of animals, percentage of the population (UK and full Management Unit) with the potential to experience auditory injury, based on maximum-over-depth peak and sound exposure level, during geophysical site investigation surveys (N/A denotes not applicable)

Hearing group	Species	Density (animals/km^2)	Metric		Number of animals					
					MBES	SSS	SBES	SBP CHIRP 2.0kHz	SBP CHIRP 3.5kHZ	Sparker
PW	Grey seal	0.252	PK	Number of animals	<1	<1	<1	N/A	<1	N/A
				% of UK portion of MU	<0.001	<0.001	<0.001	N/A	<0.001	N/A

Hearing group	Species	Density (animals/km²)	Metric		Number of animals					
					MBES	SSS	SBES	SBP CHIRP 2.0kHz	SBP CHIRP 3.5kHZ	Sparker
				% of full MU	N/A	N/A	N/A	N/A	N/A	N/A
			SEL	Number of animals	<1	N/A	<1	<1	<1	<1
				% of UK portion of MU	<0.001	N/A	<0.001	<0.001	<0.001	<0.001
				% of full MU	N/A	N/A	N/A	N/A	N/A	N/A
	Harbour seal	1.20×10^{-7}	PK	Number of animals	<1	<1	<1	N/A	<1	N/A
				% of UK portion of MU	<0.001	<0.001	<0.001	N/A	<0.001	N/A
				% of full MU	N/A	N/A	N/A	N/A	N/A	N/A
			SEL	Number of animals	<1	<1	<1	<1	<1	<1
				% of UK portion of MU	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

Hearing group	Species	Density (animals/km^2)	Metric		Number of animals					
					MBES	SSS	SBES	SBP CHIRP 2.0kHz	SBP CHIRP 3.5kHZ	Sparker
				% of full MU	N/A	N/A	N/A	N/A	N/A	N/A
VHF cetaceans	Harbour porpoise	0.599	PK	Number of animals	<1	<1	<1	<1	<1	<1
				% of UK portion of MU	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
				% of full MU	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
			SEL	Number of animals	<1	<1	<1	N/A	<1	N/A
				% of UK portion of MU	<0.001	<0.001	<0.001	N/A	<0.001	N/A
				% of full MU	<0.001	<0.001	<0.001	N/A	<0.001	N/A
HF cetaceans	Bottlenose dolphin	0.005	PK	Number of animals	<1	<1	<1	N/A	<1	N/A
				% of UK portion of MU*	N/A	N/A	N/A	N/A	N/A	N/A

Hearing group	Species	Density (animals/km^2)	Metric		Number of animals					
					MBES	SSS	SBES	SBP CHIRP 2.0kHz	SBP CHIRP 3.5kHZ	Sparker
				% of full MU*	N/A	N/A	N/A	N/A	N/A	N/A
			SEL	Number of animals	<1	<1	<1	N/A	<1	N/A
				% of UK portion of MU*	N/A	N/A	N/A	N/A	N/A	N/A
				% of full MU*	N/A	N/A	N/A	N/A	N/A	N/A

*No percentage of the Coastal East Scotland MU population for bottlenose dolphin was calculated as there was no overlap of the auditory injury ranges with the MU (paragraph 6.3.3.36).

6.3.3.9 Ruppel *et al.* (2022) categorised marine acoustic sources into four tiers based on their potential to injure marine mammals using physical criteria about the sources (e.g. source level, transmission frequency, directionality, beamwidth, and pulse repetition rate). Those in Tier 4 were considered unlikely to result in 'incidental take' (i.e. loss of individuals) of marine mammals and therefore termed de minimis, and included most high-resolution geophysical sources (MBES, SSS, SBP, low-powered sparkers). For context, Tier 1 refers to high-energy airgun surveys with a total volume larger than 1,500 in or arrays with more than 12 airguns, Tier 2 covers the remaining low/intermediate energy airgun and Tier 3 covers most non-airgun seismic sources, which either have characteristics that do not meet the de minimis category (e.g. some sparkers) or could not be fully evaluated in Ruppel *et al.* (2022) (e.g., bubble guns, some boomers). The study also suggested surveys that simultaneously deploy multiple, non-impulsive de minimis sources are unlikely to result in incidental take of marine mammals. All geophysical sources used, in Morven South MBES, SSS, SBES, and both CHIRP systems, are classified as Tier 4, while the sparker may fall into either Tier 3 or Tier 4 depending on its energy output and configuration.

6.3.3.10 The site investigation surveys are considered short-term as they are intermittent. As part of the designed-in measures (Table 6.28) standard mitigation from JNCC (2017) will be adhered to for the geophysical surveys, which will involve the use of MMObs/PAM monitoring. Where operating mode of the equipment allows, soft starts will be applied for electromagnetic equipment (such as SBP and SSS), as well as seismic sources (UHRS). Since the injury is presumed to be fully mitigated via designed-in measures, there is considered to be no residual risk of injury and therefore no population-level effects on any Annex II marine mammals.

Disturbance

6.3.3.11 For intermittent sources (including impulsive and non-impulsive) the underwater sound modelling adopted the NOAA (2018) thresholds with an SPL of 160dB. The underwater sound modelling predicted that the behavioural effects as a result of site investigation surveys can occur within a range of between 0.153km (SBES) and up to 3.798km (CHIRP 3.5kHz) (Table 6.31).

Table 6.31: Maximum horizontal distances in kilometres from the geophysical sources to behavioural threshold for marine mammals from intermittent (impulsive and non-impulsive) sources from NMFS (2024)

Survey type	Potential disturbance range for all species (km)
MBES	0.682
SSS	0.229
SBES	0.153
CHIRP 2.0kHz	0.316
CHIRP 3.5kHz	3.798
Sparker	0.501

6.3.3.12 For the site investigation surveys, no more than one animal is predicted to be disturbed during MBES, SSS, SBES, CHIRP 2.0kHz and sparker. With the use of the CHIRP 3.5kHz one bottlenose dolphin, 27 harbour porpoise, 12 grey seal and up to one harbour seal are at risk of experiencing disturbance and would therefore only affect very small proportions of the relevant MUs (Table 6.32). The underwater sound model assumes the 3.5kHz CHIRP source emits sound equally in all directions due to its wide beam width, simplifying calculations but likely causing an overestimation of how far sound travels. A more accurate model would require detailed beam pattern data, but in its absence, this conservative approach ensures potential impacts are not underestimated.

6.3.3.13 However, for those animals disturbed, there is likely to be a proportional response, i.e. not all animals will be disturbed to the same extent. There is no dose response curve available to apply in the context of site investigation surveys. However, Joy *et al.* (2019) derived a dose response for killer whales and underwater sound from vessels, indicating that marine mammals display a proportional response to non-impulsive sound. It is important to note that the life history of an individual and the context (ambient noise) will also influence the likelihood of an individual to exhibit an aversive response to sound (Southall *et al.*, 2021). Considering therefore that the underwater sound modelling used a single threshold, which assumes all animals are disturbed within this area, the numbers of animals presented for site investigation surveys are likely to be an overestimate (Table 6.32).

6.3.3.14 It is widely recognised that the transmission frequencies of commercial sonar systems (approximately 12kHz to 1,800kHz) overlap with the hearing ranges of multiple marine mammal species (Richardson *et al.*, 1995). Many frequencies associated with sonar systems are very high and have peak frequencies well above marine mammal hearing ranges.

6.3.3.15 Ruppel *et al*. (2022) reported that in response to sonar-like sound sources (e.g. MBES, SBES), marine mammals may show subtle behavioural responses, although species, behavioural context, location, and prey availability are likely to play more of a role than the acoustic signals themselves. In a study undertaken by MacGillivray *et al.* (2014), seven acoustic sources (including air guns, SBP, MBES and SSS) were compared, and the sound level above hearing threshold was documented as a function of horizontal distance. Weighting sounds according to hearing sensitivity allows assessment of relative risks associated with exposure, and while this analysis did not directly relate to the potential for behavioural responses, it allowed comparison of modelled acoustic sources. The modelling undertaken in MacGillivray *et al.* (2014) suggested that odontocetes were most likely to hear sounds from mid-frequency sources (such as fisheries, communication, and hydrographic systems), while pinnipeds from both mid and low frequency sources. For all species included within the study, modelled sensation levels were lowest for the high frequency sources (e.g. SSS and MBES), which operate at the upper limits of the audible spectrum.

6.3.3.16 A recent study by Kates Varghese *et al.* (2021) on MBES surveys showed that the only marine mammal behaviour that was identified as changing was vocalisation rate, with neither changes in displacement nor foraging being observed. Similarly, Quick *et al.* (2017) reported that tagged short-finned pilot whale *Globicephala macrorhynchu*s that were exposed to a SBES did not change their foraging behaviour, but variance in directionality of movement was observed, suggesting increased vigilance while the SBES was active. It was, however, stated that the range of behaviours exhibited could not be directly attributed to SBES operation, and that changes in behaviour were unlikely to be biologically significant. A study by Cholewiak *et al.* (2017) investigated the impact of SBES on toothed whales and reported that fewer beaked whale vocalisations were recorded when the source was actively transmitting. This suggested that animals either move away from the area or reduced foraging activity (although findings were not statistically significant).

6.3.3.17 Many studies to date have focused on the effects of multi-array seismic surveys on marine mammals, and therefore there is less widely available evidence for behavioural responses to seismic sources (e.g. MBES, SSS, SBPs). Multi-array impulsive sound sources are broadband in character (i.e. produce sound across a wide range of frequencies), unlike seismic sources, which typically produce more tonal sound either at a discrete frequency or a range of discrete frequencies. However, findings from studies of multi-array impulsive sources may be useful in supporting predictions of behavioural responses of marine mammals to geophysical survey sources in general, given the overlap of parameters that typically characterise sound sources (i.e. transmission frequency; source level; pulse duration) (see MacGillivray *et al.* (2014) and Ruppel *et al.* (2022)). While evidence on the behavioural responses to MBES is limited, an Independent Scientific Review Panel deemed a 12kHz

MBES to be the most plausible trigger for an extreme behavioural response in melon-headed whale *Peponocephala electra*, which resulted in a mass group stranding in a shallow lagoon in Madagascar in 2008 (Southall *et al.*, 2013) (an area where such open-ocean species would not usually frequent). While an unequivocal cause and effect relationship between MBES and the strandings cannot be concluded, the paper states that intermittent, repeated sounds of this nature could present a salient and potential aversive stimulus and suggests potential for such behavioural responses (or indirect injury) from MBES should be considered in environmental assessments (Southall *et al.*, 2013).

Table 6.32: Estimated number of animals, percentage of the population (UK portion and full Management Unit) with the potential to be disturbed during geophysical site investigation surveys (N/A denotes not applicable)

Hearing group	Species	Density (animals/km^2)	Metric	Number of animals					
				MBES	SSS	SBES	SBP CHIRP 2.0kHz	SBP CHIRP 3.5kHZ	Sparker
PW	Grey seal	0.252	Number of animals	1	<1	<1	1	12	1
			% of UK portion of MU	0.003	<0.001	<0.001	0.003	0.033	0.003
			% of full MU	N/A	N/A	N/A	N/A	N/A	N/A
	Harbour seal	1.20×10^{-7}	Number of animals	<1	<1	<1	<1	<1	<1
			% of UK portion of MU	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
			% of full MU	N/A	N/A	N/A	N/A	N/A	N/A
VHF cetaceans	Harbour porpoise	0.599	Number of animals	1	<1	<1	<1	27	1
			% of UK portion of MU	0.001	<0.001	<0.001	<0.001	0.017	0.001
			% of full MU	0.0003	<0.001	<0.001	<0.001	0.0078	0.0003
HF cetaceans	Bottlenose dolphin	0.005	Number of animals	<1	<1	<1	<1	1	<1
			% of UK portion of MU*	N/A	N/A	N/A	N/A	N/A	N/A
			% of full MU*	N/A	N/A	N/A	N/A	N/A	N/A

*No percentage of the Coastal East Scotland MU population for bottlenose dolphin was calculated as there was no overlap of the disturbance ranges with the MU (paragraph 6.3.3.37).

6.3.3.18 Thompson *et al.* (2013) used PAM and DAS to study changes in the occurrence of harbour porpoise across a 2,000km^2 study area during a commercial two-dimensional seismic survey in the North Sea. Although site investigation surveys are considered to be lower in impact magnitude in comparison to seismic, it is useful to consider small seismic sources for context. Thompson *et al.* (2013) found that acoustic detections decreased significantly during the survey period in the impact area compared with a control area, but this effect was small in relation to natural variation. Animals were typically detected again at affected sites within a few hours, and the level of response declined through the survey period (ten days) suggesting exposure led to some tolerance of the activity (Thompson *et al.*, 2013). The authors suggested that prolonged seismic survey sound did not lead to broader-scale displacement into sub-optimal or higher risk habitat. Similarly, a ten-month study of overt responses to seismic exploration in humpback whale, sperm whale *Physeter macrocephalus* and Atlantic spotted dolphin *Stenella frontalis*, demonstrated no evidence of prolonged or large- scale displacement of each species from the region during the survey (Weir, 2008).

6.3.3.19 Behavioural response tests to two sonar systems (200kHz and 375kHz systems) have been carried out on grey seals at the SMRU seal holding facility (Hastie *et al.*, 2014). Results showed that both systems had significant effects on seal behaviour, with significantly more time spent hauled out during the 200kHz sonar operation and although animals remained swimming during operation of the 375kHz sonar, they were distributed further from the sonar.

Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation

Grey seal

6.3.3.20 An overview of potential auditory injury due to elevated underwater sound from site investigation surveys (including geophysical surveys) is described in paragraphs 6.3.3.6 to 6.3.3.10 and for potential behavioural disturbance is described in paragraphs 6.3.3.11 to 6.3.3.18.

6.3.3.21 As presented in Table 6.29, the maximum horizontal distance over which the AUD INJ threshold was exceeded for PW (i.e. grey seal) was 0.09km for the 3.5kHz CHRIP SBP, based on the SEL_{24h} metric. None of the auditory injury ranges for the geophysical equipment overlapped with either the Berwickshire and North Northumberland Coast SAC or the Isle of May SAC, and less than one seal had the potential to experience auditory injury (Table 6.30). As described in paragraph 6.3.3.10, designed-in measures adopted as part of Morven South include adhering to standard JNCC mitigation (2017) for the geophysical surveys (Table 6.28), which are assumed to fully mitigate the risk of injury.

6.3.3.22 As presented in Table 6.31, behavioural disturbance from geophysical equipment sources could occur to a maximum distance of 3.8km for the 3.5kHz CHIRP SBP, potentially disturbing 12 grey seal (0.033% of the combined East Scotland and Northeast England SMUs; Table 6.32). However, as described in paragraph 6.3.3.13, assuming a single threshold for behavioural disturbance is likely to present an overestimate in the number of animals disturbed by the geophysical surveys. The maximum disturbance range (3.8km) does not overlap with either the Berwickshire and North Northumberland Coast SAC or the Isle of May SAC, which are located 97.2km southwest and 108.6km southwest of the Morven South Boundary, respectively. Therefore, there is no adverse effect on the grey seal population the Berwickshire and North Northumberland Coast SAC or the viability of the grey seal feature of the Isle of May SAC. There will also be no significant disturbance to the grey seal feature of either SAC due to site investigation surveys.

Conclusion

6.3.3.23 Adverse effects on the grey seal qualifying feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SAC will not occur as a result of injury and disturbance from site investigation surveys during construction and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.33.

6.3.3.24 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result injury and disturbance to grey seals from site investigation surveys with respect to the construction and O&M phases of Morven South.

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

6.3.3.25 An overview of potential auditory injury due to elevated underwater sound from site investigation surveys (including geophysical surveys) is described in paragraphs 6.3.3.6 to 6.3.3.10 and for potential behavioural disturbance is described in paragraphs 6.3.3.11 to 6.3.3.18.

6.3.3.26 As presented in Table 6.29, the maximum horizontal distance over which the AUD INJ threshold was exceeded for PW (i.e. harbour seal) was 0.09km for the 3.5kHz CHRIP SBP, based on the SEL_{24h} metric. None of the auditory injury ranges for the geophysical equipment overlapped with the Firth of Tay and Eden Estuary SAC, and less than one seal had the potential to experience auditor injury (Table 6.30). As described in paragraph 6.3.3.10, designed-in measures adopted as part of Morven South include adhering to standard JNCC mitigation (2017) for the geophysical surveys (Table 6.28), which are assumed to fully mitigate the risk of injury.

6.3.3.27 As presented in Table 6.31, behavioural disturbance from geophysical equipment sources could occur to a maximum distance of 3.8km for the 3.5kHz CHIRP SBP, potentially disturbing one harbour seal (0.205% of the combined East Scotland and Northeast England SMUs5; Table 6.32). However, as described in paragraph 6.3.3.13, assuming a single threshold for behavioural disturbance is likely to present an overestimate in the number of animals disturbed by the geophysical surveys. The maximum disturbance range (3.8km) does not overlap with the Firth of Tay and Eden Estuary SAC, which is located 109.3km southwest of the Morven South Boundary. Therefore, there is no risk of injury nor significant disturbance on the harbour seal population within the SAC from site investigation surveys.

Conclusion

6.3.3.28 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from site investigation surveys during construction and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.33.

6.3.3.29 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of injury and disturbance to harbour seals from site investigation surveys with respect to the construction and O&M phases of Morven South.

Southern North Sea Special Area of Conservation

Harbour porpoise

6.3.3.30 An overview of potential auditory injury due to elevated underwater sound from site investigation surveys (including geophysical surveys) is described in paragraphs 6.3.3.6 to 6.3.3.10 and for potential behavioural disturbance is described in paragraphs 6.3.3.11 to 6.3.3.18.

6.3.3.31 As presented in Table 6.29, the maximum horizontal distance over which the AUD INJ threshold was exceeded for VHF cetaceans (i.e. harbour porpoise) was 0.2km for the MBES, based on the SEL_{24h} metric. None of the auditory injury ranges for the geophysical equipment overlapped with the Southern North Sea SAC, and less than one harbour porpoise had the potential to experience auditory injury (Table 6.30). As described in paragraph 6.3.3.10, designed-in measures adopted as part of Morven South include adhering to standard JNCC mitigation (2017) for the geophysical surveys (Table 6.28), which are assumed to fully mitigate the risk of injury.

6.3.3.32 As presented in Table 6.31, behavioural disturbance from geophysical equipment sources could occur to a maximum distance of 3.8km for the 3.5kHz CHIRP SBP, potentially disturbing 27 harbour porpoise (Table 6.32). However, as described in paragraph 6.3.3.13, assuming a single threshold for behavioural disturbance is likely to present an overestimate in the number of animals disturbed by the geophysical surveys. The maximum disturbance range (3.8km) does not overlap with Southern North Sea SAC, which is 135.1km southeast of the Morven South Boundary. Therefore, as only a very small proportion of the North Sea MU is predicted to be disturbed (0.008% of the full North Sea MU and 0.017% of the UK portion of the MU; Table 6.32), the impact will not be at a scale that would cause adverse effects on the viability of, or significant disturbance to, the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.3.3.33 Adverse effects on the harbour porpoise qualifying feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from site investigation surveys during construction and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.33.

6.3.3.34 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of injury and disturbance to harbour porpoise from site investigation surveys with respect to the construction and O&M phases of Morven South.

<u>Moray Firth Special Area of Conservation</u>

Bottlenose dolphin

6.3.3.35 An overview of potential auditory injury due to elevated underwater sound from site investigation surveys (including geophysical surveys) is described in paragraphs 6.3.3.6 to 6.3.3.10 and for potential behavioural disturbance is described in paragraphs 6.3.3.11 to 6.3.3.18.

6.3.3.36 As presented in Table 6.29, the maximum horizontal distance over which the AUD INJ threshold was exceeded for HF cetaceans (i.e. bottlenose dolphin) was 0.04km for the SBP CHIRP 3.5kHz based on the SEL_{24h} metric. None of the auditory injury ranges for the geophysical equipment overlapped with the Moray Firth SAC or with the Coastal East Scotland MU (paragraph 6.2.7.2), so it is unlikely that the up to one bottlenose dolphin with the potential to experience auditory injury will be from the SAC population (Table 6.30). As described in paragraph 6.3.3.10, designed-in measures adopted as part of Morven South include adhering to standard JNCC mitigation (2017) for the geophysical surveys (Table 6.28), which are assumed to fully mitigate the risk of injury should a dolphin from the Coastal East Scotland MU be injured.

6.3.3.37 As presented in Table 6.31, behavioural disturbance from geophysical equipment sources could occur to a maximum distance of 3.8km for the 3.5kHz CHIRP SBP, potentially disturbing one bottlenose dolphin (Table 6.32). However, as described in paragraph 6.3.3.13, assuming a single threshold for behavioural disturbance is likely to present an overestimate in the number of animals disturbed by the geophysical surveys. The maximum disturbance range (3.8km) does not overlap with Moray Firth SAC, which is 215.8km northwest of the Morven South Boundary, nor does it overlap with the Coastal East Scotland MU (paragraph 6.2.7.2). Therefore, based on the assumption that any bottlenose dolphins disturbed would not belong to the Coastal East Scotland MU population, and thus the Moray Firth SAC population, there is no impact pathway for disturbance to bottlenose dolphins within the SAC population. As such, site investigation surveys would not lead to significant disturbance to the bottlenose dolphin feature of the Moray Firth SAC and thus no adverse effect on the SAC population.

Conclusion

6.3.3.38 Adverse effects on the bottlenose dolphin qualifying feature of the Moray Firth SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from site investigation surveys during construction and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.7.5) is presented in Table 6.33.

6.3.3.39 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Moray Firth SAC as a result of injury and disturbance to bottlenose dolphin from site investigation surveys with respect to the construction and O&M phases of Morven South.

Table 6.33: Conclusions against the conservation objectives of the Special Areas of Conservation designated for marine mammals from injury and disturbance to marine mammals from site investigation surveys during the construction and operation and maintenance phase

SAC	Feature	Conservation objective	Conclusion
Berwickshire and North Northumberland Coast SAC	Grey seal	The extent and distribution of qualifying natural habitats and habitats of the qualifying species are maintained.	There is no impact pathway between site investigation surveys and the extent, distribution, structure, and function of the habitats and supporting processes of grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Supplementary advice (Natural England, 2023) refers to maintaining spatial extent and distribution of supporting habitats including haul-out sites and the assessment found that there was no overlap with the SAC and the sound contours did not reach the coastal area where key haul outs are located. Furthermore, the maximum auditory injury or disturbance range would not impede connectivity between the site and the wider environment as grey seal are able to forage widely and disturbance from surveys would only occur as short-term reversible events after which animals would return to baseline levels. Therefore, the presence, abundance, condition and diversity of habitats and species required to support grey seal will not be adversely affected and will be maintained.
		The structure and function of the habitats of the qualifying species are maintained.	
		The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely are maintained.	
		The populations of each of the qualifying species are maintained	As described in paragraphs 6.3.3.20 to 6.3.3.24, site investigation surveys are unlikely to lead to injury or significant disturbance of grey seals as there is no overlap of the maximum auditory injury or disturbance range with the SAC. Only a small proportion (0.033%) of the relevant SMUs would potentially be impacted by behavioural disturbance and therefore with respect to the supplementary advice the reproductive and recruitment capability of the species would be maintained (Natural England, 2023). Therefore, the population and distribution of grey seal within the SAC will not be adversely affected and so will be maintained.
		The distribution of qualifying species within the site are maintained.	
Isle of May SAC	Grey seal	2a. ensure grey seals are a viable component of the Isle of May SAC.	As described in paragraphs 6.3.3.20 to 6.3.3.24, site investigation surveys are unlikely to lead to injury or strong behavioural disturbance of grey seals. The range of auditory injury is out to a

SAC	Feature	Conservation objective	Conclusion
			maximum of 0.09km (SBP CHIRP 3.5kHz) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. Similarly, grey seal would not be disturbed within the site as the maximum disturbance range does not overlap the SAC from site investigation surveys, ensuring grey seals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2025a). Importantly, this means that there is no effect on reproductive capability of grey seal during the breeding season and pup production would not be expected to decline as a result of this impact, ensuring stable or increasing grey seal numbers are maintained. Therefore, grey seals will remain a viable component of the SAC.
		2b. ensure the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals.	This conservation objective refers to potential for long-term declines in the use of the site, changes in the distribution of the species on a sustained basis or changes in their behaviour such that it reduces the ability of the species to survive, breed or rear young (NatureScot, 2025a). As described in paragraphs 6.3.3.20 to 6.3.3.24, significant disturbance of grey seals during site investigation surveys will be avoided as the maximum disturbance range does not overlap the SAC. Only a small proportion (0.033%) of the relevant SMUs would potentially be impacted by behavioural disturbance, which would not lead to changes in behaviour that would reduce the ability of seals to survive, Therefore, the distribution of grey seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats relevant to grey seal are maintained.	The focus of this conservation objective is on maintaining the extent, quality, and distribution of the supporting habitats required by breeding grey seals (NatureScot, 2025a). The assessment found that there is no impact pathway between site investigation surveys and the supporting habitats relevant to grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Thus, there is unlikely to be any effect at key times of year when seals, which rely on these habitats, may be resting or foraging within or close to the SAC.

SAC	Feature	Conservation objective	Conclusion
			Therefore, the habitats required to support grey seal will not be adversely affected and will be maintained.
Firth of Tay and Eden Estuary SAC	Harbour seal	2a. ensure harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality.	As described in paragraphs 6.3.3.25 to 6.3.3.29, site investigation surveys are unlikely to lead to injury (and therefore mortality) of harbour seals as the range of effect is out to a maximum of 0.09km (SBP CHIRP 3.5kHz) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. This ensures that the recovery of harbour seal at a population level is not impeded and animals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2024). Therefore, harbour seals within the SAC will not be at significant risk of injury or mortality and will not be adversely affected.
		2b. ensure the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.3.25 to 6.3.3.29, significant disturbance of harbour seals throughout the site during site investigation surveys will be avoided. Disturbance would not be significant as maximum disturbance range from site investigation surveys would not overlap the SAC. This ensures harbour seals continue to have access to, and can utilise, all habitats suitable for haul-outs and breeding associated within the site (NatureScot, 2024). Therefore, the distribution of harbour seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to harbour seal are maintained.	The focus of this conservation objective is on maintaining habitats within the SAC to support recovery of the species due to its declining status (NatureScot, 2024). The assessment found that there is no impact pathway between site investigation surveys and the supporting habitats and processes relevant to harbour seal (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour seal will not be adversely affected and will be maintained.

SAC	Feature	Conservation objective	Conclusion
Southern North Sea SAC	Harbour porpoise	1. harbour porpoise are a viable component of the site.	As described in paragraphs 6.3.3.30 to 6.3.3.34, site investigation surveys are unlikely to lead to injury or strong behavioural disturbance of harbour porpoises. The range of auditory injury is out to a maximum of 0.2km (MBES) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. Similarly, harbour porpoise would not be disturbed within the site as the maximum disturbance range does not overlap the SAC. Only a small proportion (0.008%) of the North Sea MU would potentially be impacted by behavioural disturbance, so there is no restriction on the survivability and reproductive potential of harbour porpoise using the site (JNCC and Natural England, 2019) from site investigation surveys. Therefore, harbour porpoise will remain a viable component of the SAC.
		2. there is no significant disturbance of the species.	This conservation objective considers disturbance significant if it leads to the exclusion of harbour porpoise from a significant portion of the site (JNCC and Natural England, 2019). As described in paragraphs 6.3.3.30 to 6.3.3.34, significant disturbance of harbour porpoise during site investigation surveys will be avoided as the maximum disturbance range does not overlap the SAC. There will be no displacement of harbour porpoise from the site from site investigation surveys. Therefore, the SAC population will not be adversely affected.
		3. the condition of supporting habitats and processes, and the availability of prey is maintained.	This conservation objective (JNCC and Natural England, 2019) refers to the maintenance of supporting habitats (i.e. characteristics of the seabed and water column) and processes (i.e. movements and physical properties of the habitat) contributing to ensuring that prey is maintained within the site and is available to harbour porpoises. As the assessment found that there was no overlap with the area of significant disturbance with the SAC, there is no impact pathway between site investigation surveys and the supporting habitats and processes relevant to harbour porpoise. With respect to the availability of prey, no adverse effects were predicted on prey species

SAC	Feature	Conservation objective	Conclusion
			(see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support harbour porpoise will not be adversely affected and will be maintained.
Moray Firth SAC	Bottlenose dolphin	2a. ensure the population of bottlenose dolphin is a viable component of the site.	As described in paragraphs 6.3.3.35 to 6.3.3.39, site investigation surveys are unlikely to lead to injury of bottlenose dolphin as the range of effect is out to a maximum of 0.04km (SBP CHIRP 3.5kHz) and this will be mitigated with designed-in standard mitigation measures such that there is no residual risk. As such, there is no risk of injury or mortality to bottlenose dolphin from site investigation surveys (NatureScot, 2025c). Therefore, bottlenose dolphin will remain a viable component of the SAC.
		2b. ensure the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.3.35 to 6.3.3.39, to significant disturbance of bottlenose dolphin throughout the site during site investigation surveys will be avoided as the maximum disturbance range does not overlap the SAC nor the functionally linked Coastal East Scotland MU (NatureScot, 2025c). Bottlenose dolphin will continue to use and have access to all areas of the site and therefore, the distribution of bottlenose dolphin within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to bottlenose dolphin and their prey/food resources for bottlenose dolphins are maintained.	The focus of this conservation objective is on maintaining sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site (NatureScot, 2025c). The assessment found that there is no impact pathway between site investigation surveys and the supporting habitats and processes relevant to bottlenose dolphin (i.e. no overlap with the area of significant disturbance with the SAC nor functionally linked Coastal East Scotland MU). With respect to the availability of prey, no adverse effects were predicted on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA

SAC	Feature	Conservation objective	Conclusion
			Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats required to support bottlenose dolphin will not be adversely affected and will be maintained.

6.3.4 Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities

6.3.4.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction, O&M and decommissioning phases, LSE[2] could not be ruled out for injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities. This relates to all five SACs (Table 3.1) and relevant Annex II marine mammal features:

- Berwickshire and North Northumberland Coast SAC:
  - Grey seal.
- Isle of May SAC:
  - Grey seal.
- Firth of Tay and Eden Estuary SAC:
  - Harbour seal.
- Southern North Sea SAC:
  - Harbour porpoise.
- Moray Firth SAC:
  - Bottlenose dolphin.

6.3.4.2 The MDS and designed-in measures considered for the assessment of injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities are shown in Table 6.34 and Table 6.35, respectively.

Table 6.34: Maximum Design Scenario considered for the assessment of potential impacts to Annex II marine mammals due to injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities during the construction, operation and maintenance and decommissioning phases

Project phase	Maximum Design Scenario	Justification
Construction	• Up to a total of 41 construction vessels on site at any one time (15 main installation and support vessels, 8 tug/anchor handlers, 4 cable lay installation and support vessels, 2 guard vessels, 2 survey vessels, 3 seabed preparation vessels for boulder removal, grapnel, pre-sweep/levelling, 6 crew transfer vessels and 1 scour protection installation vessel). • Up to 3,060 installation vessel movements (return trips) during the construction phase (488 main installation and support vessels, 416 tug/anchor handlers, 162 cable lay installation and support vessels, 172 guard vessels, 156 survey vessels, 50 seabed preparation vessels for boulder removal, grapnel, pre-sweep/levelling, 1,460 crew transfer vessels, and 156 scour protection installation vessels. • **Other activities:** – Drilling, ploughing, trenching and jetting, cable burial and rock dumping. Maximum offshore construction duration of up to 5 years (includes pre-construction surveys).	The maximum number of construction vessels on site at any one time and maximum number of return trips represents the MDS for vessel use during construction. Sound modelling considered four typical scenarios to represent combined sound sources (including the use of dynamic positioning) during different activities which consider a range of vessel types and associated sound sources. The maximum number of construction vessels on site at any one time and maximum number of return trips will also result in the greatest potential impact in terms of physical presence for vessels (i.e. disturbance from vessel movements).
O&M	• Up to a total of 19 vessels on site at any one time (eight crew transfer vessels/workboats, two jack-up vessels, two cable repair vessels, four survey vessels (unmanned surface vehicles), 3 other vessels). • For foundations (WTG); up to 702 annual return trips (143 routine inspections including scour protection inspection and geophysical surveys, 96 repairs and replacements of navigational equipment, 382 removal of marine growth including guano removal, 15 replacement of corrosion protection anodes, 51 painting, five replacement of access	The maximum number of vessels on site at any one time and maximum number of return trips represents the MDS for vessel use during the O&M phase. Sound modelling considered four typical scenarios to represent combined sound sources (including the use of dynamic positioning) during different activities which consider a range of vessel types and associated sound sources. The maximum number of vessels on site at any one time and maximum number of return trips will also result in the greatest

Project phase	Maximum Design Scenario	Justification
	ladders and boat landings, and 10 modifications to/replacement of J-tubes). • For wind turbines; up to 1,165 annual return trips (382 routine inspections, 764 minor repairs and replacements within the WTG, three major component replacements, and 16 painting or other coatings). • For foundations (OSP): up to 35 annual return trips (11 removal of marine growth including guano removal, six replacement of corrosion protection anodes, six painting, six replacement of access ladders and boat landings, and six modifications to/replacement of J-tubes; scour protection inspection included in routine inspections and geophysical surveys). • For offshore substation: Up to a total of 101 annual return trips (66 routine inspections, 26 replacements of consumables and minor components, three major component replacements, and 6 painting or other coatings; guano removal included in removal of marine growth). 232 routine inspections including scour protection inspection and geophysical surveys, 116 geophysical surveys, 2 inter-array cable repairs, and one inter-array cable reburial). • 20 routine inspections including scour protection inspection and geophysical surveys, 10 geophysical surveys, two interconnector cable repairs, and one interconnector cable reburial; modifications to/replacement of J-tubes counted in 'Foundations' above).	potential impact in terms of physical presence for vessels (i.e. disturbance from vessel movements).
Decommissioning	Vessel traffic during the decommissioning phase is expected to be of similar magnitude (or lower) to that for the construction phase, and is, therefore, not discussed in its own right.	As above for construction phase.

Table 6.35: Designed-in measures considered for the assessment of potential impacts to Annex II marine mammals from injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities during the construction, operation and maintenance and decommissioning phases

Reference number	Designed-in measures	Justification	Primary or tertiary
MM-7	Development of and adherence to a Navigation Safety Plan and Vessel Management Plan (NSPVMP).	A NSPVMP will be developed to reduce the risk introduced due to the presence of project vessels. The NSPVMP will confirm the types and numbers of vessels engaged in Morven South and consider vessel coordination, including indicative transit route planning. It will include requirements relating to marine mammals such as not deliberately approaching marine mammals, avoiding abrupt changes in course or speed should marine mammals approach the vessel to bow-ride, remaining at safe speeds at all times and reducing speed when a marine mammal is in the vicinity.	Primary

Information to inform the assessment

Underwater sound from vessel use

6.3.4.3 Increased vessel movements and other non-piling sound-producing activities associated with Morven South have the potential to result in a range of effects to marine mammals such as injury, avoidance behaviour, displacement, masking of vocalisations or changes in vocalisation rate. While disturbance may result from both the presence and the sound emissions, at present it is not possible to disentangle the effect from presence versus sound, therefore this Stage 2 assessment has focused on the risk of disturbance due to the sound emissions.

6.3.4.4 Modelling was undertaken based on the MDS outlined in Table 6.34 with a detailed assessment provided in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report. Numbers have been provided for the construction phase and O&M phase only; vessels involved in decommissioning were assumed to be similar to those used in construction although the impacts will be of a smaller magnitude (i.e. fewer vessels and fewer trips) and therefore decommissioning vessels have not been modelled separately.

6.3.4.5 Numerous vessels (and activities) will occur throughout all phases of Morven South and while it is infeasible to reflect all combinations of vessels, four representative (and maximum adverse) scenarios have been modelled to provide an indication of the likely radiated sound fields for the main operations:

- foundation installation;
- wind turbine installation;
- cable laying;
- crew transfer.

6.3.4.6 The four scenarios are calculated for the high-reflectivity seabed, which is the most conservative case. Details of the modelled scenarios, vessels and activities are summarised in Table 6.36, and a full account of the modelling is presented in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report.

6.3.4.7 Impacts from non-vessel sound-producing activities (such as rock dumping, dredging) fall within the envelope modelled for the vessels (i.e. where the vessel noise dominates, only vessel noise is modelled). For trenching, the worst-case sound from the activity itself is incorporated in the source and radiated sound levels (see Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of EIA Report for details). Drilling falls within the maximum design envelope for foundation installation where piling would lead to greater impact ranges in Section 6.3.1.

Table 6.36: Summary of modelled vessel scenarios

Scenario	Phase	Vessel	Activity	Description
Foundation installation	Construction	Pile installation vessel	Dynamic positioning	Installation vessels (pile and jacket) are close to the pile location and modelled using dynamic positioning, with tugs moving at low speed (3kts) while the guard vessel 1km from site transiting at a higher speed (10kts).
		Jacket installation vessel	Dynamic positioning	
		Tugs	Barge handling	
		Guard vessel	Orbiting	

Scenario	Phase	Vessel	Activity	Description
Wind turbine installation	Construction; O& M	Wind turbine installation vessel	Dynamic positioning	Installation vessel and offshore support vessel are close to the pile location and using dynamic positioning while the guard vessel is 1km from the site transiting at a higher speed (10kts).
		Offshore support vessel	Dynamic positioning	
		Guard vessel	Orbiting	
Cable laying	Construction; O&M	Trenching vessel	Trenching	Precautionary scenario of trenching and cable laying being performed by two separate vessels; trenching vessel and cable laying vessel (with dynamic positioning) with an offshore support vessel (with dynamic positioning) and an orbiting guard vessel 1km from the site (transiting at speed of 10kts).
		Cable lay vessel	Dynamic positioning	
		Support vessel	Dynamic positioning	
		Guard vessel	Orbiting	
Crew transfer	Construction; O&M	Crew transfer vessel	Transit to/from site	Single transiting crew transfer vessel at a transit speed of 10kts.

Physical presence

6.3.4.8 Evidence suggests that nuanced characteristics of individual ship encounters besides noise and proximity, such as route predictability (steady vs. erratic paths) or speed may be relevant to the degree of disturbance (Baş *et al.*, 2015, Oakley *et al.*, 2017). Annex II marine mammals may, therefore, be accustomed to regular and predictable vessel traffic such as that found in the Morven South Shipping and Navigation Study Area (see paragraph 6.3.4.15), resulting in minimal additional disturbance.

6.3.4.9 Cetaceans can both be attracted to and disturbed by vessels. Aversive behaviours to vessel presence may include increased swimming speed, greater time travelling, less time resting or socialising, avoidance, increased group cohesion and longer dive (Marley *et al.*, 2017, Miller *et al.*, 2008, Toro *et al.*, 2021). Behaviour also depends on the animals' activity at the time, for example resting dolphins are likely to avoid vessels, foraging dolphins will ignore them, and socialising dolphins may approach vessels (Richardson *et al.*, 1995).

6.3.4.10 Anderwald *et al.* (2013) showed bottlenose dolphin were positively correlated with total number of boats and number of utility vessels, although it was unclear whether they were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time. A study by Richardson (2012) on the effect of disturbance on bottlenose dolphin community structure in Cardigan Bay, Wales, found that group size was significantly smaller in areas of high vessel traffic. A study by Veneruso *et al.* (2011) on bottlenose dolphin to vessel interactions in New Quay bay, West Wales recorded 13% negative response behaviour, 6% positive and 82% neutral responses. Thompson *et al.* (2011) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth would not have an adverse effect on the local population of bottlenose dolphin (although it did note that foraging may be disrupted by disturbance from vessels).

6.3.4.11 Disturbance may also lead to changes in vocalisation in marine mammals, as discussed for bottlenose dolphin in paragraph 6.3.4.70. Pirotta *et al.* (2015) found that transit of vessels (moving motorised boats) in the Moray Firth resulted in a reduction (by almost half) of the likelihood of recording bottlenose dolphin prey capture buzzes. Pirotta *et al.* (2015) suggested that vessel presence, not just vessel sound, resulted in disturbance. Bottlenose dolphin also show late responses to vessel movements and quick recovery times from vessel presence (Lemon *et al.*, 2006, Ribeiro *et al.*, 2005), which is potentially a strategy to reduce unnecessary energy expenditure.

Construction phase

6.3.4.12 During the construction phase, the increased levels of vessel activity will contribute to background underwater sound levels. The MDS for construction activities (Table 6.34) assumes a total of up to 41 vessels to be present within the Morven South boundary at any one time. This is likely to be an absolute maximum as there will be up to 3,060 return trips across the five year offshore construction period (average of 612 return trips per year = 12 trips per week). Vessel types include main installation and support vessels, tug/anchor handlers, cable lay installation & support vessels, guard vessels, survey vessels, seabed preparation vessels for boulder removal, grapnel, pre-sweep/levelling, crew transfer vessels, scour protection installation vessels and cable protection installation vessels.

6.3.4.13 A proportion of construction vessels will be relatively small in size (e.g. tugs, support vessels, crew transfer vessels, dive boats, barges) with good manoeuvrability and would be able to avoid marine mammals where detected (Schoeman *et al.*, 2020). Larger vessels such as cargo-barges and installation vessels with lower manoeuvrability may need larger distances to avoid an animal. However, they would also be expected to travel at slower speeds, providing more time to react if a marine mammal is detected.

6.3.4.14 The detailed vessel baseline environment is detailed in Volume 2 Chapter 13: Shipping and Navigation, and Volume 3, Annex 13.1: Shipping and Navigation Shared Navigational Risk Assessment, of the EIA Report. Two 14-day vessel traffic surveys (comprising Automatic Identification System (AIS), radar and visual observation surveys) were undertaken in Summer 2024 and Winter 2024. Table 6.37 summarises the vessel baseline for these survey periods (Volume 3, Annex 13.1: Shipping and Navigation Shared Navigational Risk Assessment, of the EIA Report). A maximum of 13 to 19 unique vessels per day were recorded within the Morven South Shipping and Navigation Study Area across winter and summer survey seasons, respectively. Of these, a maximum of five (winter) to seven (summer) unique vessels per day entered the Morven South boundary. Survey data shows a seasonal trend with increased vessels during summer months (with increase of recreational and passenger vessels) and decreases in the winter months.

6.3.4.15 While there will be an uplift in vessel activity during phases of Morven South, the movements will be limited to within the Morven South Boundary and are likely to follow existing shipping routes to and from the ports. For example, Volume 2 Chapter 13: Shipping and Navigation, of the EIA Report, identified 16 main commercial routes within the Morven South Shipping and Navigation Study Area. Areas of higher density were observed in the northwest of the Regional Shipping and Navigation study area during summer and winter surveys.

Table 6.37: Summary of vessel baseline within the Morven South Shipping and Navigation Study Area

Study area	Parameter	Survey period	
		Summer 2024	Winter 2024
Morven South Shipping and Navigation Study Area	Maximum daily unique vessels	19	13
	Minimum daily unique vessels	4	3
	Mean daily unique vessels	11	6 to 7

Study area	Parameter	Survey period	
		Summer 2024	Winter 2024
Morven South Boundary	Maximum daily unique vessels	7	5
	Minimum daily unique vessels	1	0
	Mean daily unique vessels	3	1 to 2
	% within Morven South boundary	25	27

Injury

6.3.4.16 Injury thresholds are based upon hearing group-specific frequency weightings (NMFS, 2024;

6.3.4.17 Table 6.3) and a conservative assumption has been made that all individuals will respond aversively to increases in vessel noise (i.e. that there is no intra or interspecific variation or context-dependent differences such as ambient sound level). Sound exposure (SEL_{24h}) has been estimated for each modelled vessel scenario based on 24 hours continuous operation. Modelling considers animals swimming at the depth providing the highest sound levels and does not consider surfacing for breathing.

6.3.4.18 As discussed in paragraph 6.3.4.5, four indicative scenarios were modelled to represent common scenarios for vessel clustering and the results of underwater sound modelling for each modelled vessel scenario, the distances to hearing group-specific frequency-weighted AUD INJ thresholds, and the number of animals potentially injured are summarised in Table 6.38.

6.3.4.19 The injury threshold was not exceeded for any species for any of the vessel assemblages modelled for Morven South Table 6.38).

6.3.4.20 This RIAA Part 2 has adopted a highly precautionary approach assuming that all individual marine mammals will be affected in the same way to vessel sound (i.e. that there is no intra or inter-specific variation or context-dependent differences). The distance over which effects may occur will, however, vary according to the species, the ambient sound levels, hearing ability, vertical space use and behavioural response differences. Vessels and construction sound will be temporary and transitory, as opposed to permanent and fixed.

6.3.4.21 Designed-in measures adopted as part of Morven South include the development of, and adherence to, a Navigation Safety Plan and Vessel Management Plan (NSPVMP) (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35). These will include requirements to not deliberately approach marine mammals as a minimum, avoid abrupt changes in course or speed should marine mammals approach the vessel to bow-ride and to remain at safe speeds at all times and reduce speed when a marine mammal is in the vicinity.

6.3.4.22 While the construction phase (including pre-construction surveys) occurs over the medium term (up to 5 years), the likelihood of auditory injury is extremely low (paragraph 6.3.4.19). Furthermore, it is likely that disturbance from underwater noise associated with vessels will deter animals from the injury zone and so will be of highly localised spatial extent and intermittent. Although the impact itself is reversible (i.e. the elevation in underwater sound only occurs during the activities), the effect of exceeding the AUD INJ threshold is permanent. However, given the ranges for all scenarios lead to no auditory injury and those ranges that were exceeded led to zero animals being potentially injured, and the adoption of the NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35), there are no AEOI of SACs (discussed further in the SAC sections below).

Table 6.38: Maximum distances (km) to impact thresholds for auditory injury from the vessel assemblage modelled for construction activities, based on SEL_{24h} with hearing group-specific frequency weighting applied (N/E denotes Auditory Injury threshold not exceeded)

Hearing group	Species	Threshold (dB re 1 µPa²s)	Foundation installation		Wind turbine installation		Cable laying		Crew transfer	
			Distance to threshold (km)	Number of animals affected	Distance to threshold (km)	Number of animals affected	Distance to threshold (km)	Number of animals affected	Distance to threshold (km)	Number of animals affected
PW	Grey seal Harbour seal	195	N/E	0	N/E	0	N/E	0	N/E	0
VHF	Harbour porpoise	181	N/E	0	N/E	0	N/E	0	N/E	0
HF	Bottlenose dolphin	201	N/E	0	N/E	0	N/E	0	N/E	0

Disturbance

6.3.4.23 As discussed in paragraph 6.3.4.12, the MDS for construction activities assumes a maximum of 41 vessels to be present within the Morven South boundary at any one time, and an average of 612 return trips per year (corresponding to a maximum total of 3,060 return trips across offshore construction period) (Table 6.34).

6.3.4.24 The results of underwater sound modelling for each modelled vessel scenario (see paragraph 6.3.4.5) and the distances to the behavioural disturbance threshold (120db re 1µPa) are summarised in Table 6.39.

Table 6.39: Distance to the behavioural disturbance threshold (120db re 1µPa) for each modelled vessel assemblage (based upon $R_{95\%}$), and corresponding area of disturbance

Disturbance	Foundation installation	Wind turbine installation	Cable laying	Crew transfer
Distance (km)	45.3	36.2	29.5	0.60

6.3.4.25 Disturbance from vessel sound is likely to occur only where vessel sound associated with the construction of Morven South exceeds the background ambient sound level. Therefore, consideration of the background underwater sound level is valuable when assessing effects from elevated underwater sound due to vessel use.

6.3.4.26 A detailed comparison of background sound levels in the North Sea is given in Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report, and highlights the North Sea is one of the most intensively used marine areas in the world, and its underwater soundscape reflects this. Farcas *et al.* (2020) produced early large-scale, validated maps of shipping noise in the Northeast Atlantic, including the North Sea, and demonstrated that areas such as the English Channel, Norwegian Trench, and regions near major ports and offshore infrastructure consistently exhibit median SPLs exceeding 120dB re 1µPa, with ship noise often surpassing natural wind-generated sound by more than 20dB. Farcas *et al.* (2020) also highlighted seasonal variability, with ship noise excess peaking in summer months due to increased vessel activity and reduced wind noise. Further studies demonstrated that broadband SPLs in the North Sea typically range from 100 to 130dB re 1µPa, with the highest levels observed in areas like the English Channel, southern North Sea, and major shipping lanes (de Jong *et al.*, 2022, Sertlek *et al.*, 2024). More recently, Farcas *et al.* (2025) completed the ship noise assessment for the UK Marine Strategy (Descriptor 11) and produced annual median broadband (63 Hz - 4 kHz) sound level data for UK waters for the years 2018 to 2022. Farcas *et al.* (2025) highlighted over half of the UK Greater North Sea region exceeded 110dB in all years from 2018 to 2022, with almost 20% exceeding 120dB, evidencing marine mammals show some tolerance to moderate ambient sound levels.

6.3.4.27 Frankish *et al.* (2023) highlighted tracked harbour porpoises around Denmark spent over half their time within 10km of a vessel and spent a third of their time experiencing vessel noise above ambient noise, and regularly reacted by moving away during the daytime or diving deeper during the night. Therefore, it is important to bear in mind when viewing these potential disturbance radii that the 120dB re 1µPa SPL_{rms} criterion is very precautionary and does not consider background sound levels, and that ambient sound levels in the area could well exceed this value (particularly in summer).

6.3.4.28 For impulsive sound sources there is an understanding of the difference between strong and mild disturbance, whereas for non-impulsive (continuous) sound sources such as from vessels, there is only a single available unweighted threshold (120dB re 1µPa (rms), the Level B harassment threshold) (NMFS, 2005) which is proposed as the basis for the onset of a behavioural reaction in all marine mammal species. There is no differentiation between mild and strong disturbance for continuous underwater sound (just one single fixed threshold for Level B harassment) and this assumes 100% of animals above this threshold are disturbed (single step-function criterion used in the NMFS thresholds assume a "all-or-none" threshold). JNCC *et al.* (2010) state that "it is most unlikely that a passing vessel would cause more than trivial disturbance. It is the repeated or chronic exposure to vessel noise that could cause disturbance".

6.3.4.29 In reality, as with piling noise, there is likely to be a proportional response for animals disturbed (i.e. not all animals will be disturbed to the same extent). At present there is no agreed dose response curve available to apply in the context of non-impulsive sound sources for marine mammal species in the North Sea and few dose response relationships have been established for addressing impacts of vessel noise on cetaceans (Frankish *et al.*, 2023). However, there is substantial empirical evidence of a proportional response to vessel sound in marine mammals in scientific literature.

6.3.4.30 Williams *et al.* (2014) measured swim speed, dive time, and surfacing behaviours of northern resident killer whales (a HF cetacean) when tugs, cargo vessels and cruise ships transited past the whales. Behavioural responses of killer whales to ship transits were modelled (as a dose response function of estimated received noise levels in both broadband and audiogram-weighted terms). The authors concluded 'subtle' or 'minor' responses (i.e. those ≤ 2 on the Southall *et al.* (2007) severity scale e.g. minor change in respiration) occurred around broadband received levels of 130dB re 1µPa (rms). More 'severe' or 'moderate' responses (those ≤ 3 on the Southall *et al.* (2007) severity scale, (i.e. minor change in locomotion speed, direction, and/or deviation, moderate change in respiration) were hypothesised to occur at received levels beyond 150dB re 1µPa (but authors caveated data was lacking at these received levels).

6.3.4.31 More recently, Joy *et al.* (2019) developed two dose response functions for southern resident killer whales relating to 'low' and 'moderate' disturbance scored based on the Southall *et al.* (2007) severity scale, using data from three empirical studies, which included Williams *et al.* (2014). Measured dive depths, whale movement, and respiration rates using digital acoustic recording tags alongside global position system field measurements were utilised (Wright *et al.*, 2017) alongside data from passive acoustic monitoring at Lime Kiln listening station with scored amplitude changes of killer whale calls in response to passing commercial ship traffic. Joy *et al.* (2019) set the threshold for low response (corresponding to Southall *et al.* (2007) severity scale of 2-3) at received levels of 129.5dB re 1µPa and for moderate response (corresponding to Southall *et al.* (2007) severity scale of 4-6) at 137.2dB re 1µPa. This dose response was used in the noise exposure model to conclude how behavioural response to received levels translates into 'potential lost foraging time'. Notably, low severity responses were assumed to last 5 minutes while moderate severity responses were assumed to last 25 minutes (therefore although moderate severity responses had a lower chance of occurring, their net effect on 'potential lost foraging time' is greater than low severity responses). Joy *et al.* (2019) concluded slower ships reduced underwater sound, despite longer transit times, benefiting whale habitat near shipping lanes.

6.3.4.32 Benhemma-Le Gall *et al.* (2021) suggested increased vessel activity (and other construction activities) led to a decrease in porpoise acoustic detections and activity at distances of up to 4km, when comparing occurrence and foraging activity between two offshore windfarms in the Moray Firth. Harbour porpoise responses were measured using arrays of echolocation click detectors (C-PODs) which were deployed in 25km by 25km impact and reference blocks throughout the construction period (2017 to 2019). Calibrated noise recorders were deployed at three locations to characterise variation in underwater sound levels. The magnitude of harbour porpoise responses was then quantified in relation to changes in the acoustic environment and vessel activity. Harbour porpoise responses decreased as the mean vessel distance increased (−24% at 3km) until no apparent response was observed at 4km (+ 7.2%) (and could be interpreted as a form of dose response).

6.3.4.33 Volume 3, Annex 10.2: Underwater Sound Shared Technical Report, of the EIA Report presents the maximum distance to the identified threshold level from the closest sound source for each vessel scenario (see paragraph 6.3.4.5), and is summarised in Volume 2, Chapter 10: Marine Mammals, of the EIA Report. Following the thresholds derived by Joy *et al.* (2019) and Williams *et al.* (2014), at 130dB re 1µPa SPL_{rms} (subtle/low behavioural responses) impact distances are smaller (ranging from 13.0km to 0.13km) and more localised compared to distances out to 120dB re 1µPa SPL_{rms} (

6.3.4.34 Table 6.40). Similarly, at 150dB re 1µPa SPL_{rms} (severe behavioural responses (Williams *et al.*, 2014)) the distances range from 0.90km to <0.01km, and more conservatively at 140dB re 1µPa SPL_{rms} (moderate behavioural response (Joy *et al.*, 2019)) the distances range from 3.99km to 0.03km, therefore indicating a highly localised impact area for stronger disturbance responses (

6.3.4.35 Table 6.40). This suggests that higher sound levels affect marine mammals only very close to the source causing moderate disturbance in a smaller, localised area. Lower noise levels (out to 120dB re 1µPa SPL_{rms}) impact a much larger area, but the disturbance is less intense and therefore careful interpretation of impact ranges out to this distance (45.3km) is required.

Table 6.40 Maximum horizontal distances in kilometres to maximum-over-depth sound pressure level (SPL dB re 1µPa) (based on R_{95}) for behavioural responses based on responses recorded at different sound pressure level values

SPL (dB re 1µPa)	Maximum horizontal distance to threshold level (km)			
	1) Foundation installation	2) Wind turbine installation	3) Cable Laying	4) Crew transfer
120	45.3	36.2	29.5	0.60
130	13.0	10.7	8.67	0.13
140	3.99	3.18	2.53	0.03
150	0.90	0.72	0.57	<0.01

6.3.4.36 In addition to evidence for proportional (dose) responses of marine mammals to vessels, empirical data has been gathered from field studies on wild harbour porpoise to determine realistic impact ranges. Wisniewska *et al.* (2018) used animal-borne acoustic tags on seven harbour porpoise in coastal waters with high levels of vessel traffic and suggested a maximum reaction distance of 7km (based on a single vessel pass, for a single animal) for harbour porpoise. AIS data and the rapid increase and decrease in sound levels suggested this reaction in one harbour porpoise was in response to a fast ferry moving between the island of Zealand and the Jutland Peninsula, with a recorded speed of 33 knots (much higher than the modelled speeded for typical vessels used in construction on Morven South) and closest approach to the harbour porpoise of 140m. Graham *et al.* (2017) used echolocation detectors and noise recorders to assess harbour porpoise responses during construction of a North Sea wind farm over a 10-month period. While the focus of the study was on response to piling, AIS detections within 1km/500m of each C-POD allowed a control for disturbance by vessel activity. The study indicated higher vessel activity within 1km was significantly associated with an increased probability of response in harbour porpoise. Frankish *et al.* (2023) demonstrated harbour porpoise responded to broadband received sound pressure levels (Lp, vhf) and proximity to ships. Highest deterrence probabilities occurred at short distances from ships (<300m), but porpoises were still predicted to respond 5–9% of the time to ships >2km away depending on received values of Lp,vhf. Porpoises were mostly deterred by ships in shallow waters (15m to 30m depth), while changes in dive behaviour was predominately found in deeper waters (50m to100m depth).

6.3.4.37 Therefore, to give quantitative indication of impact, a range of distances from empirical studies (1km to 7km) have been used as an effective impact range (and conservatively assumes all animals within this radius are disturbed, rather than a dose response) and the numbers of animals predicted to be disturbed is presented in Table 6.41, applying densities in Section 6.2.2. It is important to highlight that multiplying these animals by the numbers of vessels would lead to unrealistic estimates as it does not allow for any overlap between vessels (and therefore would double count), nor does it account for periods when vessels are stationary.

Table 6.41: Potential number of animals predicted to be disturbed per vessel for a range between 1km (minimum) and 7km (maximum) with percentage of the UK portion of the Management Unit disturbed (N/A denotes Not Applicable as to estimate percentage of the Coastal East Scotland Management Unit would be over precautionary)

Species	1km		4km		7km	
	Number of animals	% of MU (UK portion)	Number of animals	% of MU (UK portion)	Number of animals	% of MU (UK portion)
Grey seal	<1	0.003	13	0.035	39	0.106
Harbour seal	<1	0.205	<1	0.205	<1	0.205
Harbour porpoise	2	0.001 (0.001)	31	0.009 (0.019)	93	0.027 (0.058)
Bottlenose dolphin	<1	N/A	<1	N/A	<1	N/A

6.3.4.38 Temporally, disturbance would be expected to occur intermittently as a vessel passes and there is evidence to suggested that duration of disturbance is very short-lived with animals recovering quickly after the event (paragraph 6.3.4.31). The elevation in underwater sound only occurs during activities and so is reversible, as is the effect of behavioural disturbance as Annex II marine mammals are expected to recover within hours/days.

6.3.4.39 Disturbance levels for Annex II marine mammal will be dependent on individual hearing ranges, background noise levels and the marine mammal activity at the time of disturbance (IWC, 2006, Senior *et al.*, 2008) with the level of response dependent on upon vessel type and behaviour (e.g., heading, speed) (Hermannsen *et al.*, 2019, Oakley *et al.*, 2017). It is difficult to quantifiably assess the direct responses of animals to vessel noise, as effects are only measurable when there are step changes in the noise level above the gradually increasing baseline levels (Tournadre, 2014), such as those directly owing to changes in vessel speed or routing. Wisniewska *et al.* (2018) highlighted a lack of baseline 'sound-free' periods with which to compare and suggested that demonstrating behavioural responses to noise under natural conditions convincingly is notoriously difficult, particularly because the history of an animal's exposure to vessel noise is rarely known. Evidence suggests that characteristics of individual ship encounters besides noise and proximity, such as route predictability (steady vs. erratic paths) or speed may be relevant to the degree of disturbance (Baş *et al.*, 2015, Oakley *et al.*, 2017). Annex II marine mammals may, therefore, be accustomed to regular and predictable vessel traffic such as that found in the Morven South Shipping and Navigation Study Area (see paragraph 6.3.4.15), resulting in minimal additional disturbance.

6.3.4.40 Reactions of marine mammals to vessel sound are often linked to changes in the engine and propeller speed with faster or erratic movements triggering avoidance (Richardson *et al.*, 1995). Dolphins and porpoises are more sensitive to high frequency sound from small, fast moving vessels. Disturbance may lead to changes in vocalisation in marine mammals, as discussed for bottlenose dolphin in paragraph 6.3.4.70. Reactions of pinnipeds to approaching vessels includes increased alertness (Henry and Hammill, 2001), head raising (Niemi, 2013) and flushing off haul-out sites into the sea (Andersen *et al.*, 2012, Blundell and Pendleton, 2015, Jansen *et al.*, 2015, Johnson and Acevedo-Gutiérrez, 2007) (noting studies focused on the presence of the vessel rather than vessel sound).

6.3.4.41 It is suggested that if marine mammals depend on specific areas to maintain their activities, and the benefits exceed the cost of disturbance, animals may show increased tolerance instead of site avoidance (Antichi *et al.*, 2022). Marine mammals therefore could continue to regularly visit the areas where they may be affected by the vessel presence (Antichi *et al.*, 2022, Rako Gospić and Picciulin, 2016). Given the existing levels of vessel activity in the Morven South Shipping and Navigation Study Area, it is expected that marine mammals would tolerate the effects of any disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

6.3.4.42 Joy *et al.* (2019) demonstrated slower vessels have smaller footprints (despite longer passage times) and lower risk of eliciting behavioural responses in southern resident killer whales. Speed reductions resulted in significant reductions in broadband noise exposure from all commercial vessel types (as well as noise reductions across most frequency bands) and therefore important reductions to noise exposure risk. Most vessels involved in the construction phase are likely to be travelling considerably slower than 11 knots (see modelled scenarios in Table 6.36). All vessels will be travelling at safe speeds at all times and reduce speed if appropriate when a marine mammal is in the vicinity, as detailed in the NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35). While it cannot be assumed that tolerance to a stressor is evidence of absence of detrimental consequences for targeted animals (e.g. physiological responses are not easily detectable in free-ranging wild animals), there is evidence of animals (from multiple species) remaining in areas of high vessel traffic.

6.3.4.43 The presence of vessels in foraging grounds could result in reduced foraging success. A vessel slowdown trial in critical habitat of at-risk southern resident killer whales showed a 22% reduction in 'potential lost foraging time' for killer whales with slower vessels (with 40% reduction when 100% of vessels were under the 11 knot speed limit) (Joy *et al.*, 2019) (see paragraph 6.3.4.31). Foraging context is important when interpreting avoidance behaviour, for examples in grey seals avoidance rates were dependent on the perceived risk (e.g. silence, pile driving sound, operational sound from tidal turbines) versus the quality of the prey patch (Hastie *et al.*, 2021).

6.3.4.44 There is indication of tolerance to vessel traffic in the scientific literature (and anthropogenic sounds and activities in general) and so a slight increase from the existing levels of traffic in the vicinity of Morven South may not necessarily result in high levels of disturbance (Vella *et al.*, 2001). There is also substantial evidence from scientific peer-reviewed literature indicating that marine mammals can return quickly to the area. Therefore, if the benefits of staying in an area exceed the cost of disturbance, animals may tolerate disturbance rather than avoid it. It is suggested that if marine mammals depend on specific areas to maintain their activities, and the benefits exceed the cost of disturbance, animals may show increased tolerance instead of site avoidance (Antichi *et al.*, 2022). Marine mammals therefore could continue to regularly visit the areas where they may be affected by the vessel presence (Antichi *et al.*, 2022, Rako Gospić and Picciulin, 2016). Given the existing vessel activity in the Morven South area, it is expected that marine mammals would tolerate the effects of any disturbance without any long-term impacts on reproduction or survival and would return to previous activities once the impact had ceased. Thus there will be no AEOI of the SACs (discussed further in the SAC sections in paragraphs 6.3.4.45 to 6.3.4.79).

Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation

Grey seal

6.3.4.45 An overview of potential auditory injury due to elevated underwater sound from vessel use and other (non-piling) sound-producing activities is described in paragraphs 6.3.4.16 to 6.3.4.22 and for potential behavioural disturbance is described in paragraphs 6.3.4.23 to 6.3.4.44.

6.3.4.46 In terms of disturbance responses specific to grey seal, Mikkelsen *et al.* (2019) found when studying responses of seals to ship sound, a tagged grey seal changed its diving behaviour, switching rapidly from a dive ascent to descent. Pérez Tadeo *et al.* (2021) found that ecotourism vessels approaching within 500 m of White Strand Beach in southwest Ireland showed strong influence on the proportion of grey seal entering the water and increase in vigilance and decrease in resting behaviour. High co-occurrence between grey seal and shipping traffic within 50km of the coastline near to haul-out sites were shown in a national scale assessment of seals and shipping in the UK (Jones *et al.*, 2017).

6.3.4.47 Hastie *et al.* (2021) demonstrated how foraging context is important when interpreting avoidance behaviour in grey seals, and should be considered when predicting the effects of anthropogenic activities. Avoidance rates appeared to depend on the perceived risk (e.g. silence, pile driving sound, operational sound from tidal turbines) versus the quality of the prey patch (Hastie *et al.*, 2021). Thus, sound exposure in different prey patch qualities may result in markedly different avoidance behaviour.

6.3.4.48 As presented in paragraph 6.3.4.19 and Table 6.38, the AUD INJ threshold was not exceeded for grey seal for any of the scenarios of vessel assemblages modelled for Morven South.

6.3.4.49 As presented in Table 6.39, behavioural disturbance for the modelled vessel assemblages could occur to a maximum distance of 45.3km for foundation installation. The crew transfer scenario could disturb the smallest range: 0.6km. More realistically (in consideration of background noise levels in the North Sea and based on empirical evidence of measured aversive responses) the maximum range of effect is likely to be 7km. Grey seals are likely to show some tolerance to moderate ambient sound levels (paragraph 6.3.4.26) and behavioural disturbance is of high recoverability. Table 6.41 indicates that up to 39 animals are predicted to be disturbed out to 7km, which is equivalent to 0.106% of the combined East Scotland and Northeast England SMUs population.

6.3.4.50 The potential for auditory injury or behavioural disturbance within the Berwickshire and North Northumberland Coast SAC and Isle of May SAC from vessel use and other (non-piling) sound-producing activities is limited. The maximum disturbance range for grey seal (45.3km) does not overlap with the Berwickshire and North Northumberland Coast SAC, which is located 97.2km southwest of the Morven South Boundary or the Isle of May SAC is located 108.6km southwest. Designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury. Therefore, there will be no adverse effects on the grey seal population of the Berwickshire and North Northumberland Coast SAC or the Isle of May SAC nor significant disturbance to the grey seal feature of either SAC.

Conclusion

6.3.4.51 Adverse effects on the grey seal qualifying Annex II marine mammal feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SACs will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.42.

6.3.4.52 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result of injury and disturbance to grey seals from vessel use and other (non-piling) sound-producing activities with respect to the construction phase of Morven South.

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

6.3.4.53 An overview of potential auditory injury due to elevated underwater sound from vessel use and other (non-piling) sound-producing activities is described in paragraphs 6.3.4.16 to 6.3.4.22 and for potential behavioural disturbance is described in paragraphs 6.3.4.23 to 6.3.4.44.

6.3.4.54 In terms of disturbance responses specific to harbour seal, this species showed avoidance behaviour or alert reactions when vessels approach within 100m of a haul-out (Paterson *et al.*, 2015). Such disturbance to seal haul-outs could have adverse consequences during the pupping season, due to trade-offs between feeding and nursing. Harbour seal have been shown to be alerted and move away when a boat approaches (Andersen *et al.*, 2012, Blundell and Pendleton, 2015) but this response varies by season. During the breeding season, they showed weaker and shorter lasting responses appearing more reluctant to flee and return to the haul-out site after being disturbed (Andersen *et al.*, 2012) (likely due to a trade-off with nursing). In a study of harbour seal in Alaska, haul-out probability was adversely affected by vessels, with cruise ships having the strongest effect (Blundell and Pendleton, 2015). High co-occurrence between harbour seal and shipping traffic within 50km of the coastline near to haul-out sites were shown in a national scale assessment of seals and shipping in the UK (Jones *et al.*, 2017).

6.3.4.55 As presented in paragraph 6.3.4.19 and Table 6.38, the AUD INJ threshold was not exceeded for harbour seal for any of the scenarios of vessel assemblages modelled for Morven South.

6.3.4.56 As presented in Table 6.39, behavioural disturbance for the modelled vessel assemblages could occur to a maximum distance of 45.3km for foundation installation. The crew transfer scenario could disturb the smallest range: 0.6km. More realistically (in consideration of background noise levels in the North Sea and based on empirical evidence of measured aversive responses) the maximum range of effect is likely to be 7km. Harbour seals are likely to show some tolerance to moderate ambient sound levels (paragraph 6.3.4.26) and behavioural disturbance is of high recoverability. Table 6.41 indicates that only up to one animal is predicted to be disturbed out to 7km, which is equivalent to 0.205% of the combined East Scotland and Northeast England SMUs[5] population.

6.3.4.57 The potential for auditory injury or behavioural disturbance within the Firth of Tay and Eden Estuary SAC from vessel use and other (non-piling) sound-producing activities is limited. The maximum disturbance range for harbour seal (45.3km) does not overlap with the Firth of Tay and Eden Estuary SAC, which is located 109.3km southwest of the Morven South Boundary, while designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury. Therefore, there is no risk of injury nor significant disturbance on the harbour seal feature of the Firth of Tay and Eden Estuary SAC.

Conclusion

6.3.4.58 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.42.

6.3.4.59 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of injury and disturbance from disturbance to harbour seals from vessel use and other (non-piling) sound-producing activities with respect to the construction phase of Morven South.

Southern North Sea Special Area of Conservation

Harbour porpoise

6.3.4.60 An overview of potential auditory injury due to elevated underwater sound from vessel use and other (non-piling) sound-producing activities is described in paragraphs 6.3.4.16 to 6.3.4.22 and for potential behavioural disturbance is described in paragraphs 6.3.4.23 to 6.3.4.44.

6.3.4.61 In terms of disturbance responses specific to harbour porpoise, as a VHF cetacean it is particularly sensitive to high frequency sound and likely to avoid vessels at close ranges (Benhemma-Le Gall *et al.*, 2021, Heinänen and Skov, 2015). Wisniewska *et al.* (2018) studied the temporary change in foraging rates of harbour porpoise in response to vessel sound in coastal waters with high traffic rates and showed that occasional high sound levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation.

6.3.4.62 Hao *et al.* (2024) found harbour porpoise responses were linked to the speed of the approaching boat (and therefore the rate of change in sound level), rather than to sound intensity (as the received sound level did not vary with boat speed). Harbour porpoise were more likely to move further away from the boat path when approached at slower speeds (10 knots) than at faster speeds (20 knots), but swam faster when approached at faster speeds (20 knots) and slowed down again once the boat has passed.

6.3.4.63 There is substantial evidence from scientific peer-reviewed literature indicating that marine mammals either remain in areas of high -vessel traffic or return quickly to the area. For example, Wisniewska *et al.* (2018) found tagged porpoises did not appear to avoid highly trafficked areas, potentially because these overlapped with important foraging habitats (deep waters which may aggregate important prey items). Harbour porpoise dove away from the surface but resumed foraging eight minutes later Similarly, (Frankish *et al.*, 2023) found that tagged harbour porpoises dove deep in response to ships (monitoring by AIS) particularly at short distances from ships (2km). Oakley *et al.* (2017) studied reactions of harbour porpoise to vessel traffic in the coastal waters of South West Wales, UK, observing 2,153 vessels (large commercial cargo ships, kayaks, recreational/commercial fishing vessels, rib, jet-ski, speedboat, cruiser and yachts) from seven land-based sites noting interactions with harbour porpoise. The study found 74% of interactions were neutral, with harbour porpoise showing no change in directional movement prior to, and after the arrival of the vessel. The mean distance for a neutral reaction to a vessel approach was approximately 250m (ranging between 10m to 1km). At Port Talbot docks, there were five cases of continuing presence of harbour porpoise near large cargo ships, often alongside the ship or within 800m of it, indicating habituation to the stationary ships, vessel traffic at the site and associated sound. Oakley *et al.* (2017) recorded 10 instances (26%) of negative behaviour in harbour porpoises, with the mean distance from a vessel for a negative reaction circa 25m.

6.3.4.64 Potlock *et al.* (2023) used C-POD detections of sonar activity as a proxy for vessel disturbance during wind turbine construction off Blyth, Northumberland. Sonar activity significantly reduced harbour porpoise presence, by 50% for eight minutes sonar per hour. Despite this, the increase in harbour porpoise occurrence across this study suggests that construction and after construction vessel activity did not result in any overall decline in area usage (Potlock *et al.*, 2023). Owen *et al.* (2024) studied the long-term presence of harbour porpoises during the rerouting of the major shipping lane through the Kattegat into the Baltic Sea and found no significant changes in monthly presence or foraging behaviour; nor was there any increase in presence in areas where the vessel traffic/sound levels had decreased. The study suggested harbour porpoise have preferred habitat that they continued to use, even when faced with sudden changes in vessel traffic and noise levels.

6.3.4.65 As presented in paragraph 6.3.4.19 and Table 6.38, the AUD INJ threshold was not exceeded for harbour porpoise for any of the scenarios of vessel assemblages modelled for Morven South.

6.3.4.66 As presented in Table 6.39, behavioural disturbance for the modelled vessel assemblages could occur to a maximum distance of 45.3km for foundation installation. The crew transfer scenario could disturb the smallest range: 0.6km. More realistically (in consideration of background noise levels in the North Sea and based on empirical evidence of measured aversive responses) the maximum range of effect is likely to be 7km. Harbour porpoise are likely to show some tolerance to moderate ambient sound levels (paragraph 6.3.4.26) and behavioural disturbance is of high recoverability. Table 6.41 indicates that up to 93 animals are predicted to be disturbed out to 7km, which is equivalent to 0.027% of the full North Sea Mu and 0.058% of the UK portion of the MU population.

6.3.4.67 The potential for auditory injury or behavioural disturbance within the Southern North Sea SAC from vessel use and other (non-piling) sound-producing activities is limited. The maximum disturbance range for harbour porpoise (45.3km) does not overlap with the Southern North Sea SAC, which is located 135.1km southeast of the Morven South Boundary, while designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury. Therefore, there will be no adverse effects on the viability of, or significant disturbance to, the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.3.4.68 Adverse effects on the harbour porpoise qualifying Annex II marine mammal feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.42.

6.3.4.69 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of injury and disturbance to harbour porpoise from vessel use and other (non-piling) sound-producing activities with respect to the construction phase of Morven South.

<u>Moray Firth Special Area of Conservation</u>

Bottlenose dolphin

6.3.4.70 An overview of potential auditory injury due to elevated underwater sound from vessel use and other (non-piling) sound-producing activities is described in paragraphs 6.3.4.16 to 6.3.4.22 and for potential behavioural disturbance is described in paragraphs 6.3.4.23 to 6.3.4.44.

6.3.4.71 In terms of disturbance responses specific to bottlenose dolphin, dolphins exposed to increases in ship sounds in the North Atlantic (both within and below the dolphin call bandwidth) simplified vocal calls, resulting in higher dolphin whistle frequencies and a reduction in whistle contour complexity (Fouda *et al.* (2018), potentially decreasing effective communication. Bottlenose dolphins have been found to both increase and decrease whistle frequencies in noisy environments, avoiding acoustic masking and improving signal transmission (Heiler *et al.*, 2016, La Manna *et al.*, 2013, May-Collado and Wartzok, 2008, Peters, 2018, Rako Gospić and Picciulin, 2016). (Pirotta *et al.*, 2015) found that transit of vessels (moving motorised boats) in the Moray Firth resulted in a reduction (by almost half) of the likelihood of recording bottlenose dolphin prey capture buzzes but suggested vessel presence, not just vessel sound, resulted in disturbance.

6.3.4.72 As described in paragraph 6.3.4.64, Potlock *et al.* (2023) used C-POD detections of sonar activity as a proxy for vessel disturbance during construction of wind turbines foundations. The vessel sonar variable was significant in the dolphin (potentially bottlenose dolphin) model. The effect size was also substantial in dolphin, with around 13 minutes of sonar occurrence per hour leading to a 50% decline in dolphin occurrence. Despite this, dolphin occurrence during and after construction were not significantly different to the occurrence before the construction phase (Potlock *et al.*, 2023).

6.3.4.73 As presented in paragraph 6.3.4.19 and Table 6.38, the AUD INJ threshold was not exceeded for bottlenose dolphin for any of the scenarios of vessel assemblages modelled for Morven South.

6.3.4.74 As presented in Table 6.39, behavioural disturbance for the modelled vessel assemblages could occur to a maximum distance of 45.3km for foundation installation. The crew transfer scenario could disturb the smallest range: 0.6km. More realistically (in consideration of background noise levels in the North Sea and based on empirical evidence of measured aversive responses) the maximum range of effect is likely to be 7km. Bottlenose dolphin are likely to show some tolerance to moderate ambient sound levels (paragraph 6.3.4.26) and behavioural disturbance is of high recoverability.

6.3.4.75 There is an indication of tolerance to vessel traffic in the scientific literature and so a slight increase from the existing levels of traffic in the vicinity of Morven South may not necessarily result in high levels of disturbance (Vella *et al.*, 2001). While there might be an initial immediate avoidance response to vessels, animals would be likely to return to the area and vessel presence is therefore unlikely to elicit an effect of ongoing displacement.

6.3.4.76 Table 6.41 indicates that only up to one animal is predicted to be disturbed. It is unlikely that the disturbed dolphin will belong to the Coastal East Scotland MU (paragraph 6.3.1.24) for most non-piling sound-producing activities as the Morven South Boundary in not within the coastal MU. However, sound from vessels could provide a small amount of disturbance to up to one bottlenose dolphin belonging to the Coastal East Scotland MU on transit to and from Morven South.

6.3.4.77 The potential for auditory injury or behavioural disturbance within the Moray Firth SAC from vessel use and other (non-piling) sound-producing activities is limited. The maximum disturbance range for bottlenose dolphin (45.3km) does not overlap with the Moray Firth SAC directly, which is located 215.8km northwest of the Morven South Boundary, nor the Coastal East Scotland MU (paragraph 6.2.7.2). Designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury and reduce behavioural disturbance. Therefore, there will be no significant disturbance to the bottlenose dolphin feature of the Moray Firth SAC and thus no adverse effect on the SAC population.

Conclusion

6.3.4.78 Adverse effects on the bottlenose dolphin qualifying feature of the Moray Firth SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.7.5) is presented in Table 6.42.

6.3.4.79 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Moray Firth SAC as a result of injury and disturbance to bottlenose dolphin from vessel use and other (non-piling) sound-producing activities with respect to the construction phase of Morven South.

Operation and maintenance phase

6.3.4.80 The MDS for the O&M phase assumes a total of up to 19 vessels to be present within the Morven South Boundary at any one time, with a maximum total of 2,387 return trips per year, and an expected operational life span of 35 years (Table 6.34). Vessel types that will be required during the O&M phase includes those used during routine inspections, geophysical surveys, repairs and replacements of navigational equipment, painting, replacement of corrosion protection anodes, removal of marine growth, including guano removal, replacement of access ladders and boat landings, modifications to/ replacement of J-tubes, minor repairs and replacements within the WTG and major component replacements to WTG or OSPs (Table 6.34). This will involve eight crew transfer vessels/workboats, two jack-up vessels, two cable repair vessels, four survey vessels and three other vessels. There will be up to 702 annual return trips for wind turbine foundations and 1,165 annual return trips for wind turbines (Table 6.34).

6.3.4.81 While there will be an uplift in vessel activity during phases of Morven South, the movements will be limited to within the Morven South Boundary and are likely to follow existing shipping routes to and from the ports. The designed-in measures and mitigation to reduce the behavioural disturbance to marine mammals, the NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report) will be issued to all project vessel operators as described in Table 6.35.

6.3.4.82 While noise modelling was not carried out for specific O&M vessels, it is considered that the trenching scenario is a suitable proxy for excavator or back-hoe dredging (representing a conservative assessment of radiated sound at least as the dynamic positioning vessels would swamp the soundscape, and if dynamic positioning not required then levels would be noticeably lower). It is considered the crew transfer vessel would be a suitable proxy for a cable repair vessel (falling under general transit noise). It is considered therefore that underwater sound results will be similar to that presented in the construction phase for the modelled scenarios Table 6.36, expect for the foundation installation scenario, which is not relevant. The volume of vessel movements and return trips during the O&M phase is significantly lower than during the construction phase.

6.3.4.83 An overview of potential impacts from elevated underwater noise due to vessel use and other non-piling sound-producing activities, as well as associated effects (injury and disturbance) are discussed in paragraph 6.3.4.3 *et seq*. and from physical presence (disturbance from vessel movements) in paragraph 6.3.4.8 *et seq*. for the construction phase. As such, evidence has not been reiterated here for the O&M phase of Morven South.

<u>Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation</u>

Grey seal

6.3.4.84 As detailed for the construction phase (paragraphs 6.3.4.70 to 6.3.4.77), the AUD INJ threshold for PW (grey seal) was not exceeded for any of the modelled vessel scenarios (Table 6.38). Behavioural disturbance could occur to a maximum distance of 36.2km (Table 6.39), which is slightly smaller than the distance for the construction phase (paragraph 6.3.4.49) as foundation installation is not anticipated during the O&M phase. Based on the realistic disturbance range of 7km (paragraph 6.3.4.49), up to 39 grey seals could be disturbed by Morven South O&M activities within a range of 7km (Table 6.41; equivalent to 0.106% of the combined East Scotland and Northeast England SMUs population).

6.3.4.85 Therefore, the potential for auditory injury or behavioural disturbance during the O&M phase within the Berwickshire and North Northumberland Coast SAC and/or Isle of May SAC from vessel use and other (non-piling) sound-producing activities remains limited. The maximum disturbance range for grey seal (36.2km) does not overlap with the Berwickshire and North Northumberland Coast SAC, which is located 97.2km southwest of the Morven South Boundary or the Isle of May SAC is located 108.6km southwest. Designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury. Therefore, there will be no adverse effects on the grey seal population of the Berwickshire and North Northumberland Coast SAC or the viability of the grey seal feature of the Isle of May SAC. There will also be no significant disturbance to the grey seal feature of either SAC.

Conclusion

6.3.4.86 Adverse effects on the grey seal qualifying feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SACs will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.42.

6.3.4.87 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result of injury and disturbance to grey seals from vessel use and other (non-piling) sound-producing activities with respect to the O&M phase of Morven South.

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

6.3.4.88 As detailed for the construction phase (paragraphs 6.3.4.70 to 6.3.4.77), the AUD INJ threshold for PW (harbour seal) was not exceeded for any of the modelled vessel scenarios (Table 6.38). Behavioural disturbance could occur to a maximum distance of 36.2km (Table 6.39), which is slightly smaller than the distance for the construction phase (paragraph 6.3.4.56) as foundation installation is not anticipated during the O&M phase. Based on the realistic disturbance range of 7km (paragraph 6.3.4.56), up to one harbour seal could be disturbed by Morven South O&M activities (Table 6.41; equivalent to 0.205% of the combined East Scotland and Northeast England SMUs[5] population).

6.3.4.89 Therefore, the potential for auditory injury or behavioural disturbance during the O&M phase within the Firth of Tay and Eden Estuary SAC from vessel use and other (non-piling) sound-producing activities remains limited. The maximum disturbance range for harbour seal (36.2km) does not overlap with the Firth of Tay and Eden Estuary SAC, which is located 109.3km southwest of the Morven South Boundary, while designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury. Therefore, there is no significant risk of injury nor significant disturbance on the harbour seal feature of the Firth of Tay and Eden Estuary SAC.

Conclusion

6.3.4.90 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.42.

6.3.4.91 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of injury and disturbance to harbour seals from vessel use and other (non-piling) sound-producing activities with respect to the O&M phase of Morven South.

Southern North Sea Special Area of Conservation

Harbour porpoise

6.3.4.92 As detailed for the construction phase (paragraphs 6.3.4.70 to 6.3.4.77), the AUD INJ threshold for VHF cetaceans (harbour porpoise) was not exceeded for any of the modelled vessel scenarios (Table 6.38). Behavioural disturbance could occur to a maximum distance of 36.2km (Table 6.39), which is slightly smaller than the distance for the construction phase (paragraph 6.3.4.66) as foundation installation is not anticipated during the O&M phase. Based on the realistic disturbance range of 7km (paragraph 6.3.4.66), up to 93 harbour porpoises could be disturbed by Morven South O&M activities within a range of 7km (Table 6.41; equivalent to 0.058% of the UK portion of the North Sea MU population).

6.3.4.93 Therefore, the potential for auditory injury or behavioural disturbance during the O&M phase within the Southern North Sea SAC from vessel use and other (non-piling) sound-producing activities remains limited. The maximum disturbance range for harbour porpoise (36.2km) does not overlap with the Southern North Sea SAC, which is located 135.1km southeast of the Morven South Boundary, while designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury. Therefore, there will be no adverse effects on the viability of, or significant disturbance to, the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.3.4.94 Adverse effects on the harbour porpoise qualifying feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.42.

6.3.4.95 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of injury and disturbance to harbour porpoise from vessel use and other (non-piling) sound-producing activities with respect to the O&M phase of Morven South.

Moray Firth Special Area of Conservation

Bottlenose dolphin

6.3.4.96 As detailed for the construction phase (paragraphs 6.3.4.70 to 6.3.4.77), the AUD INJ threshold for HF cetaceans (bottlenose dolphin) was not exceeded for any of the modelled vessel scenarios (Table 6.38). Behavioural disturbance could occur to a maximum distance of 36.2km (Table 6.39), which is slightly smaller than the distance for the construction phase (paragraph 6.3.4.74) as foundation installation is not anticipated during the O&M phase. Based on the realistic disturbance range of 7km (paragraph 6.3.4.74), up to one bottlenose dolphin could be disturbed by Morven South O&M activities (Table 6.41). As for the construction phase, it is unlikely that the disturbed dolphin will belong to the Coastal East Scotland MU (paragraphs 6.3.1.24 and 6.3.4.74) for most activities. However, vessels on transit to/from Morven South may cause a small amount of disturbance to up to one bottlenose dolphin belonging to the Coastal East Scotland MU on transit to and from Morven South.

6.3.4.97 Therefore, the potential for auditory injury or behavioural disturbance within the Moray Firth SAC from vessel use and other (non-piling) sound-producing activities remains limited. The maximum disturbance range for bottlenose dolphin (36.2km) does not overlap with the Moray Firth SAC directly, which is located 215.8km northwest of the Morven South Boundary, nor the Coastal East Scotland MU (paragraph 6.2.7.2). Designed-in measures adopted as part of Morven South include the development of, and adherence to, a NSPVMP (Volume 4, Annex 5: Outline Navigation Safety and Vessel Management Plan, of the EIA Report; Table 6.35) are assumed to fully mitigate the risk of injury and reduce behavioural disturbance. Therefore, there is no significant disturbance to the bottlenose dolphin feature of the Moray Firth SAC and thus no adverse effect on the SAC population.

Conclusion

6.3.4.98 Adverse effects on the bottlenose dolphin qualifying feature of the Moray Firth SAC that undermine the conservation objectives of the SAC will not occur as a result of injury and disturbance from vessel use and other (non-piling) sound-producing activities during O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.7.5) is presented in Table 6.42.

6.3.4.99 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Moray Firth SAC as a result of injury and disturbance to bottlenose dolphin from vessel use and other (non-piling) sound-producing activities with respect to the O&M phase of Morven South.

Decommissioning phase

6.3.4.100 During the decommissioning phase of Morven South, the increased levels of vessel activity will contribute to background underwater sound levels. A Decommissioning Programme will be submitted to MD-LOT for consultation and approval and will be updated during Morven South's lifespan to take account of changing best practice and new technologies. It is anticipated there will be a range of vessels used for decommissioning activities such as removal of foundations, cables and cable protection (Table 6.34). There is no information regarding the number of vessel transits for the decommissioning phase and therefore a quantitative assessment is not possible for this phase. However, it is anticipated that the number of vessels, number of transits and duration of the decommissioning phase will be considerably less compared to the construction phase.

6.3.4.101 An overview of potential impacts from elevated underwater noise due to vessel use and other non-piling sound-producing activities, as well as associated effects (injury and disturbance) are discussed in paragraph 6.3.4.3 *et seq*. and from physical presence (disturbance from vessel movements) in paragraph 6.3.4.8 et seq. for the construction phase. As such, evidence has not been reiterated here for the decommissioning phase of Morven South.

6.3.4.102 As the MDS for the construction phase is considered the MDS for the decommissioning phase of Morven South, the assessment of SACs designated for Annex II marine mammals is the same as during the construction phase (paragraphs 6.3.4.45 to 6.3.4.79) and is not repeated here. An assessment of the effects during the decommissioning phase against the relevant conservation objectives is presented in Table 6.42.

6.3.4.103 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of any SAC designated for Annex II marine mammals as a result of injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities with respect to the decommissioning phase of Morven South.

Table 6.42: Conclusions against the conservation objectives of the Special Areas of Conservation designated for marine mammals from injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities during the construction, operation and maintenance and decommissioning phases

SAC	Feature	Conservation objective	Conclusion
Berwickshire and North Northumberland Coast SAC	Grey seal	The extent and distribution of qualifying natural habitats and habitats of the qualifying species are maintained.	There is no impact pathway between vessel use and other (non-piling activities) and the extent, distribution, structure, and function of the habitats and supporting processes of grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Supplementary advice (Natural England, 2023) refers to maintaining spatial extent and distribution of supporting habitats including haul-out sites and the assessment found that there was no overlap with the SAC and the sound contours did not reach the coastal area where key haul outs are located. Furthermore, the maximum auditory injury or disturbance range would not impede connectivity between the site and the wider environment as grey seal are able to forage widely and disturbance from vessel use and other (non-piling) activities would only occur as intermittent events to which animals have some tolerance and would return to baseline levels soon after. Therefore, the presence, abundance, condition and diversity of habitats and species required to support grey seal will not be adversely affected and will be maintained.
		The structure and function of the habitats of the qualifying species are maintained.	
		The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely are maintained.	
		The populations of each of the qualifying species are maintained	As described in paragraphs 6.3.4.45 to 6.3.4.52 for the construction phase, paragraphs 6.3.4.84 to 6.3.4.87 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, vessel use and other (non-piling activities) is unlikely to lead to injury or significant disturbance of grey seals as there is no overlap of the maximum auditory injury or disturbance range with the SAC. Only a small proportion (0.106%) of the relevant SMUs would potentially be impacted by behavioural disturbance and therefore with respect to the supplementary advice the reproductive and recruitment capability of the species would be maintained (Natural England, 2023). Therefore, the population and distribution of grey seal within the SAC will not be adversely affected and so will be maintained.
		The distribution of qualifying species within the site are maintained.	

SAC	Feature	Conservation objective	Conclusion
Isle of May SAC	Grey seal	2a. ensure grey seals are a viable component of the Isle of May SAC.	As described in paragraphs 6.3.4.45 to 6.3.4.52 for the construction phase, paragraphs 6.3.4.84 to 6.3.4.87 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, vessel use and other (non-piling activities) is unlikely to lead to injury or strong behavioural disturbance of grey seals. There is no impact pathway for injury from vessel use or other (non-piling) activities, as AUD INJ thresholds are not exceeded and designed-in standard mitigation measures fully mitigate the risk of injury. Similarly, grey seal would not be disturbed within the site as the maximum disturbance range does not overlap the SAC, ensuring grey seals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2025a). Importantly, this means that there is no effect on reproductive capability of grey seal during the breeding season and pup production would not be expected to decline as a result of this impact, ensuring stable or increasing grey seal numbers are maintained. Therefore, grey seals will remain a viable component of the SAC.
		2b. ensure the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals.	This conservation objective refers to potential for long-term declines in the use of the site, changes in the distribution of the species on a sustained basis or changes in their behaviour such that it reduces the ability of the species to survive, breed or rear young (NatureScot, 2025a). As described in paragraphs 6.3.4.45 to 6.3.4.52 for the construction phase, paragraphs 6.3.4.84 to 6.3.4.87 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, significant disturbance of grey seals from vessel use and other (non-piling activities) will be avoided as the maximum disturbance range does not overlap the SAC. Only a small proportion (0.106%) of the relevant SMUs would potentially be impacted by behavioural disturbance, which would not lead to changes in behaviour that would reduce the ability of seals to survive. Therefore, the distribution of grey seals within the SAC will not be adversely affected and will be maintained.

SAC	Feature	Conservation objective	Conclusion
		2c. ensure the supporting habitats relevant to grey seal are maintained.	The focus of this conservation objective is on maintaining the extent, quality, and distribution of the supporting habitats required by breeding grey seals (NatureScot, 2025a). The assessment found that there is no impact pathway between vessel use and other (non-piling activities) and the supporting habitats relevant to grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Thus, there is unlikely to be any effect at key times of year when seals, which rely on these habitats, may be resting or foraging within or close to the SAC. Therefore, the habitats required to support grey seal will not be adversely affected and will be maintained.
Firth of Tay and Eden Estuary SAC	Harbour seal	2a. ensure harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality.	As described in paragraphs 6.3.4.53 to 6.3.4.59 for the construction phase, paragraphs 6.3.4.88 to 6.3.4.91 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, vessel use and other (non-piling) activities is unlikely to lead to injury (and therefore mortality) of harbour seals. There is no impact pathway for injury from vessel use or other (non-piling) activities, as AUD INJ thresholds are not exceeded and designed-in standard mitigation measures fully mitigate the risk of injury. This ensures that the recovery of harbour seal at a population level is not impeded (noting that the condition of harbour seal within the SAC was last assessed as unfavourable – declining; see paragraph 6.2.5.7) and animals can move safely between the site and important areas of functionally linked sea outwith the site (NatureScot, 2024). Therefore, harbour seals within the SAC will not be at significant risk of injury or mortality and will not be adversely affected.
		2b. ensure the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.4.53 to 6.3.4.59 for the construction phase, paragraphs 6.3.4.88 to 6.3.4.91 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, significant disturbance of harbour seals throughout the site from vessel use and other (non-piling) activities will be avoided. Disturbance would not be significant as the maximum disturbance range does not overlap the SAC. This ensures harbour seals continue

SAC	Feature	Conservation objective	Conclusion
			to have access to, and can utilise, all habitats suitable for haul-outs and breeding associated within the site (NatureScot, 2024). Therefore, the distribution of harbour seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to harbour seal are maintained.	The focus of this conservation objective is on maintaining habitats within the SAC to support recovery of the species due to its declining status (NatureScot, 2024). The assessment found that there is no impact pathway between vessel use and other (non-piling) activities and the supporting habitats and processes relevant to harbour seal (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour seal will not be adversely affected and will be maintained.
Southern North Sea SAC	Harbour porpoise	1. harbour porpoise are a viable component of the site.	As described in paragraphs 6.3.4.60 to 6.3.4.69 for the construction phase, paragraphs 6.3.4.92 to 6.3.4.95 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, vessel use and other (non-piling activities) is unlikely to lead to injury or strong behavioural disturbance of harbour porpoises. There is no impact pathway for injury from vessel use or other (non-piling) activities, as AUD INJ thresholds are not exceeded and designed-in standard mitigation measures fully mitigate the risk of injury. Similarly, harbour porpoise would not be disturbed within the site as the maximum disturbance range does not overlap the SAC. Only a small proportion (0.027%) of the North Sea MU would potentially be impacted by behavioural disturbance, so there is no restriction on the survivability and reproductive potential of harbour porpoise using the site (JNCC and Natural England, 2019) from vessel use and other (non-piling) activities. Therefore, harbour porpoise will remain a viable component of the SAC.
		2. there is no significant disturbance of the species.	This conservation objective considers disturbance significant if it leads to the exclusion of harbour porpoise from a significant portion of the site (JNCC and Natural England, 2019). As described in

SAC	Feature	Conservation objective	Conclusion
			paragraphs 6.3.4.60 to 6.3.4.69 for the construction phase, paragraphs 6.3.4.92 to 6.3.4.95 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, significant disturbance of harbour porpoise from vessel use and other (non-piling activities) will be avoided. as the maximum disturbance range does not overlap the SAC. There will be no displacement of harbour porpoise from the site from vessel use or other (non-piling) activities. Therefore, the SAC population will not be adversely affected.
		3. the condition of supporting habitats and processes, and the availability of prey is maintained.	This conservation objective (JNCC and Natural England, 2019) refers to the maintenance of supporting habitats (i.e. characteristics of the seabed and water column) and processes (i.e. movements and physical properties of the habitat) contributing to ensuring that prey is maintained within the site and is available to harbour porpoises. As the assessment found that there was no overlap with the area of significant disturbance with the SAC, there is no impact pathway between vessel noise and other (non-piling) activities and the supporting habitats and processes relevant to harbour porpoise. With respect to the availability of prey, no adverse effects were predicted on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support harbour porpoise will not be adversely affected and will be maintained.
Moray Firth SAC	Bottlenose dolphin	2a. ensure the population of bottlenose dolphin is a viable component of the site.	As described in paragraphs 6.3.4.70 to 6.3.4.79 for the construction phase, paragraphs 6.3.4.96 to 6.3.4.99 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, there is no impact pathway for injury from vessel use or other (non-piling) activities, as AUD INJ thresholds are not exceeded and designed-in standard mitigation measures fully mitigate the risk of injury. As such, there is no risk of injury or mortality to bottlenose dolphin from vessel use or other (non-piling) activities (NatureScot,

SAC	Feature	Conservation objective	Conclusion
			2025c). Therefore, bottlenose dolphin will remain a viable component of the SAC.
		2b. ensure the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.	As described in paragraphs 6.3.4.70 to 6.3.4.79 for the construction phase, paragraphs 6.3.4.96 to 6.3.4.99 for the O&M phase and paragraphs 6.3.4.100 to 6.3.4.103 for the decommissioning phase, significant disturbance of bottlenose dolphin throughout the site from vessel use and other (non-piling) activities will be avoided the maximum disturbance range does not overlap the SAC nor the functionally linked Coastal East Scotland MU (NatureScot, 2025c). Bottlenose dolphin will continue to use and have access to all areas of the site and therefore, the distribution of bottlenose dolphin within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to bottlenose dolphin and their prey/food resources for bottlenose dolphins are maintained.	The focus of this conservation objective is on maintaining sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site (NatureScot, 2025c). The assessment found that there is no impact pathway between vessel noise and other (non-piling) activities and the supporting habitats and processes relevant to bottlenose dolphin (i.e. no overlap with the area of significant disturbance with the SAC nor functionally linked Coastal East Scotland MU). With respect to the availability of prey, no adverse effects were predicted on prey species (see Volume 2, Chapter 9: Fish and Shellfish Ecology of the EIA Report) and so prey species populations are expected to be maintained in the Long-term. Therefore, the habitats and processes required to support bottlenose dolphin will not be adversely affected and will be maintained.

6.4 Assessment of the adverse effects of Morven South in-combination with other plans and projects

6.4.1 Overview

6.4.1.1 The potential impacts that have been considered for Annex II marine mammals in the Morven South in-combination assessment are a subset of those considered for the Morven South alone assessment. This is because some of the potential impacts identified and assessed for the Morven South alone assessment are localised and temporary in nature or have been assessed to have no LSE[2]. It is considered therefore, that these potential impacts have limited or no potential to interact with similar changes associated with other plans or projects. These have therefore been screened out of the in-combination assessment. These impacts and the justification for screening them out of the in-combination assessment are presented in Table 6.43. These were discussed and agreed in the workshop with NatureScot and MD-Lot on 23 October 2025 (Table 2.1).

6.4.1.2 Similarly, some of the potential impacts considered within the Morven South alone assessment are specific to a particular phase of development (e.g. construction, O&M or decommissioning). As in-combination effects with other plans or projects only have potential to occur where there is spatial or temporal overlap with Morven South during certain phases of development, impacts associated with a certain phase may be omitted from further consideration where no plans or projects have been identified that have the potential for in-combination effects during that period.

6.4.1.3 The other plans and projects that have been identified as having the potential for in-combination effects are presented in Figure 6.9 and Table 6.44. The following approach has been applied in order to screen projects in and out of the in-combination assessment:

- Long list as per the CEA in Volume 2, Chapter 10: Marine Mammals of the EIA Report (Table 6.44):
  - Projects located within the Morven Regional Marine Mammal Study Area) were screened in as agreed with SNCBs.
  - From this subset, projects with no temporal overlap with any phase of Morven South were screened out.
  - From this subset, projects where there is no effect-receptor pathway were screened out.
  - The short list of projects was then taken forward for further screening.
- Short list (projects included in the MDS tables, Table 6.45 and Table 6.49):
  - Projects where any of the construction, O&M and/or decommissioning activities were already occurring in 2025 were screened out as these were considered to be part of the baseline.
  - Projects that did not have HRA documentation (a RIAA or LSE[2] screening) or did not assess the same SACs as Morven South were screened out as there was considered to be no potential for in-combination adverse effects on qualifying features.
  - Remaining projects were considered at a species-specific level to determine if further screening could occur if a project was within the Morven Regional Marine Mammal Study Area but not within a specific species' MU (which may be smaller, such as those for grey seal and harbour seal).
  - For potential impacts within the construction phase, temporal overlap was considered to occur for projects constructing up to one year on either side of the construction phase of Morven South (2033 to 2042) based on NatureScot advice for other Scottish Projects (Caledonia OWF Ltd, 2024, Cenos Offshore Windfarm Limited, 2024a, Muir Mhòr Offshore Wind Farm, 2024c). Therefore, projects with construction occurring within 2032 to 2043 were considered to have the potential for temporal overlap for relevant impacts.

- Impact-specific effects were further screened based on outcome of project alone assessment and taking a proportionate approach (further to information submitted by recent ScotWind projects) to focus only on those impacts where there is potential for a cumulative effect. This is discussed further in Section 6.4.2 and 6.4.3 when defining the in-combination MDSs for each impact screened into the assessment.

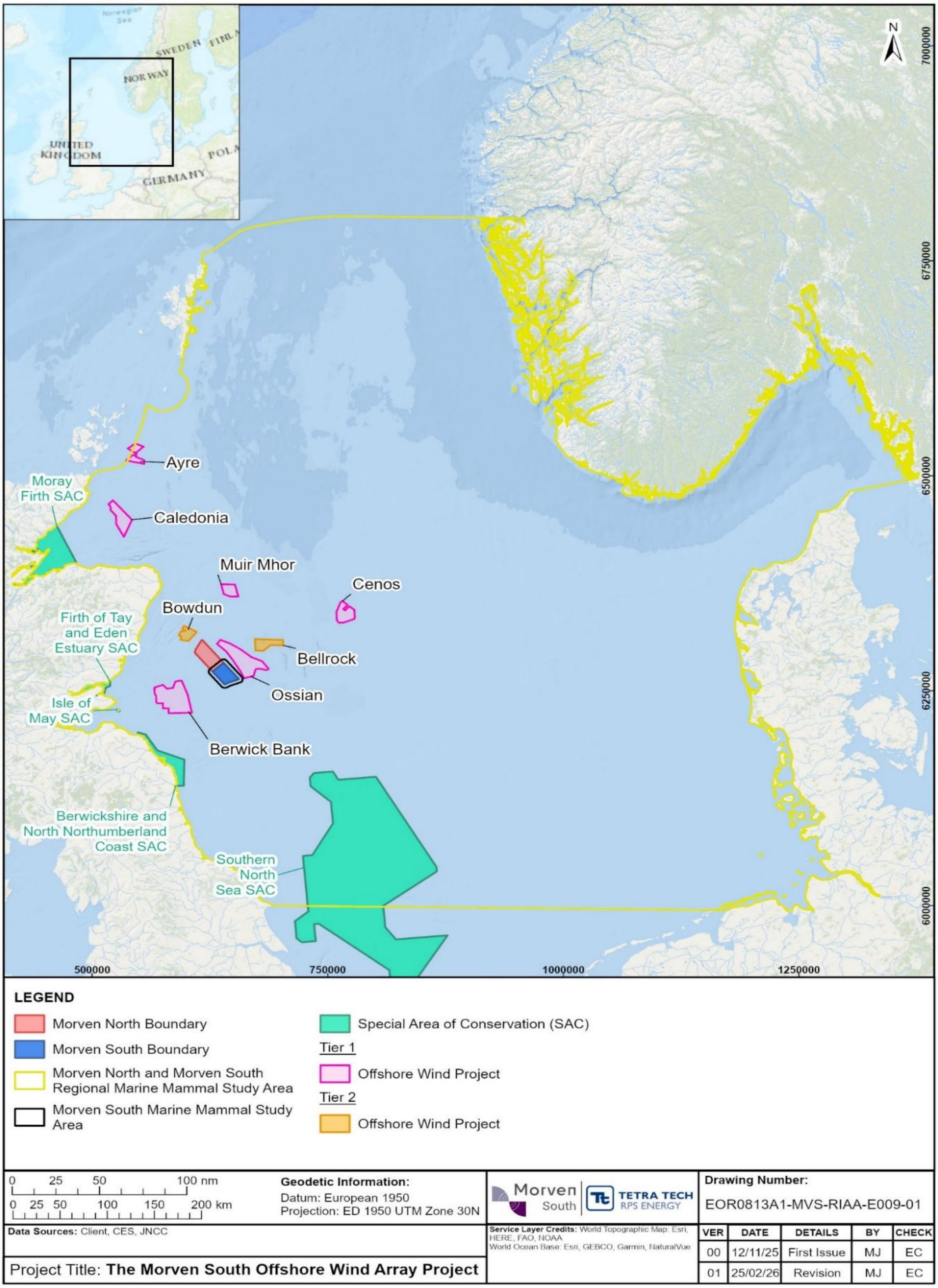

Figure 6.9: Location of other plans and projects considered for the in-combination effects assessment on Special Areas of Conservation with Annex II marine mammal features

Table 6.43: Impacts screened in and out of the in-combination assessment for Annex II marine mammals

Impact	Phase			Screened in or out of in-combination assessment	Justification
	C	O	D		
Injury from underwater sound generated during piling	✓	×	×	Out	Suitable mitigation must be in place following statutory guidelines for all projects to reduce the risk of injury from piling for the projects alone to negligible (EPS legislation). Therefore, there is no potential for residual risks that could lead to a in-combination effect, and this impact is screened out.
Disturbance from underwater sound generated during piling	✓	×	×	In	Underwater sound from piling could lead to population-level disturbance to marine mammals where multiple projects are piling either sequentially or within a similar time frame due to the potential large effect area that extends beyond the boundaries of OWF sites. This impact is screened into the in-combination assessment for the construction phase.
Injury and disturbance from underwater sound generated during UXO clearance	✓	×	×	Out	Morven South has committed to using low order clearance techniques such that injury can be mitigated via standard industry measures. Furthermore, all projects included in the in-combination assessment are expected to include low order deflagration as the method of clearance in line with the Joint Position statement (UK Government, 2025) and it has been reported that this technique has successfully cleared all types of UXO with none resulting in high order detonation (Ocean Winds, 2024). Therefore, there is no risk of injury to marine mammals as a result of underwater sound generated during UXO clearance. Disturbance could occur as a very short-term (1 second) event that leads to a startle response and therefore no prolonged effect and no potential for in-combination effects.
Injury to marine mammals from site investigation surveys	✓	✓	×	Out	Construction phase Injury during site-investigation surveys predicted small effect ranges (<0.9km) that would be localised within the Morven South Boundary. This range is for the SBP Chirp which is a directional system expected radiate noise primarily vertically with limited horizontal spread. For all other survey equipment, the injury ranges were between 2m to 262m. Typically, each type of survey would involve no more than two survey vessels on site at any one time and assuming an (unlikely) worst case where each survey type is conducted from a different vessel, a total of 32 vessels

Impact	Phase			Screened in or out of in-combination assessment	Justification
	C	O	D		
					would be involved over the pre-construction phase. Injury could occur intermittently within relatively short timeframes (six to eight months) for up to one or two years, depending on survey type. The number of vessels is captured in the assessment on vessel sound and this impact therefore focuses only on the survey noise. As injury is presumed to be fully mitigated via designed-in measures, there is considered to be no risk of injury from Morven South alone and so there is not anticipated to be any potential for in-combination effects and this impact is screened out. O&M phase The assessment of injury during site-investigation surveys from Morven South alone predicted small effect ranges that would be localised within the Morven South Boundary. Typically, each type of survey would involve no more than two survey vessels and there would be no more than four vessels conducting geophysical or Remotely Operated Vehicle surveys of the wind turbine/OSP foundations or inter-array cables and all associated infrastructure at any one time. Therefore, there is a no risk of injury to marine mammals from Morven South alone due to designed-in measures, and so there is not anticipated to be any potential for in-combination effects and this impact is screened out. Disturbance could occur intermittently within relatively short timeframes (six to eight months) annually for the first five years and thereafter every four years. Therefore, it is anticipated there is no potential for an in-combination effect with other plans or projects, and this impact has been screened out.
Disturbance to marine mammals from site investigation surveys	✓	✓	×	Out	Construction phase Disturbance during site-investigation surveys predicted small effect ranges (<3.8km) that would be localised within the Morven South Boundary. This range is for the SBP Chirp which is a directional system expected radiate noise primarily vertically with limited horizontal spread. For all other survey equipment, the disturbance ranges were between 150m to 680m. Typically, each type of survey would involve no more than two survey vessels on site at any one time and assuming an (unlikely) worst case where each survey type is conducted from a different vessel, a total of 32 vessels would be involved over the pre-construction

Impact	Phase			Screened in or out of in-combination assessment	Justification
	C	O	D		
					phase. Disturbance could occur intermittently within relatively short timeframes (six to eight months) for up to one or two years, depending on survey type. The number of vessels is captured in the assessment on vessel sound and this impact therefore focuses only on the survey noise. Due to the very small effect ranges for different surveys there is not anticipated to be any potential for in-combination effects and this impact is screened out. O&M phase Disturbance during site-investigation surveys predicted small effect ranges (<3.8km) that would be localised within the Morven South Boundary. This range is for the SBP Chirp which is a directional system expected radiate noise primarily vertically with limited horizontal spread. For all other survey equipment, the disturbance ranges were between 150m to 680m. Typically, each type of survey would involve no more than two survey vessels and there would be no more than four vessels conducting geophysical or Remotely Operated Vehicle (ROV) surveys of the wind turbine/OSP foundations or inter-array cables and all associated infrastructure. Effect ranges for disturbance are highly localised and therefore no risk of injury to marine mammals is predicted from Morven South alone. Disturbance could occur intermittently within relatively short timeframes (six to eight months) annually for the first five years and thereafter every four years. Therefore, it is anticipated there is no potential for an in-combination effect with other plans or projects, and this impact has been screened out.
Injury to marine mammals from vessel use and other non-piling sound-producing activities	✓	✓	✓	Out	During all phases, effect ranges for injury are highly localised (Table 6.38) and therefore negligible risk of injury to marine mammal receptors is predicted from project alone. Thus, limited potential for an in-combination effect with other plans or projects, and this impact has been screened out.
Disturbance to marine mammals from vessel use and other non-piling sound-producing activities	✓	✓	✓	In (for the construction and O&M phases)	**Construction and O&M phase** Large numbers of vessel potentially involved in OWFs potentially leading to a chronic disturbance during the construction phase (Morven South with up to 41 present on site at any one time and an average of 612 trips per year). There is

Impact	Phase			Screened in or out of in-combination assessment	Justification
	C	O	D		
				Out (for the decommissioning phase)	potential for in-combination effects of vessel noise with construction of other projects. **Decommissioning phase** Limited information is available to assess this quantitatively for the project alone and in-combination and it is anticipated that only small numbers of vessels would be involved during this phase. This impact is therefore screened out of the decommissioning phase.

Table 6.44: List of other plans and projects with potential for in-combination effects on Annex II marine mammal features for scenario 4 (see Section 4.6)

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
Tier 1						
Morven North	Application submitted/awaiting decision	0	Included as part of Scenario 4	2033 – 2042[6]	2038 – 2073 or 2043 to 2078[7]	The construction phase of Morven South has potential to overlap with the construction phase of Morven North[6]. The O&M phase of Morven North will overlap with Morven South[7].
Berwick Bank OWF	Consented	34	Berwick Bank OWF is proposed for up to 307 wind turbines with a capacity of up to 4,100MW.	2025 - 2033	2034 - 2069	The construction and O&M phases of Berwick Bank OWF overlap with the construction and O&M phases of Morven South.

[6] At this stage, Morven South and Morven North could be constructed anywhere between 2033 to 2042, with both projects possibly being constructed concurrently or one after another. As a precaution, the widest possible construction phase of ten years has been used in the in-combination assessment.

[7] While Morven South and Morven North could be constructed anywhere between 2033 to 2042, the O&M phase has been assumed as commencing in 2038 as a precaution in the instance that one project is constructed first and operational while the other is still in its construction phase. The operational lifecycle of Morven South and Morven North is 35 years and could end in either 2073 (if operational in 2038) or in 2078 (if operational in 2043).

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
Caledonia OWF	Application submitted/Pre-construction	146	Caledonia OWF are proposed for up to 150 wind turbines at a capacity of 2,000MW.	2028 – 2032	2033 - 2068	Construction completed in year prior to Morven South; O&M phases overlap.
Cenos OWF	Application submitted/Pre-construction	124	Cenos OWF is proposed for up to 1,400 MW.	2030 – 2036	2037 -2071	The construction and O&M phases of Cenos OWF overlap with the construction and O&M phases of Morven South.
Muir Mhòr OWF	Application submitted/Awaiting decision	77	Muir Mhòr OWF is proposed for a capacity of 798MW.	2029 – 2033	2034 - 2069	The construction phase of Muir Mhòr OWF overlaps with that of Morven South for one year in 2033.
Ossian OWF	Application submitted/Awaiting decision	5	The Ossian OWF is proposed for up to 3,610MW capacity.	2031 – 2038	2039 - 2074	The construction and O&M phases of the Ossian OWF overlap with those of Morven South.

Project/plan	Status	Distance from Morven South (km)	Description of project/plan	Estimated dates of construction (If applicable)	Estimated dates of operation (If applicable)	Overlap with Morven South
Ayre OWF[8]	Consenting/Pre-Construction	246	Ayre OWF is proposed for up to 67 wind turbines at a capacity of 1,000MW.	2029 – 2034	2035 – 2064	The construction and O&M phases of Ayre OWF overlap with those of Morven North.
Tier 2						
Bellrock OWF	Consenting/Pre-Construction	35	Bellrock Floating OWF is proposed for a capacity of 1,200MW.	2027 – 2030	2031 onwards	The O&M phase of Bellrock OWF overlaps with the O&M phase of Morven South.
Bowdun OWF	Consenting/Pre-Construction	44	Bowdun OWF is proposed for up to 60 wind turbines at a capacity of 1,008MW.	2029 – 2033	2034 onwards	The construction and O&M phases of the Bowdun OWF overlap with those of Morven South.
Tier 3						
There were no Tier 3 projects identified.						

[8] The cumulative iPCoD modelling (Volume 3, Annex 10.5: Marine Mammals iPCoD Modelling Report of the EIA Report) was based upon the information available at the time of undertaking the modelling; however, it is noted that since completing the cumulative iPCoD modelling, Ayre has moved from a Tier 2 to a Tier 1 project.

6.4.2 Disturbance from underwater sound generated from piling

6.4.2.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1 identified that during the construction phase, in-combination LSE[2] could not be ruled out for disturbance from underwater sound generated from piling. This relates to the following SACs and relevant Annex II marine mammal features:

- Berwickshire and North Northumberland Coast SAC:
  - Grey seal.
- Isle of May SAC:
  - Grey seal.
- Firth of Tay and Eden Estuary SAC:
  - Harbour seal.
- Southern North Sea SAC:
  - Harbour porpoise.

6.4.2.2 The Moray Firth SAC has been screened out of further consideration in this in-combination assessment as there was no overlap of the noise impact contours in the Morven South alone assessment with either the Moray Firth SAC or the Coastal East Scotland MU (paragraph 6.3.1.102). Therefore, there is no impact pathway between the bottlenose dolphin feature of the Moray Firth SAC and in-combination disturbance from underwater sound generated from piling.

6.4.2.3 The MDS considered for this in-combination assessment is shown in Table 6.45. The designed-in measures are presented in Table 6.7 for the assessment of Morven South alone are also relevant for the in-combination assessment.

6.4.2.4 For the purposes of the MDS for the in-combination assessment (Table 6.45), projects have been screened in and out on the following basis for disturbance from underwater sound generated from piling:

- **Construction phase** – the impact area for piling can extend beyond the boundaries of proposed OWFs and therefore, adopting a precautionary approach, the assessment has screened in projects within the Morven Regional Marine Mammal Study Area whose construction phases overlap with the construction phase of Morven South (2033 to 2042). Further, projects wherein construction occurs within one year either side of this phase (i.e. within 2032 to 2043) were also included, as the sequential piling at respective projects could lead to a longer duration of effects and allows for potential delays in offshore construction programmes.

6.4.2.5 The in-combination assessment presented in this RIAA Part 2 has been undertaken on the basis of information presented in the RIAAs (or LSE[2] Screening Reports) for the other projects, which is based upon their respective MDS. The level of potential in-combination impact on Annex II marine mammals would likely be reduced significantly from those presented here.

6.4.2.6 The list of projects considered in the MDS (Table 6.45) is reduced from the list in Table 6.44 as the RIAAs for the Tier 1 projects Caledonia OWF, Cenos OWF, Muir Mhòr OWF and Ayre OWF (Ayre OWF Limited, 2025, Caledonia OWF Limited, 2024, Cenos Offshore Windfarm Limited, 2024b, Muir Mhòr Offshore Wind Farm, 2024b) only considered the Moray Firth SAC, for which no AEOI were predicted from Morven South alone (paragraph 6.4.2.2). The Tier 2 project Bellrock OWF was not considered for the same reason (i.e. the LSE[2] screening documentation for this project (Bellrock Offshore Wind Farm, 2024) only considered the Moray Firth SAC).

Table 6.45: Maximum Design Scenario considered for the assessment of potential impacts to Annex II marine mammals due to due to disturbance from underwater sound generated from piling during the construction phase of Morven South in-combination with other plans and projects

Project phase	Maximum Design Scenario	Justification
Construction	**Scenario 4** MDS as described for Morven South (Table 6.6), assessed in-combination with the following other projects and plans: Tier 1 • Morven South; • Berwick Bank OWF; • Ossian OWF. Tier 2 • Bowdun OWF. Tier 3 • No Tier 3 projects identified for this impact.	The Morven Regional Marine Mammal Study Area was used to screen projects into the in-combination assessment for this impact. As detailed in paragraph 6.4.1.3, projects with a construction phase between 2032 to 2043 with a RIAA that assessed the three seal SACs and/or the harbour porpoise SAC were screened in. The MHPGC Project (Scenario 1) and MBAGC Project (Scenario 2) were not included for this impact as no piling is likely to occur and therefore there is no conceptual impact receptor pathway. Therefore, this impact focusses on Scenario 4 only (Table 4.1).

Construction phase

6.4.2.7 A summary of the in-combination assessment (Scenario 4 only; Table 4.1) is presented in Table 6.47. Information to inform the in-combination assessment for this impact is presented in the following paragraphs.

6.4.2.8 As detailed in Table 6.43, there is no potential for in-combination effects of auditory injury from underwater sound from pilling and therefore, the in-combination assessment focuses on disturbance only.

6.4.2.9 As detailed in Table 6.45, Morven North and two other Tier 1 projects (Berwick Bank OWF and Ossian OWF) and one Tier 2 project (Bowdun OWF) were identified with the potential for in-combination disturbance associated with underwater sound from pilling. It should be noted that piling at each of these projects will occur as a discrete stage within the overall construction phase (listed in Table 6.44), and therefore, the periods of piling may not coincide. These timelines are, therefore, indicative and may be subject to change.

6.4.2.10 Methods used to assess behavioural disturbance differed across the Tier 1 projects, with criteria and noise thresholds used in the modelling differing between projects. Therefore, it is necessary to exercise considerable caution when comparing the sound modelling results of each Tier 1 project (Table 6.46). Some projects presented the disturbance range within which animals could experience behavioural disturbance, and the potential numbers of animals disturbed, while others only presented the number of animals disturbed. In addition, densities used varied across the Tier 1 projects to estimate the number of animals potentially disturbed. As these values were derived from different sources per project, density details may reflect various densities of respective species throughout the year (i.e. seasonal versus average across the year). The Tier 1 projects also used different reference populations and MUs. Therefore, assessment of the potential behavioural effects on marine mammals predicted by the Tier 2 projects is not necessarily directly comparable to those presented for Morven South alone due to different approaches taken by other offshore developers, with different noise criteria and thresholds used, and differing levels of detail presented in associated RIAAs.

6.4.2.11 Given uncertainty in the degree of temporal and spatial overlap of these activities summing these figures would give an overestimate of the total number of animals impacted. There is also the possibility that the same individuals might be affected on multiple occasions across projects sequentially. Given uncertainties surrounding animal turnover and movements at this temporal and spatial scale it is very challenging to predict a realistic overall level of disturbance.

6.4.2.12 The combination of uncertainties in project timelines and the need to apply precautionary assumptions leads to numerous levels of precaution within this in-combination assessment which results in highly precautionary estimates of effects. Specifically, the main areas of precaution in the assessment include:

- The number of developments undertaking construction activities at the same time: for example, the assessment precautionarily assumes that up to four offshore windfarm developments could all be constructing on the same day within Scottish waters. This is considered to be unlikely.
- The inclusion of lower tier developments (Tier 2) which do not have quantitative information or detail on indicative piling timelines. The most reliable information regarding construction timelines is available for Tier 1 projects, as these have publicly accessible quantitative assessments and the highest probability of being completed.
- The assumption that piling can take place at any time during the construction period is applied to developments lacking publicly available detailed piling schedules. Consequently, most projects show piling activities spanning multiple consecutive years, leading to disturbance levels that are significantly higher than what would occur.

- Use of EDR approach (see paragraph 6.4.2.13) for Tier 2 projects in the absence of quantitative information on number of animals disturbed. This is not based on project-specific modelling and is therefore likely to differ to the final EIA.

6.4.2.13 In the absence of a guidance for a standardised approach, this assessment has followed the common industry approach taken for marine mammal CEA outlined in paragraph 6.4.1.3 and Volume 2, Chapter 10: Marine Mammals of the EIA Report. For Tier 2 projects no quantitative information is available in the public domain (information restricted to LSE screening reports only) and therefore for Tier 2 projects, published EDRs have been used to derive indicative numbers of animals disturbed, on the assumption that there is sufficient information to develop a piling scenario (i.e. number and type of foundations and offshore construction (or piling) phase provided) in the screening reports (as discussed and agreed in the workshop with NatureScot and MD-LOT on 23 October 2025, see Table 2.1). For piling, an EDR of 20km was used for monopiles/pin piles without noise abatement, based on the latest EDR guidance (JNCC, 2025g). SCANS IV densities have been used for calculating numbers of cetaceans disturbed for Tier 2 projects. For pinnipeds, the densities used for Morven South are used in the absence of project-specific densities (see Section 6.2.2).

6.4.2.14 Population-level effects for the in-combination assessment are discussed in relation to iPCoD results for all projects within the Morven Regional Marine Mammal Study Area (i.e. up to 10 projects that may be piling), as presented in the CEA assessment in Volume 2, Chapter 10: Marine Mammals of the EIA Report. The disturbance impacts predicted for Morven South together with the Tier 1 and Tier 2 projects identified were taken through for population modelling using iPCoD in order to inform the CEA in Volume 2, Chapter 10: Marine mammal of the EIA Report. The maximum temporal scenario for Morven South, as outlined in Table 6.6 and Table 6.46, was used as a MDS for the in-combination assessment as this has the potential for larger changes in population compared to the maximum spatial design. Importantly, the CEA assessment concluded that there was only a low potential for Long-term population effect from the cumulative piling scenario using population modelling for harbour seal, grey seal and harbour porpoise (Volume 3, Annex 10.5: Marine Mammals iPCoD Modelling Report of the EIA Report).

Table 6.46: Wind turbine and Offshore Substation Platform piling parameters incorporated into the Maximum Design Scenarios of the in-combination projects

Project	Scenario	Capacity (MW)	Max number of wind turbines/OSPs	Max number of piles	Max pile diameter (m)	Max hammer energy (kJ)	Max number of piling days	Piling phase	Reference
Morven South	Wind turbine	1,500	95	380	3.7	4,000	192	2034 - 2035	Section 4 of RIAA Part 1
	OSP (HVAC collector)		4	96	5.3*	4,000	48		
	OSP (HVDC converter)		1	48	5.3*	4,000	24		
Tier 1									
Morven North	Wind turbine	1,500	96	384	3.7	4,000	192	2035 - 2036	MvOWL (2026b)
	OSP (HVAC collector)		4	96	5.3*	4,500	48		
	OSP (HVDC converter)		1	48	5.3*	4,500	24		
Berwick Bank OWF	Wind turbine	4,100	307	1,432	5.5	4,000	95	Apr – Dec 2026, Apr – Dec 2027, Apr – Dec 2031	SSE Renewables (2022b)
	OSP		8	192	3	4,000	17	Jan - Mar 2026, Jan - Mar 2027,	

Project	Scenario	Capacity (MW)	Max number of wind turbines/OSPs	Max number of piles	Max pile diameter (m)	Max hammer energy (kJ)	Max number of piling days	Piling phase	Reference
								Jan - Mar 2031	
Ossian OWF	Wind turbine	3,600	265	1,590	4.5	3,000	530	Between Q2 to Q4 each year from 2031 to 2038	Ossian OWFL (2024a)
	OSP		15	216	4.5	4,400	72		
Tier 2									
Bowdun OWF	N/A	1,000	Up to 67 wind turbines and an unspecified number of OSPs	Parameters not provided in the Scoping Report or Screening Report, but maximum piling days is assumed, conservatively, to be based on up to 6 piles per foundation, with a maximum of two pin piles installed per day giving a total of 201 piling days.				May commence in 2029, with an estimated construction phase of five years	Bowdun OWF Limited (2024a)

*Captures the 4.5m pin pile (HVAC collector OSP) and the 5m pin pile (HVDC converter OSP), see Table 6.8.

Table 6.47: Morven South in-combination assessment for disturbance from underwater sound generated during piling

In-combination assessment Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 projects
Construction phase
The in-combination assessment for Scenario 4 considers Morven South together with the Tier 1 and Tier 2 (no Tier 3 projects screened into this impact) below. <u>Tier 1</u> Tier 1 includes: • Morven North; • Berwick Bank OWF; • Ossian OWF. Table 6.46 summarises the MDSs of the respective in-combination projects, and maximum number of animals potentially disturbed, and the associated percentage of the total MU population are discussed in the SAC sections of this RIAA Part 2. Given uncertainty in the degree of temporal and spatial overlap of these activities, summing these figures would give an overestimate of the total number of animals impacted and therefore is not carried out. For grey seal, across all Tier 1 projects, the maximum number of grey seals potentially disturbed ranges from 131 individuals (0.4% of the combined East Scotland and Northeast SMUs population) during piling at Ossian OWF (which lies 5km from Morven South) to 1,450 individuals (12.06% of the MUs) during piling at Berwick Bank OWF (which lies 34km from Morven South). Population modelling (which included more cumulative projects than are screened into this in-combination assessment; paragraph 6.4.2.14) showed that changes in the impacted population size over time were larger than those predicted for an unimpacted population, although the impacted population appeared to stabilise towards the end of the model, after cumulative piling had ceased (Volume 3, Annex 10.5: Marine Mammals iPCoD Modelling Report of the EIA Report). For harbour seal, the maximum number of harbour seals potentially disturbed is very low, ranging from up to one animal (0.2% of the combined East Scotland and Northeast SMUs[5] population) during piling at Morven South and Morven North, to three animals (0.6% of combined East Scotland and Northeast SMUs[5] population) during piling at Berwick Bank OWF (which lies 34km from Morven South). Population modelling (which included more cumulative projects than are screened into this in-combination assessment; paragraph 6.4.2.14) showed there was no difference in the trajectories of the impacted and un-impacted populations (Volume 3, Annex 10.5: Marine Mammals iPCoD Modelling Report of the EIA Report). For harbour porpoise, across all Tier 1 projects, the maximum number of harbour porpoise potentially disturbed ranged from 834 animals (0.5% of the UK portion of the North Sea MU) during piling at Morven North, to 3,857 animals (2.4% of the UK portion of the North Sea MU) during piling at Ossian OWF (which lies 5km from Morven South). Population modelling (which included more cumulative projects than are screened into this in-combination assessment; paragraph 6.4.2.14) showed that there is potential for a population-level effects upon harbour porpoise within the North Sea MU in the medium term (i.e. during the period when

In-combination assessment
multiple projects are piling). However, the population was shown to stabilise in the long-term, after cumulative piling ceased. This modelling study concluded that Morven South is likely to have only a small relative contribution to this cumulative effect, since much of the population effects were seen in the years preceding piling at Morven South when there was a high level of piling activity expected from multiple projects (see Volume 3, Annex 10.5: Marine Mammals iPCoD Modelling Report of the EIA Report for further details). <u>Tier 2</u> Tier 2 includes Tier 1 projects, plus Bowdun OWF. For grey seal, the maximum number of animals potentially disturbed is 398 grey seals (1.1% of the combined East Scotland and Northeast SMUs population) during piling at Bowdun OWF (using EDR approach). For harbour seal, the maximum number of animals potentially disturbed is one harbour seal (0.2% of the combined East Scotland and Northeast SMUs[5] population) during piling at Bowdun OWF (using EDR approach). For harbour porpoise, the maximum number of animals potentially disturbed is 753 animals 0.5% of the UK portion) during piling at Bowdun OWF (using EDR approach). The population modelling included Tier 2 projects (Volume 3, Annex 10.5: Marine Mammals iPCoD Modelling Report of the EIA Report) and conclusions regarding population trends for the three species remained the same as for Tier 1; no change for harbour seal and stabilised in the long-term for grey seal and harbour porpoise.

Berwickshire and North Northumberland Coast SAC and Isle of May Special Area of Conservation

Grey seal

6.4.2.15 The only Tier 1 projects relevant to grey seal feature of the Isle of May SAC are Morven North and Berwick Bank OWF, as the Ossian OWF RIAA does not assess the Isle of May SAC (Ossian OWFL, 2024d). All three Tier 1 projects (i.e. including Ossian OWF) are relevant to the grey seal feature of the Berwickshire and North Northumberland Coast SAC.

6.4.2.16 Within the Morven North RIAA the 160db rms strong disturbance contour had no overlap with the Berwickshire and North Northumberland Coast SAC or Isle of May SAC, therefore there is only potential for mild disturbance to affect the grey seals within either SAC (MvOWL, 2026a). Similarly, in the Berwick Bank OWF RIAA, there was a potential overlap with the 135dB disturbance contour with the northern end of the Berwickshire and North Northumberland Coast SAC. This overlap was considered unlikely to cause significant disturbance to grey seals as it is the southern half of the SAC that is considered an important breeding site for grey seals; there was no predicted overlap of noise impact contours with the Isle of May SAC (SSE Renewables, 2022d). Within the Ossian OWF RIAA no noise impact contours overlapped with the Berwickshire and North Northumberland Coast SAC (Ossian OWFL, 2024d). There was no spatial information available for use at the time of writing relating to the Tier 2 project, Bowdun OWF.

6.4.2.17 Table 6.47 presents information on the predicted effects from Tier 1 and Tier 2 projects included in the iPCoD cumulative assessment for grey seal (see Volume 3, Annex 10.5: Marine Mammal iPCoD Modelling Report of the EIA Report for more details). As discussed in paragraph 6.4.2.13, for Tier 2 projects, an indicative number of animals disturbed is presented based on the 20km EDR approach, using information gathered from the EIA scoping report for Bowdun OWF (no magnitude is presented at this stage for Tier 2 projects). There is no anticipated effect on the reference population. As such, there is no adverse effect on the population, nor significant disturbance, of the grey seal feature of the Berwickshire and North Northumberland Coast SAC and/or the Isle of May SAC.

Conclusion

6.4.2.18 Adverse effects on the grey seal qualifying feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SAC will not occur as a result of in-combination disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.48.

6.4.2.19 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result of disturbance from underwater sound generated during piling with respect to the construction phase of Morven South in-combination with other plans and projects.

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

6.4.2.20 The only Tier 1 projects relevant to harbour seal feature of the Firth of Tay and Eden Estuary SAC are the Morven North and Berwick Bank OWF, as the Ossian OWF RIAA does not assess harbour seal SACs (Ossian OWFL, 2024d).

6.4.2.21 Within the Morven North RIAA there is no overlap of noise impact contours with the Firth of Tay and Eden Estuary SAC, therefore there is no potential for Morven North to affect the SAC (MvOWL, 2026a). In the Berwick Bank OWF RIAA the 135dB disturbance contour had the potential to overlap with the SAC itself, so while there may be mild behavioural disturbance, prolonged or sustained behavioural effects, including displacement, are unlikely to occur (SSE Renewables, 2022d). There was no spatial information available for use at the time of writing relating to the Tier 2 project, Bowdun OWF.

6.4.2.22 Table 6.47 presents information on the predicted effects from Tier 1 and Tier 2 projects included in the iPCoD cumulative assessment for harbour seal (see Volume 3, Annex 10.5: Marine Mammal iPCoD Modelling Report of the EIA Report for more details). As discussed in paragraph 6.4.2.13, for Tier 2 projects, an indicative number of animals disturbed is presented based on the 20km EDR approach, using information gathered from the EIA scoping report for Bowdun OWF (no magnitude is presented at this stage for Tier 2 projects). There is no anticipated effect on the reference population. As such, there will be no adverse effect on the population, nor significant disturbance, of harbour seal throughout the Firth of Tay and Eden Estuary SAC.

Conclusion

6.4.2.23 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of in-combination disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.48.

6.4.2.24 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of disturbance from underwater sound generated during piling with respect to the construction phase of Morven South in-combination with other plans and projects.

Southern North Sea Special Area of Conservation

Harbour porpoise

6.4.2.25 All three Tier 1 projects are relevant to harbour porpoise feature of the Southern North Sea SAC.

6.4.2.26 Within the Morven North RIAA there is no overlap of noise impact contours with the Southern North Sea SAC, therefore there is no potential to affect the SAC (MvOWL, 2026a). In the Berwick Bank OWF RIAA there was no overlap of noise impact contours with the Southern North Sea SAC (SSE Renewables, 2022d). Within the Ossian OWF RIAA the 143dB disturbance contour was not predicted to extend to the Southern North Sea SAC (Ossian OWFL, 2024d). Therefore, harbour porpoise are unlikely to experience significant disturbance within the SAC from any Tier 1 projects. There was no spatial information available for use at the time of writing relating to the Tier 2 project, Bowdun OWF.

6.4.2.27 Table 6.47 presents information on the predicted effects from Tier 1 and Tier 2 projects included in the iPCoD cumulative assessment for harbour porpoise (see Volume 3, Annex 10.5: Marine Mammal iPCoD Modelling Report of the EIA Report for more details). As discussed in paragraph 6.4.2.13, for Tier 2 projects, an indicative number of animals disturbed is presented based on the 20km EDR approach, using information gathered from the EIA scoping report for Bowdun OWF (no magnitude is presented at this stage for Tier 2 projects). There is no anticipated effect on the reference population. As such, there is no adverse effect on the population, nor significant disturbance, of the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.4.2.28 Adverse effects on the harbour porpoise qualifying feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of in-combination disturbance from underwater sound generated from piling during construction phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.48.

6.4.2.29 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of disturbance from underwater sound generated during piling with respect to the construction phase of Morven South in-combination with other plans and projects.

Table 6.48: Conclusions against the conservation objectives of the Special Areas of Conservation designated for marine mammals from in-combination disturbance from underwater sound generated during piling with respect to the construction phase

SAC	Feature	Conservation objective	Conclusion
Berwickshire and North Northumberland Coast SAC	Grey seal	The extent and distribution of qualifying natural habitats and habitats of the qualifying species are maintained.	There is no impact pathway between underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects and the extent, distribution, structure, and function of the habitats and supporting processes of grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Supplementary advice (Natural England, 2023) refers to maintaining spatial extent and distribution of supporting habitats including haul-out sites. The in-combination assessment found that only the mild disturbance contours overlapped the SAC from Morven South and Berwick Bank OWF. However, the area ensonified by in-combination piling would not impede connectivity between the site and the wider environment as grey seal are able to forage widely and disturbance during piling would only occur as short-term reversible events after which animals would return to baseline levels. Therefore, the presence, abundance, condition and diversity of habitats and species required to support grey seal will not be adversely affected and will be maintained.
		The structure and function of the habitats of the qualifying species are maintained.	
		The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely are maintained.	
		The populations of each of the qualifying species are maintained	There is no impact pathway for injury to grey seals from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects within the SAC. As described in Table 6.47 and paragraphs 6.4.2.15 to 6.4.2.17 underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects is unlikely to lead to significant disturbance of grey seals. There is no significant disturbance from project alone piling from any project; only the mild disturbance contours overlapped the SAC from Morven South and Berwick Bank OWF; and no population effect was demonstrated from the population modelling.
		The distribution of qualifying species within the site are maintained.	

SAC	Feature	Conservation objective	Conclusion
			Therefore, with respect to the supplementary advice the reproductive and recruitment capability of the species would be maintained (Natural England, 2023) and the population and distribution of grey seal within the SAC will not be adversely affected.
Isle of May SAC	Grey seal	2a. ensure grey seals are a viable component of the Isle of May SAC.	There is no impact pathway for injury to grey seals from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects within the SAC. As described in Table 6.47 and paragraphs 6.4.2.15 to 6.4.2.17, underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects is unlikely to lead to strong behavioural disturbance of grey seals. There is no significant disturbance from project alone piling from any project; only the mild disturbance contour from Morven South overlapped with the SAC, and no population effect was demonstrated from the population modelling. This ensures grey seals can move safely between the site and important areas of functionally linked sea outwith the site and that there is no effect on reproductive capability of grey seal during the breeding season and pup production would not be expected to decline as a result of this impact, ensuring stable or increasing grey seal numbers are maintained (NatureScot, 2025a). Therefore, grey seals will remain a viable component of the SAC.
		2b. ensure the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals.	This conservation objective refers to potential for long-term declines in the use of the site, changes in the distribution of the species on a sustained basis or changes in their behaviour such that it reduces the ability of the species to survive, breed or rear young (NatureScot, 2025a). As described in Table 6.47 and paragraphs 6.4.2.15 to 6.4.2.17 significant disturbance of grey seals from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects will be avoided. There is no significant disturbance from project alone piling from any project, as

SAC	Feature	Conservation objective	Conclusion
			only the mild disturbance contour from Morven South overlapped with the SAC, maintaining their ability to use and access all areas within the site used for pupping and nursing, and no population effect was demonstrated from the population modelling. Therefore, the distribution of grey seals within the SAC will not be adversely affected.
		2c. ensure the supporting habitats relevant to grey seal are maintained.	The focus of this conservation objective is on maintaining the extent, quality, and distribution of the supporting habitats required by breeding grey seals (NatureScot, 2025a). There is no impact pathway between underwater sound generated during piling at Morven South in-combination with piling from other plans and projects and the supporting habitats relevant to grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Thus, there is unlikely to be any effect at key times of year when seals, which rely on these habitats, may be resting or foraging within or close to the SAC. Therefore, the habitats required to support grey seal will not be adversely affected and will be maintained.
Firth of Tay and Eden Estuary SAC	Harbour seal	2a. ensure harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality.	The focus of this conservation objective is on protecting harbour seals from any mortality or injury that can prevent a longer-term recovery of harbour seal within the site (NatureScot, 2024). There is no impact pathway for injury to harbour seals from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects within the SAC as injury was screened out of the in-combination assessment (Table 6.43). Therefore, harbour seal will not be at significant risk of injury or mortality.
		2b. ensure the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.	As described in Table 6.47 and paragraphs 6.4.2.20 to 6.4.2.20, significant disturbance of harbour seals throughout the site from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects will be avoided. There is no significant disturbance from project alone piling

SAC	Feature	Conservation objective	Conclusion
			from any project; only the mild disturbance contour from Berwick Bank OWF overlapped with the SAC, and no population effect was demonstrated from the population modelling. This indicates harbour seals will continue to have access to, and can utilise, all habitats suitable for haul-outs and breeding associated within the site (NatureScot, 2024). Therefore, the distribution of harbour seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to harbour seal are maintained.	The focus of this conservation objective is on maintaining habitats within the SAC to support recovery of the species due to its declining status (NatureScot, 2024). There is no impact pathway between underwater sound generated during piling at Morven South in-combination the piling of other plans and projects and the supporting habitats and processes relevant to harbour seal (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour seal will not be adversely affected and will be maintained.
Southern North Sea SAC	Harbour porpoise	1. harbour porpoise are a viable component of the site.	There is no impact pathway for injury to harbour porpoise from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects within the SAC. As described in Table 6.47 and paragraphs 6.4.2.25 to 6.4.2.27, underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects is unlikely to lead to injury or strong behavioural disturbance of harbour porpoises. There is no significant disturbance from project alone piling from any project as none of the relevant disturbance contours extended to the SAC and no population effect was demonstrated from the population modelling. As such, there is no restriction on the survivability and reproductive potential of harbour porpoise using the site (JNCC and Natural England, 2019) from underwater sound during in-combination piling.

SAC	Feature	Conservation objective	Conclusion
			Therefore, harbour porpoise will remain a viable component of the SAC.
		2. there is no significant disturbance of the species.	This conservation objective considers disturbance significant if it leads to the exclusion of harbour porpoise from a significant portion of the site (JNCC and Natural England, 2019). As described in Table 6.47 and paragraphs 6.4.2.25 to 6.4.2.27, significant disturbance of harbour porpoise from underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects will be avoided. There is no significant disturbance from project alone piling from any project, none of the relevant disturbance contours extend to the SAC and no population effect was demonstrated from the population modelling. Therefore, there will be no displacement of harbour porpoise from the site from underwater sound during in-combination piling and the SAC population will not be adversely affected.
		3. the condition of supporting habitats and processes, and the availability of prey is maintained.	This conservation objective (JNCC and Natural England, 2019) refers to the maintenance of supporting habitats (i.e. characteristics of the seabed and water column) and processes (i.e. movements and physical properties of the habitat) contributing to ensuring that prey is maintained within the site and is available to harbour porpoises. There is no impact pathway between underwater sound generated during piling at Morven South in-combination with the piling of other plans and projects and the supporting habitats and processes relevant to harbour porpoise (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour porpoise will not be adversely affected and will be maintained.

6.4.3 Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities

6.4.3.1 The LSE[2] assessment presented in the Morven Site HRA Screening Report and Section 5 of RIAA Part 1identified that during the construction and O&M phases, in-combination LSE[2] could not be ruled out for disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities. This relates to the following SACs and relevant Annex II marine mammal features:

- Berwickshire and North Northumberland Coast SAC:
  - Grey seal.
- Isle of May SAC:
  - Grey seal.
- Firth of Tay and Eden Estuary SAC:
  - Harbour seal.
- Southern North Sea SAC:
  - Harbour porpoise.
- Moray Firth SAC:
  - Bottlenose dolphin.

6.4.3.2 The Moray Firth SAC is included in the in-combination assessment as transit of vessels to Morven South may impact bottlenose dolphins associated with the Coastal East Scotland MU, the population of which is considered equivalent to the SAC population (paragraph 6.2.7.2).

6.4.3.3 The MDS considered for this in-combination assessment is shown in Table 6.49. The designed-in measures are presented in Table 6.35 for the assessment of Morven South alone are also relevant for the in-combination assessment.

6.4.3.4 For the purposes of the MDS for the in-combination assessment (Table 6.49), projects have been screened in and out on the following basis for disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities:

- Construction and O&M phases – it is expected that each project will contribute to the increase of vessel traffic and hence to the amount of vessel noise in the environment during the construction and O&M phases. However, the potential to experience disturbance by marine mammal receptors would be expected to be localised to within the close vicinity (i.e. within kilometres) of the respective projects and as such the in-combination assessment has focused only on projects within a 86km buffer of Morven South as a precautionary approach.

6.4.3.5 The in-combination assessment presented in this RIAA Part 2 has been undertaken on the basis of information presented in the RIAAs (or LSE Screening Reports) for the other projects, which is based upon their respective MDS. The level of potential in-combination impact on Annex II marine mammals would likely be reduced significantly from those presented here.

6.4.3.6 The list of projects considered in the MDS (Table 6.49) is reduced from the list in Table 6.44 as the Tier 1 projects Caledonia OWF and Cenos OWF, and the Tier 2 project Ayre OWF are outwith the 86km buffer. Ossian OWF was screened out as the HRA documentation did not consider vessel noise and other (non-piling) sound-producing activities as an impact pathway (Bellrock Offshore Wind Farm, 2024, Ossian OWFL, 2024d).

Table 6.49: Maximum Design Scenario considered for the assessment of potential impacts to Annex II marine mammals due to disturbance from vessel use during the construction and operation and maintenance phase of Morven South in-combination with other plans and projects

Project phase	Maximum Design Scenario	Justification
Construction	**Scenario 1** MDS as described for Morven South (Table 6.34), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 6.34), assessed cumulatively with MBAGC Project. **Scenario 4** MDS as described for Morven South (Table 6.34), assessed cumulatively with the following other projects and plans: <u>Tier 1</u> • Morven North; • Berwick Bank OWF; • Muir Mhòr OWF. <u>Tier 2</u> • MHPGC Project; • Bowdun OWF. <u>Tier 3</u> • MBAGC Project.	A precautionary buffer of 86km from the Morven South Boundary was used to screen projects into the in-combination assessment for this impact.
O&M	**Scenario 1** MDS as described for Morven South (Table 6.34), assessed cumulatively with MHPGC Project. **Scenario 2** MDS as described for Morven South (Table 6.34), assessed cumulatively with MBAGC Project. **Scenario 4**	

Project phase	Maximum Design Scenario	Justification
	MDS as described for Morven South (Table 6.34), assessed cumulatively with the following other projects and plans: Tier 1 • Morven North; • Berwick Bank OWF. • Muir Mhòr OWF. Tier 2 • MHPGC Project; • Bellrock OWF; • Bowdun OWF. Tier 3 • MBAGC Project.	

Construction phase and operation and maintenance phase

6.4.3.7 The summary of the whole project assessment for disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities is presented in Table 6.50 (Scenario 1 and 2; Table 4.1) and the in-combination is presented in Table 6.51 (Scenario 4, Table 4.1).

6.4.3.8 As detailed in Table 6.43, it is considered there is no potential for in-combination effects of auditory injury from underwater sound from vessel use and other (non-piling) sound-producing activities and therefore, the in-combination assessment focuses on disturbance only.

6.4.3.9 As detailed in Table 6.49, Morven North and three other Tier 1 projects and the MHPGC Project and two other Tier 2 projects were identified with the potential for in-combination impacts associated with underwater sound from vessel use and other (non-piling) sound-producing activities. The MBAGC Project was the only Tier 3 project identified.

6.4.3.10 The numbers of animals disturbed by vessel noise (where available, i.e. Tier 1 projects) for these projects are presented for their construction phases. This impact has also been screened in for the O&M phase, however numbers of animals potentially disturbed in this phase were considered to be lesser than or equal to those calculated for the construction phase of respective projects.

6.4.3.11 Berwick Bank OWF is located approximately 34km from Morven South. For the construction phase, the MDS for Berwick Bank OWF (SSE Renewables, 2022d) detailed up to 316 return trips of up to nine boulder clearance vessels and 104 return trips of up to three sandwave clearance vessels, construction activities associated with site preparation and inter-array and offshore export cables. Additionally, vessel movements associated with other activities such as foundation and OSPs/Offshore convertor station platform installation, will contribute to a maximum scenario of up to 11,484 vessel round trips over the construction phase. Vessel types will include main installation vessels, cargo barges, support vessels, tug/anchor handlers, guard vessels and others. The Berwick Bank OWF RIAA described that while this will lead to an uplift in vessel activity, the movements will be limited to within the Berwick Bank array area and Berwick Bank export cable corridor and will follow existing shipping routes to/from the ports. For Berwick Bank OWF, a maximum disturbance range of 4,320m was modelled for installation vessels, construction vessels, and rock placement vessels (although disturbance ranges were much lower for excavator, backhoe dredger, pipe laying, geophysical survey vessel and jack-up vessel as well as jack-up rig (300m)) (SSE Renewables, 2022d). This was predicted to result in up to 48 harbour porpoise, two bottlenose dolphin, 70 grey seal and up to one harbour seal experiencing disturbance. For other non-piling activities, a maximum disturbance range of 4,389m was modelled for cable laying activities. The Berwick Bank RIAA concluded no AEOI on any SACs during the construction phase (SSE Renewables, 2022d).

6.4.3.12 For the O&M phase, the MDS for Berwick Bank OWF (SSE Renewables, 2022d) detailed vessels for inspections, repairs, and surveys including up to four crew trans (832 annual return trips), one jack-up vessel (two trips/year), two support vessels (26 trips/year), one cable repair vessel (five trips/lifetime), two service operation vessels (four daily movements), one cable survey vessel (one trip/year), and one excavator/backhoe dredger (five trips/lifetime). The uplift in vessel activity during the O&M is considered to be relatively small in the context of the baseline levels of vessel traffic (SSE Renewables, 2022d), and vessel movements will be within the Berwick Bank array area and the Berwick Bank export cable corridor and will follow existing shipping routes to/from the ports. The size and noise outputs from vessels during the O&M phase will be similar to those used in the construction phase (numbers of animals was not presented in the Berwick Bank OWF RIAA), however, the number of vessel round trips and their frequency is much lower for the O&M phase compared to the construction phase. Therefore, the Berwick Bank RIAA concluded no AEOI on any SACs during the O&M phase (SSE Renewables, 2022d).

6.4.3.13 Muir Mhòr OWF is located approximately 77km from Morven South. For the construction phase, the MDS for Muir Mhòr assumes a maximum of 21 vessels may be present on site at the same time, resulting in a maximum of 1,711 return trips over the four year construction period (Muir Mhòr

Offshore Wind Farm, 2024b). The Muir Mhòr OWF RIAA stated that as there is already a high existing level of vessel activity within the vicinity, any vessel traffic as a result of Muir Mhòr OWF will not pose any additional risk above the current baseline levels (Muir Mhòr Offshore Wind Farm, 2024b). Only the Moray Firth SAC was screened in to the Muir Mhòr OWF RIAA and as no disturbance ranges were modelled for construction vessels there was a negligible impact on the bottlenose dolphin qualifying feature. During the O&M phase, a lower number of vessels were estimated and so the impact of vessel disturbance on the bottlenose dolphin was predicted as similar or lower than during the construction phase. Therefore, the Muir Mhòr OWF RIAA concluded no AEOI on the Moray Firth SAC (Muir Mhòr Offshore Wind Farm, 2024b).

6.4.3.14 No MDS is available for Bellrock OWF, at screening stage (Bellrock Offshore Wind Farm, 2024) and therefore numbers of vessels or type of vessels are unknown, but the HRA Screening Report includes use of vessels as a key potential underwater noise impact for both construction and O&M phases (though Bellrock is only screened into the in-combination assessment for the O&M phase as there will be no temporal overlap with the construction phase (plus one year buffer) of Morven South).

6.4.3.15 No MDS is available for Bowdun OWF, at screening stage (Bowdun OWF Limited, 2024b), and therefore numbers of vessels or type of vessels are unknown, but the Bowdun HRA Stage 1 LSE Screening Report includes injury and disturbance from underwater sound generated by vessel use and other noise producing activities as an impact.

Table 6.50: Morven South whole project assessment for disturbance to marine mammals from vessel use

Whole project assessment	
Scenario 1: Morven South + MHPGC Project	**Scenario 2: Morven South + MBAGC Project**
Construction phase	
The whole project assessment for Scenario 1 considers Morven South together with the MHPGC Project. Impacts associated with underwater sound, including disturbance to marine mammals from vessel use and other sound-producing, from the MHPGC Project are screened in for further assessment during the construction phase for the two grey seal SACs (Berwickshire and North Northumberland Coast SAC and Isle of May SAC) and the bottlenose dolphin SAC (Moray Firth SAC) in the MHPGC Project HRA Screening Report (MvOWL, 2025). However at this stage, the numbers of vessels is unknown for the MHPGC Project. It is likely to be fewer vessels for cable construction than for Morven South over a period of up to 2.5 years, and activities are likely to include pre-construction site investigation surveys; seabed preparation activities; offshore export cables installation; post installation surveys and additional cable protection (EnBW, 2024). Cumulatively across the projects there may be a minor uplift in vessel activity from the baseline (although noting that the assessments are based on the MDS and the number of vessels present at respective projects at any given time may in reality be lower). Additionally, vessel movements will be confined to the array area (Morven South) and/or offshore cable corridor routes (MHPGC Project) and are likely to follow existing shipping routes to and from port. Introduction of vessels during construction phase of the projects will not be a novel impact for marine mammals present in the area and therefore marine mammals are anticipated to demonstrate some degree of tolerance to sound from vessels (see discussion in paragraph 6.3.4.42). The duration of vessel activity is medium term (e.g. throughout the construction phase) and localised for each	The whole project assessment for Scenario 2 considers Morven South together with the MBAGC Project. Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the whole project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The whole project impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.).

Whole project assessment	
project, although it should be noted that vessel movements will occur intermittently over this period. The whole project impact is predicted to be of local spatial extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.).	
O&M phase	
The whole project assessment for Scenario 1 considers Morven South together with the MHPGC Project. Impacts associated with underwater sound, including disturbance to marine mammals from vessel use, from the MHPGC Project are screened in for further assessment during the O&M phase in the MHPGC Project HRA Screening Report (MvOWL, 2025). However at this stage, the numbers of vessels is unknown for the MHPGC Project. It is likely to be fewer vessels than for Morven South over a period of up to 35 years, and routine O&M activities may be carried out from Crew Transfer Vessels or Service Operation Vessels, with major maintenance activities (such as component exchanges) potentially requiring jack-up vessels, or specialist vessels such as cable repair and cable laying vessels (EnBW, 2024). Across the projects there may be a minor in-combination uplift in vessel activity from the baseline (although noting that the assessments are based on the MDS and the number of vessels present at respective projects at any given time may in reality be lower). Additionally, vessel movements will be confined to the array areas (Morven South) and/or offshore cable corridor routes (MHPGC Project) and are likely to follow existing shipping routes to and from port. Introduction of vessels during the O&M phases of the projects will not be a novel impact for marine mammals present in the area and therefore marine mammals are anticipated to demonstrate some degree of tolerance to sound from vessels (see discussion in paragraph 6.3.4.42). Although the duration of vessel activity	The whole project assessment for Scenario 2 considers Morven South together with the MBAGC Project. Given the similarities with Scenario 1 and the lack of publicly available parameters for the MBAGC Project in order to further quantify the whole project assessment, the magnitude of impact for Scenario 2 is as provided in the column for Scenario 1. The whole project impact is predicted to be of local spatial extent, Long-term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.).

Whole project assessment	
is considered to be long-term (e.g. throughout the O&M phase) and localised for each project, it should be noted that vessel movements will occur intermittently over this period. The whole project impact is predicted to be of local spatial extent, Long-term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.).	

Table 6.51: Morven South in-combination assessment for disturbance from vessel use

In-combination assessment
Scenario 4: Morven South and Tier 1, Tier 2 and Tier 3 Projects
Construction phase
The in-combination assessment for Scenario 4 considers Morven South together with the Tier 1, Tier 2 and Tier 3 projects below. Tier 1 The Tier 1 assessment includes Morven North, Berwick Bank OWF and Muir Mhòr OWF . The construction phase of Morven South has the potential to overlap with Morven North, Berwick Bank OWF and Muir Mhòr OWF (projects within 86km of Morven South) (see Table 6.46). It would not be realistic to present simply the sum of all vessels anticipated within each offshore wind farm as per respective MDSs as it is highly unlikely that all non-piling construction activities and all vessels would be on site at any one time at each project, and even less likely across in-combination projects due to constraints on vessels and equipment. Furthermore, the introduction of vessels during construction phase of the projects will not be a novel impact for marine mammals present in the area and therefore marine mammals are anticipated to demonstrate some degree of tolerance to sound from vessels (see paragraphs 6.3.4.42 *et seq.*). Disturbance impact ranges are localised around each project (e.g. 4.3km for Berwick Bank OWF; Muir Mhòr OWF did not present disturbance ranges) and disturbance ranges are unlikely to significantly overlap additively given the distances between projects, but it is acknowledged that the cumulative impact of repeated but individually small disturbances over multiple projects may lead to greater disturbance to marine mammals within the 86km buffer of Morven South. Berwick Bank OWF and Muir Mhòr OWF committed in their RIAAs that vessel movements will be confined to the respective array and offshore export cable corridor(s) and will follow existing shipping routes to/from port (Muir Mhòr Offshore Wind Farm, 2024b, SSE Renewables, 2022d), with animals familiar to baseline existing shipping routes. Morven North has a similar maximum disturbance range to Morven South (39.7km) and also stated that vessels would likely follow existing shipping routes to and from ports, with vessel movements limited to within the Morven North Boundary (MvOWL, 2026a).

In-combination assessment
Although the duration of vessel activity is considered to be medium term (e.g. throughout the respective construction phases) and localised for each project, it should be noted that vessel movements will occur intermittently over this period. Standard industry measures will be in place (such as a Vessel Management Plan) for each project. Overall, the in-combination effect is predicted to be of regional extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.). <u>Tier 2</u> The Tier 2 assessment includes Morven South, the Tier 1 projects and Tier 2 Projects: MHPGC Project, and Bowdun OWF. For Bowdun OWF, the exact numbers or type of vessels are not in the public domain (Bowdun OWF Limited, 2024b), but it is considered disturbance impacts are likely to be at a similar scale to that of Morven South alone (see Section 6.3.4). Given than Bowdun is approximately 44km from Morven South, it is unlikely that significant disturbance effects will overlap with those from Morven South. Designed-in measures include a NSPVMP at Bowdun, and it is likely vessel movements will be confined to the respective Array and offshore export cable corridor(s) and will follow existing shipping routes to/from port. It is possible that the construction phase of the MHPGC Project may overlap with that of Morven South, however there are no details on the MHPGC Project construction programmes currently available in the public domain. However, any additional cumulative effects over and above Tier 1 projects would extend over a similar timeframe and would similarly lead to short-term reversible effects from intermittent vessel disturbance events. The in-combination effect is predicted to be of regional extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.). <u>Tier 3</u> The Tier 3 assessment includes Morven South, the Tier 1 projects, the Tier 2 Projects, and the MBAGC Project. It is possible that the construction phases of the MBAGC Project may overlap with that of Morven South, however there are no details on their construction programmes currently available in the public domain. The contribution of the MBAGC project is considered to be small in relation to Tier 1 and Tier 2 projects and would not elevate the assessment of magnitude. The in-combination effect is predicted to be of regional extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.).
O&M phase
The in-combination assessment for Scenario 4 considers Morven South together with the Tier 1, Tier 2 and Tier 3 projects below. <u>Tier 1</u>

In-combination assessment
The Tier 1 assessment includes Morven South, Morven North, Berwick Bank OWF, and Muir MhòrOWF. It is considered the size/noise outputs from vessels will be similar to those in the construction phase, but the number of vessel round trips and their frequency is much lower for the O&M phase. The O&M phase of Morven South has the potential to overlap with Morven North, Berwick Bank OWF and Muir Mhòr OWF (projects within 86km of Morven North) (see Table 6.46). It would not be realistic to present simply the sum of all vessels anticipated within each offshore wind farm as per respective MDSs as it is highly unlikely that all non-piling construction activities and all vessels would be on site at any one time at each project, and even less likely across in-combination projects due to constraints on vessels and equipment. Furthermore, the introduction of vessels during O&M phase of the projects will not be a novel impact for marine mammals present in the area and therefore marine mammals are anticipated to demonstrate some degree of tolerance to sound from vessels (see paragraphs 6.3.4.42 *et seq.*). Disturbance impact ranges (presented for the construction phase for each project) are localised around each project and disturbance ranges are unlikely to significantly overlap additively given the distances between projects, but it is acknowledged that the cumulative impact of repeated but individually small disturbances over multiple projects may lead to greater disturbance to marine mammals. Berwick Bank OWF and Muir Mhòr OWF committed in their RIAAs that vessel movements will be confined to the respective array and offshore export cable corridor(s) and will follow existing shipping routes to/from port (Muir Mhòr Offshore Wind Farm, 2024b, SSE Renewables, 2022d), with animals familiar to baseline existing shipping routes. Morven North stated that vessels would likely follow existing shipping routes to and from ports, with vessel movements limited to within the Morven North Boundary (MvOWL, 2026a). Although the duration of vessel activity is considered to be Long-term (e.g. throughout the respective O&M phases) and localised for each project, it should be noted that vessel movements will occur intermittently over this period. Standard industry measures will be in place (such as a Vessel Management Plan) for each project. Overall, the in-combination effect is predicted to be of regional extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.). <u>Tier 2</u> The Tier 2 assessment includes Morven South, the Tier 1 projects and Tier 2 Projects: MHPGC Project, Bellrock and Bowdun OWF. For Bowdun OWF the exact numbers or type of vessels are not in the public domain (Bowdun OWF Limited, 2024b), but it is considered disturbance impacts are likely to be at a similar scale to that of Morven South alone (see Section 6.3.4). Given than Bowdun is approximately 44km from Morven South, it is unlikely that significant disturbance effects will overlap with those from Morven South. Designed-in mitigation includes a NSPVMP at Bowdun, and it is likely vessel movements will be confined to the respective Array and offshore export cable corridor(s) and will follow existing shipping routes to/from port. Similarly for Bellrock OWF (Bellrock Offshore Wind Farm, 2024) use of vessels is included under underwater sound impacts in the HRA Screening Report. For Bellrock OWF the exact numbers or type of vessels are not in the public domain, but it is considered disturbance impacts are likely to be at a similar scale to that of Morven South alone (see Section 6.3.4). Given that Bellrock OWF is approximately 35km from Morven South, it is highly unlikely that significant disturbance effects will overlap with those from Morven South, but it is acknowledged that the cumulative impact of repeated but individually small disturbances over multiple projects may lead to greater disturbance to marine mammals. Designed-in mitigation measures includes vessel best practice measures (Bellrock Offshore Wind

In-combination assessment
Farm, 2024). It is possible that the construction and O&M phases of the MHPGC Project may overlap with that of Morven North, however there are no details onthe MHPGC Project construction programmes currently available in the public domain. However, any additional cumulative effects over and above Tier 1 projects would extend over a similar timeframe and would similarly lead to short-term reversible effects from intermittent vessel disturbance events. The in-combination effect is predicted to be of regional extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.). <u>Tier 3</u> The Tier 3 assessment includes Morven South, the Tier 1 projects, the Tier 2 projects, and the MBAGC Project. It is possible that the construction phases of the MBAGC Project may overlap with that of Morven North, however there are no details on the MBAGC Project construction programmes currently available in the public domain. The contribution of the MBAGC project is considered to be small in relation to Tier 1 and Tier 2 projects and would not elevate the assessment of magnitude The in-combination effect is predicted to be of regional extent, medium term duration, intermittent and high reversibility. It is considered that not all species make aversive movements to vessels, effect ranges are small (based on empirical evidence of receptors in the field) and effects are very short lived (paragraph 6.3.4.39 *et seq*.).

Berwickshire and North Northumberland Coast Special Area of Conservation and Isle of May Special Area of Conservation

Grey seal

6.4.3.16 Table 6.50 presents the predicted effects of the whole project assessments (Scenario 1 and 2), while Table 6.51 presents information on the predicted effects from Tier 1 and Tier 2 projects.

6.4.3.17 The numbers of grey seal predicted to be disturbed by Tier 1 projects ranged from 39 for Morven South to 70 for Berwick Bank OWF (SSE Renewables, 2022d). This equates to a range of 0.1% to 0.2% of the combined East Scotland and Northeast SMUs population. No grey seals were predicted to be disturbed by Muir Mhòr OWF as the Berwickshire and North Northumberland Coast SAC and Isle of May SAC were screened out of their RIAA (Muir Mhòr Offshore Wind Farm, 2024b). Therefore, as described for Morven South alone in paragraphs 6.3.4.49 and 6.3.4.50 for the construction phase and paragraphs 6.3.4.84 and 6.3.4.85 for the O&M phase, there will be no adverse effect on the population, nor significant disturbance, of the Berwickshire and North Northumberland Coast SAC, the Isle of May, or both.

Conclusion

6.4.3.18 Adverse effects on the grey seal qualifying feature of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC that undermine the conservation objectives of these SAC will not occur as a result of in-combination disturbance from vessel use and other (non-piling) activities during construction phase and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraphs 6.2.3.5 and 6.2.4.5 respectively) is presented in Table 6.52.

6.4.3.19 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC as a result of disturbance from vessel use and other (non-piling) activities with respect to the construction and O&M phases of Morven South in-combination with other plans and projects.

Firth of Tay and Eden Estuary Special Area of Conservation

Harbour seal

6.4.3.20 Table 6.50 presents the predicted effects of the whole project assessments (Scenario 1 and 2), while Table 6.51 presents information on the predicted effects from Tier 1 and Tier 2 projects.

6.4.3.21 A maximum of one harbour seal is predicted to be disturbed by each Tier 1 projects, excluding Muir Mhòr OWF as the Firth of Tay SAC was screened out of their RIAA (Muir Mhòr Offshore Wind Farm, 2024b). This equates to 0.2% of the combined East Scotland and Northeast SMUs[5] population. Therefore, as described for Morven South alone in paragraphs 6.3.4.53 and 6.3.4.57 for the construction phase and paragraphs 6.3.4.88 and 6.3.4.89 for the O&M phase, significant disturbance of harbour seal from the Firth of Tay and Eden Estuary SAC will not occur as a result of in-combination disturbance.

Conclusion

6.4.3.22 Adverse effects on the harbour seal qualifying feature of the Firth of Tay and Eden Estuary SAC that undermine the conservation objectives of the SAC will not occur as a result of in-combination disturbance from vessel use and other (non-piling) activities during construction phase and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.5.5) is presented in Table 6.52.

6.4.3.23 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Firth of Tay and Eden Estuary SAC as a result of disturbance from vessel use and other (non-piling) activities with respect to the construction and O&M phases of Morven South in-combination with other plans and projects.

Southern North Sea Special Area of Conservation

Harbour porpoise

6.4.3.24 Table 6.50 presents the predicted effects of the whole project assessments (Scenario 1 and 2), while Table 6.51 presents information on the predicted effects from Tier 1 and Tier 2 projects.

6.4.3.25 The numbers of harbour porpoises predicted to be disturbed by Tier 1 projects, excluding Muir Mhòr OWF as the Southern North Sea SAC was screened out of their RIAA (Muir Mhòr Offshore Wind Farm, 2024b), ranged from 78 for Berwick Bank OWF (SSE Renewables, 2022d) to 93 for Morven South and Morven North (MvOWL, 2026a). This equates to less than 0.1% of the UK portion of the North Sea MU population. Therefore, as described for Morven South alone is paragraphs 6.3.4.66 and 6.3.4.67 for the construction phase and paragraphs 6.3.4.92 and 6.3.4.93 for the O&M phase, there will be no adverse effect on the population, nor significant disturbance, of the harbour porpoise feature of the Southern North Sea SAC.

Conclusion

6.4.3.26 Adverse effects on the harbour porpoise qualifying feature of the Southern North Sea SAC that undermine the conservation objectives of the SAC will not occur as a result of in-combination disturbance from vessel use and other (non-piling) activities during construction phase and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.6.4) is presented in Table 6.52.

6.4.3.27 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Southern North Sea SAC as a result of disturbance from vessel use and other (non-piling) activities with respect to the construction and O&M phases of Morven South in-combination with other plans and projects.

Moray Firth Special Area of Conservation

Bottlenose dolphin

6.4.3.28 Table 6.50 presents the predicted effects of the whole project assessments (Scenario 1 and 2), while Table 6.51 presents information on the predicted effects from Tier 1 and Tier 2 projects.

6.4.3.29 The numbers of bottlenose dolphins predicted to be disturbed by Tier 1 projects ranged from less than one for Morven South, Morven North and Muir Mhòr OWF (Muir Mhòr Offshore Wind Farm, 2024b, MvOWL, 2026a) to two for Berwick Bank OWF (SSE Renewables, 2022d). This equates to less than 0.9% of the Coastal East Scotland MU population (SSE Renewables, 2022d). Therefore, as described for Morven South alone is paragraphs 6.3.4.74 and 6.3.4.77 for the construction phase and paragraphs 6.3.4.96 and 6.3.4.97 for the O&M phase, there will be no adverse effects on the population, nor significant disturbance, of the bottlenose dolphin feature of the Moray Firth SAC.

Conclusion

6.4.3.30 Adverse effects on the bottlenose dolphin qualifying feature of the Moray Firth SAC that undermine the conservation objectives of the SAC will not occur as a result of in-combination disturbance from vessel use and other (non-piling) sound-producing activities during construction phase and O&M phase activities. An assessment of the effects from this activity against the relevant conservation objectives (as presented in paragraph 6.2.7.5) is presented in Table 6.52.

6.4.3.31 It can be concluded beyond reasonable scientific doubt that there is no risk of an AEOI of the Moray Firth SAC as a result of disturbance from vessel use and other (non-piling) activities with respect to the construction and O&M phases of Morven South in-combination with other plans and projects.

Table 6.52: Conclusions against the conservation objectives of the Special Areas of Conservation designated for marine mammals from in-combination disturbance to marine mammals from vessel use and other (non-piling) activities with respect to the construction and operation and maintenance phases

SAC	Feature	Conservation objective	Conclusion
Berwickshire and North Northumberland Coast SAC	Grey seal	The extent and distribution of qualifying natural habitats and habitats of the qualifying species are maintained.	There is no impact pathway between vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects and the extent, distribution, structure, and function of the habitats and supporting processes of grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Supplementary advice (Natural England, 2023) refers to maintaining spatial extent and distribution of supporting habitats including haul-out sites. In-combination vessel use and other (non-piling) activities would not impede connectivity between the site and the wider environment as grey seal are able to forage widely and disturbance would only occur as intermittent events to which animals have some tolerance and would return to baseline levels soon after. Therefore, the presence, abundance, condition and diversity of habitats and species required to support grey seal will not be adversely affected and will be maintained.
		The structure and function of the habitats of the qualifying species are maintained.	
		The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely are maintained.	
		The populations of each of the qualifying species are maintained	There is no impact pathway for injury to grey seals from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects within the SAC. As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.16 to 6.4.3.17, vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects is unlikely to lead to significant disturbance of grey seals. There is no significant disturbance from project alone vessel use and other (non-piling) activities from any project and no population effect was demonstrated from the population modelling. Therefore, with respect to the supplementary advice the reproductive and recruitment capability of the species would be maintained
		The distribution of qualifying species within the site are maintained.	

SAC	Feature	Conservation objective	Conclusion
			(Natural England, 2023) and the population and distribution of grey seal within the SAC will not be adversely affected.
Isle of May SAC	Grey seal	2a. ensure grey seals are a viable component of the Isle of May SAC.	There is no impact pathway for injury to grey seals from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects within the SAC. As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.16 to 6.4.3.17, vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects is unlikely to lead to strong behavioural disturbance of grey seals. There is no significant disturbance from project alone vessel use and other (non-piling) activities from any project and no population effect was demonstrated from the population modelling. This ensures grey seals can move safely between the site and important areas of functionally linked sea outwith the site and that there is no effect on reproductive capability of grey seal during the breeding season and pup production would not be expected to decline as a result of this impact, ensuring stable or increasing grey seal numbers are maintained (NatureScot, 2025a). Therefore, grey seals will remain a viable component of the SAC.
		2b. ensure the distribution of grey seal throughout the site is maintained by avoiding significant disturbance of grey seals.	This conservation objective refers to potential for long-term declines in the use of the site, changes in the distribution of the species on a sustained basis or changes in their behaviour such that it reduces the ability of the species to survive, breed or rear young (NatureScot, 2025a). As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.16 to 6.4.3.17, significant disturbance of grey seals from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects will be avoided. There is no significant disturbance from project alone vessel use and other (non-piling) activities from any project, maintaining their ability to use and access all areas

SAC	Feature	Conservation objective	Conclusion
			within the site used for pupping and nursing. and no population effect was demonstrated from the population modelling. Therefore, the distribution of grey seals within the SAC will not be adversely affected.
		2c. ensure the supporting habitats relevant to grey seal are maintained.	The focus of this conservation objective is on maintaining the extent, quality, and distribution of the supporting habitats required by breeding grey seals (NatureScot, 2025a). There is no impact pathway between vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects and the supporting habitats relevant to grey seal (i.e. no overlap with the area of significant disturbance with the SAC). Thus, there is unlikely to be any effect at key times of year when seals, which rely on these habitats, may be resting or foraging within or close to the SAC. Therefore, the habitats required to support grey seal will not be adversely affected and will be maintained.
Firth of Tay and Eden Estuary SAC	Harbour seal	2a. ensure harbour seal within the Firth of Tay and Eden Estuary SAC are not at significant risk from injury or mortality.	The focus of this conservation objective is on protecting harbour seals from any mortality or injury that can prevent a longer-term recovery of harbour seal within the site (NatureScot, 2024). There is no impact pathway for injury to harbour seals from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects within the SAC. Therefore, harbour seal will not be at significant risk of injury or mortality.
		2b. ensure the distribution of harbour seal throughout the site is maintained by avoiding significant disturbance.	As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.20 to 6.4.3.21, significant disturbance of harbour seals throughout the SAC from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects will be avoided. There will be no significant disturbance from project alone vessel use and other (non-piling) activities from any project and no population effect was demonstrated from the population modelling. This indicates harbour

SAC	Feature	Conservation objective	Conclusion
			seals will continue to have access to, and can utilise, all habitats suitable for haul-outs and breeding associated within the site (NatureScot, 2024). Therefore, the distribution of harbour seals within the SAC will not be adversely affected and will be maintained.
		2c. ensure the supporting habitats and processes relevant to harbour seal are maintained.	The focus of this conservation objective is on maintaining habitats within the SAC to support recovery of the species due to its declining status (NatureScot, 2024). There is no impact pathway between vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects and the supporting habitats and processes relevant to harbour seal (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour seal will not be adversely affected and will be maintained.
Southern North Sea SAC	Harbour porpoise	1. harbour porpoise are a viable component of the site.	There is no impact pathway for injury to harbour porpoise from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects within the SAC. As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.24 to 6.4.3.25, vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects is unlikely to lead to strong behavioural disturbance of harbour porpoises. There is no significant disturbance from project alone vessel use and other (non-piling) activities from any project and no population effect was demonstrated from the population modelling. As such, there is no restriction on the survivability and reproductive potential of harbour porpoise using the site (JNCC and Natural England, 2019) from vessel use and other (non-piling) activities. Therefore, harbour porpoise will remain a viable component of the SAC.

SAC	Feature	Conservation objective	Conclusion
		2. there is no significant disturbance of the species.	This conservation objective considers disturbance significant if it leads to the exclusion of harbour porpoise from a significant portion of the site (JNCC and Natural England, 2019). As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.24 to 6.4.3.25, significant disturbance of harbour porpoise from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects will be avoided. There is no significant disturbance from project alone vessel use and other (non-piling) activities from any project and no population effect was demonstrated from the population modelling. Therefore, there will be no displacement of harbour porpoise from the site from vessel use and other (non-piling) activities and the SAC population will not be adversely affected.
		3. the condition of supporting habitats and processes, and the availability of prey is maintained.	This conservation objective (JNCC and Natural England, 2019) refers to the maintenance of supporting habitats (i.e. characteristics of the seabed and water column) and processes (i.e. movements and physical properties of the habitat) contributing to ensuring that prey is maintained within the site and is available to harbour porpoise. There is no impact pathway between vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects and the supporting habitats and processes relevant to harbour porpoise (i.e. no overlap with the area of significant disturbance with the SAC). Therefore, the habitats and processes required to support harbour porpoise will not be adversely affected and will be maintained.
Moray Firth SAC	Bottlenose dolphin	2a. ensure the population of bottlenose dolphin is a viable component of the site.	The focus of this conservation objective is on minimising the risk to bottlenose dolphin from injury or mortality posed by activities (NatureScot, 2025c). There is no impact pathway for injury bottlenose dolphin from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects within the SAC, so no risk of injury to or

SAC	Feature	Conservation objective	Conclusion
			mortality of bottlenose dolphin. Therefore, bottlenose dolphin will remain a viable component of the SAC.
		2b. ensure the distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.	As described in Table 6.50, Table 6.51 and paragraphs 6.4.3.28 to 6.4.3.29, significant disturbance of bottlenose dolphin from vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects will be avoided. There is no significant disturbance from project alone vessel use and other (non-piling) activities from any project throughout the SAC or the functionally linked Coastal East Scotland MU (NatureScot, 2025c) and no population effect was demonstrated from the population modelling. Bottlenose dolphin will continue to use and have access to all areas of the site and therefore, the SAC population will not be adversely affected.
		2c. ensure the supporting habitats and processes relevant to bottlenose dolphin and their prey/food resources for bottlenose dolphins are maintained.	The focus of this conservation objective is on maintaining sufficient prey resources and supporting habitats and processes to support the distribution and population of bottlenose dolphin associated with the site (NatureScot, 2025c). There is no impact pathway between vessel use and other (non-piling) activities at Morven South in-combination with vessel use and other (non-piling) activities of other plans and projects and the supporting habitats and processes relevant to bottlenose dolphin (i.e. no overlap with the area of significant disturbance with the SAC nor functionally linked Coastal East Scotland MU). Therefore, the habitats and processes required to support bottlenose dolphin will not be adversely affected and will be maintained.

7 Summary

7.1.1.1 A summary of the assessments presented in this RIAA Part 2 is provided in the sections below. Table 7.1 presents the conclusions of no AEOI of each SAC in relation to Morven South alone and in-combination with other plans and projects.

Table 7.1: Summary of conclusions for the assessment of adverse effects on Special Area of Conservation site integrity for Morven South alone and in-combination

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
Annex II diadromous fish						
UK0030251	River Dee SAC	Atlantic salmon Freshwater pearl mussel	Construction	• Underwater sound impacting fish and shellfish receptors (alone and in-combination)	No AEOI of the site	No AEOI of the site
			O&M	• EMF from subsea electrical cables (alone and in-combination)	No AEOI of the site	No AEOI of the site
UK0030262	River South Esk SAC	Atlantic salmon Freshwater pearl mussel	Construction	• Underwater sound impacting fish and shellfish receptors (alone and in-combination)	No AEOI of the site	No AEOI of the site
			O&M	• EMF from subsea electrical cables (alone and in-combination)	No AEOI of the site	No AEOI of the site
UK0012691	River Tweed SAC	Atlantic salmon	Construction	• Underwater sound impacting fish and shellfish receptors (alone and in-combination)	No AEOI of the site	No AEOI of the site
			O&M	• EMF from subsea electrical cables (alone and in-combination)	No AEOI of the site	No AEOI of the site
UK0030312	River Tay SAC	Atlantic salmon	Construction	• Underwater sound impacting fish and shellfish receptors (alone and in-combination)	No AEOI of the site	No AEOI of the site

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
			O&M	• EMF from subsea electrical cables (alone and in-combination)	No AEOI of the site	No AEOI of the site
UK0030263	River Teith SAC		Construction	• Underwater sound impacting fish and shellfish receptors (alone and in-combination)	No AEOI of the site	No AEOI of the site
			O&M	• EMF from subsea electrical cables (alone and in-combination)	No AEOI of the site	No AEOI of the site
Annex II marine mammals						
UK0017072	Berwickshire and North Northumberland Coast SAC	Grey seal	Construction	• Injury and disturbance from underwater sound generated from piling (alone) • Disturbance from underwater sound generated from piling (in-combination) • Injury and disturbance from underwater sound generation from UXO clearance (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	No AEOI of the site

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
				• Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)		
			O&M	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)	No AEOI of the site	No AEOI of the site
			Decommissioning	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	N/A
UK0030172	Isle of May SAC	Grey seal	Construction	• Injury and disturbance from underwater sound generated from piling (alone) • Disturbance from underwater sound generated from piling (in-combination)	No AEOI of the site	No AEOI of the site

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
				• Injury and disturbance from underwater sound generation from UXO clearance (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)		
			O&M	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)	No AEOI of the site	No AEOI of the site
			Decommissioning	• Injury and disturbance to marine mammals from vessel use and	No AEOI of the site	N/A

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
				other (non-piling) sound-producing activities (alone)		
UK0030311	Firth of Tay and Eden Estuary SAC	Harbour seal	Construction	• Injury and disturbance from underwater sound generated from piling (alone) • Disturbance from underwater sound generated from piling (in-combination) • Injury and disturbance from underwater sound generation from UXO clearance (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)	No AEOI of the site	No AEOI of the site
			O&M	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	No AEOI of the site

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
				• Injury and disturbance to marine mammals from site investigation surveys (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)		
			Decommissioning	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	N/A
UK0030395	Southern North Sea SAC	Harbour porpoise	Construction	• Injury and disturbance from underwater sound generated from piling (alone) • Disturbance from underwater sound generated from piling (in-combination) • Injury and disturbance from underwater sound generation from UXO clearance (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	No AEOI of the site

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
				• Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)		
			O&M	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)	No AEOI of the site	No AEOI of the site
			Decommissioning	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	N/A
UK0019808	Moray Firth SAC	Bottlenose dolphin	Construction	• Injury and disturbance from underwater sound generated from piling (alone) • Injury and disturbance from underwater sound generation from UXO clearance (alone)	No AEOI of the site	No AEOI of the site

Site ID	Site name	Relevant qualifying features	Project phase	Potential impact	Conclusion for the assessment on Morven South alone	Conclusion for the assessment on Morven South in-combination with other plans and projects
				• Injury and disturbance to marine mammals from site investigation surveys (alone) • Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)		
			O&M	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone) • Injury and disturbance to marine mammals from site investigation surveys (alone) • Disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (in-combination)	No AEOI of the site	No AEOI of the site
			Decommissioning	• Injury and disturbance to marine mammals from vessel use and other (non-piling) sound-producing activities (alone)	No AEOI of the site	N/A

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