RWE Renewables UK Dogger Bank South (West) Limited

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Dogger Bank South Offshore Wind Farms

Report to Inform Appropriate Assessment

Habitats Regulations Assessment

Volume 6

Part 3 of 4 - Annex II Marine Mammals

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Glossary

Term	Definition
Agreement for Lease (AfL) Area	The Area of the seabed leased by The Crown Estate to the Applicants.
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables would be located. The Array Areas do not include the Offshore Export Cable Corridor or the Inter-Platform Cable Corridor within which no wind turbines are proposed. Each area is referred to separately as an Array Area.
Array cables	Offshore cables which link the wind turbines to the Offshore Converter Platform(s).
Automatic Identification System (AIS)	A system by which vessels automatically broadcast their identity and key statistics including location, destination, length, speed and current status, e.g., under power. Most commercial vessels and United Kingdom/European Union fishing vessels over 15m length are required to carry AIS.
Baseline	The existing conditions as represented by the latest available survey and other data which is used as a benchmark for making comparisons to assess the impact of the Projects.
Collision	The act or process of colliding (crashing) between two moving objects.
Cumulative effects	The combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor / resource.
Cumulative Effects Assessment (CEA)	The assessment of the combined effect of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor/resource.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).

Term	Definition
Development Scenario	Description of how the DBS East and / or DBS West Projects would be constructed either in isolation, sequentially or concurrently.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Electrical Switching Platform (ESP)	The Electrical Switching Platform (ESP), if required would be located either within one of the Array Areas (alongside an Offshore Converter Platform (OCP)) or the Export Cable Platform Search Area.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and EIA Regulations, including the publication of an Environmental Statement (ES).
Environmental Statement (ES)	A document reporting the findings of the EIA and produced in accordance with the EIA Directive as transposed into UK law by the EIA Regulations.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Fish and Shellfish Ecology Study Area	The Fish and Shellfish Ecology Study Area for the Projects is defined as ICES Rectangles 36E9; 36F0; 37E9; 37F0; 37F1; 37F2; 38F0; 38F1; and 38F2. It covers a total of 26,858km2, and includes the Offshore Development Area with a minimum buffer distance of 7km.
Habitats Regulations Assessment (HRA)	The process that determines whether or not a plan or project may have an adverse effect on the integrity of a European Site or European Offshore Marine Site.

Term	Definition
In Isolation Scenario	A potential construction scenario for one Project which includes either the DBS East or DBS West array, associated offshore and onshore cabling and only the eastern Onshore Converter Station within the Onshore Substation Zone and only the northern route of the onward cable route to the proposed Birkhill Wood National Grid Substation.
Inter-Platform Cable Corridor	The area where Inter-Platform Cables would route between platforms within the DBS East and DBS West Array Areas, should both Projects be constructed.
Inter-Platform Cables	Buried offshore cables which link offshore platforms.
Landfall	The point on the coastline at which the Offshore Export Cables are brought onshore, connecting to the onshore cables at the Transition Joint Bay (TJB) above mean high water.
Management Unit	Management units provide an indication of the spatial scales at which impacts of plans and projects alone, cumulatively and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK.
Offshore Development Area	The Offshore Development Area for ES encompasses both the DBS East and West Array Areas, the Inter-Platform Cable Corridor, the Offshore Export Cable Corridor, plus the associated Construction Buffer Zones.
Offshore Export Cable Corridor	This is the area which will contain the offshore export cables (and potentially the ESP) between the Offshore Converter Platforms and Transition Joint Bays at the landfall.
Offshore Export Cables	The cables which would bring electricity from the offshore platforms to the Transition Joint Bays (TJBs).

Term	Definition
Preliminary Environmental Information Report	Defined in the EIA Regulations as information referred to in part 1, Schedule 4 information for inclusion in environmental statements which has been compiled by the applicants and is reasonably required to assess the environmental effects of the development.
Projects Design (or Rochdale) Envelope	A concept that ensures the EIA is based on assessing the realistic worst case scenario where flexibility or a range of options is sought as part of the consent application.
Sequential Scenario	A potential construction scenario for the Projects where DBS East and DBS West are constructed with a lag between the commencement of construction activities. Either Project could be built first.
Special Area of Conservation (SAC)	Strictly protected sites designated pursuant to Article 3 of the Habitats Directive (via the Habitats Regulations) for habitats listed on Annex I and species listed on Annex II of the Directive.
Special Protection Area (SPA)	Strictly protected sites designated pursuant to Article 4 of the Birds Directive (via the Habitats Regulations) for species listed on Annex I of the Directive and for regularly occurring migratory species.
Statutory Nature Conservation Bodies (SNCBs)	Comprised of JNCC, Natural Resources Wales, Department of Agriculture, Environment and Rural Affairs/Northern Ireland Environment Agency, Natural England and Scottish Natural Heritage, these agencies provide advice in relation to nature conservation to government
The Applicants	The Applicants for the Projects are RWE Renewables UK Dogger Bank South (East) Limited and RWE Renewables UK Dogger Bank South (West) Limited. The Applicants are themselves jointly owned by the RWE Group of companies (51% stake) and Masdar (49% stake).
The Projects	DBS East and DBS West (collectively referred to as the Dogger Bank South Offshore Wind Farms).

Acronyms

Term	Definition
ADD	Acoustic Deterrent Device
AfL	Agreement for Lease
BNNC	Berwickshire and North Northumberland Coast
CEA	Cumulative Effects Assessment
CES	Coastal East Scotland
CL	Confidence Level
CPOD	Cetacean Porpoise Detector
CSIP	Cetacean Strandings Investigation Programme
CV	Coefficient of Variation
DCO	Development Consent Order
DBS	Dogger Bank South
ECC	Export Cable Corridor
EDR	Effective Deterrence Range
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EPP	Evidence Plan Process
EPS	European Protected Species
ES	Environmental Statement
ESP	Electrical Switching Platform
ETG	Expert Topic Group

Term	Definition
FCS	Favourable Conservation Status
HRA	Habitats Regulations Assessment
ICES	International Council for the Exploration of the Sea
JNCC	Joint Nature Conservation Committee
LSE	Likely Significant Effects
LWT	Lincolnshire Wildlife Trust
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MNR	Marine Noise Registry
MPCP	Marine Pollution Contingency Plan
MU	Management Unit
NAS	Noise Abatement Systems
NE	Natural England
NMFS	National Marine and Fisheries Service
NS	North Sea
OECC	Offshore Export Cable Corridor
OSPAR	Oslo and Paris Convention
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan

Term	Definition
PINS	Planning Inspectorate
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
SAC	Special Area of Conservation
SBP	Sub-Bottom Profiler
SEL	Sound Exposure Level
SELcum	Sound Exposure Level from cumulative exposure
SELss	Sound Exposure Level from single strike
SIP	Site Integrity Plan
SMASS	Scottish Marine Animal Strandings Scheme
SMRU	Sea Mammal Research Unit
SNS	Southern North Sea
SNCBs	Statutory Nature Conservation Bodies
SSC	Suspended Sediment Concentration
TCE	The Crown Estate
TTS	Temporary Threshold Shift
UK	United Kingdom
USBL	Ultra-Short Baseline
UXO	Unexploded Ordnance
ZOI	Zone of Influence

8 Sites Designated for Annex II Marine Mammals

8.1 Approach to Assessment

1. For each European site screened into the Appropriate Assessment the following has been provided:
   - A summary of the ecology of the marine mammal species relevant for each designated site assessment;
   - An assessment of the potential effects during the construction, operation, maintenance and decommissioning phases of Dogger Bank South (DBS) East and DBS West (hereafter referred to as 'the Projects'); and
   - An assessment of the potential for in-combination effects for the Projects alongside other relevant plans, projects and activities (hereafter referred to as 'schemes').
2. The assessment should be read in conjunction with the following linked documents:
   - **Volume 7, Chapter 5 Project Description (application ref: 7.5)**;
   - **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**;
   - **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)**;
   - **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**;
   - **Volume 7, Chapter 14 Shipping and Navigation (application ref: 7.14)**;
   - **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11);**
   - **Volume 7, Appendix 11-1 Marine Mammal Consultation Responses (application ref: 7.11.11.1)**;
   - **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**;
   - **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**;
   - **Volume 7, Appendix 11-4 iPCoD Modelling (application ref: 7.11.11.4)**;
   - **Volume 7, Appendix 11-5 CEA Screening (application ref: 7.11.11.5)**;

- **Volume 7, Appendix 11-6 Unexploded Ordnance Clearance Information and Assessment (application ref: 7.11.11.6)**; and
- **Volume 8, Stage 1 Marine Conservation Zone Assessment (application ref: 8.17)**.

3. Additional information to support the marine mammal assessment includes:

- **Volume 6, Appendix A Habitats Regulations Assessment Screening (application ref: 6.1.1)**

8.2 Consultation

4. The key elements of consultation to date have included scoping and the ongoing technical consultation via the marine mammal Expert Topic Group (ETG). The feedback received has been considered in preparing this Report to Inform Appropriate Assessment (RIAA).

5. **Table 8-1** provides a summary of how the consultation responses received to date have influenced the approach that has been taken.

Table 8-1 Consultation Responses Relevant to Marine Mammal sections of the RIAA

Consultee	Date/Document	Comment	Applicant Responses
The Planning Inspectorate (PINS)	Scoping Response 02/09/2022	Baseline characterisation, and connectivity with designations. The Applicants should make effort to agree the geographical context and population context of the marine mammal assessment with relevant consultation bodies, including any assumptions made in relation to connectivity to designated sites. The Inspectorate advises that connectivity to designations including the Southern North Sea (SNS) Special Area of Conservation (SAC) is relevant to the assessment in the Environmental Statement (ES) as well as the Habitat Regulation Assessment (HRA) screening process as stated in Paragraph 313.	Information on the study area for marine mammals, including relevant Management Units (MUs) is provided in section 8.3.5 to 8.3.9 and section 11.5 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, and further information in **Volume 7, Appendix 11-2 (application ref: 7.11.11.2**). This has been presented, discussed and agreed at the Marine Mammal ETG meetings by the MMO, Natural England and The Wildlife Trusts.
Natural England	HRA Screening Response 20/01/2023	Natural England Advise that the Moray Firth SAC should be screened in to reflect the potential for bottlenose dolphins from this site to travel within the order limits and be impacted by underwater noise during construction works and Unexploded Ordnance (UXO) clearance. There is preliminary evidence that known individuals from the bottlenose dolphin population associated with the Moray Firth SAC travel down into English waters. This population has a predominantly inshore distribution and therefore has the potential to be impacted by inshore project activities.	Noted - The Moray Firth SAC is screened into the HRA and assessed in section 8.3.9. The use of the Coastal East Scotland (CES) MU for the impact assessment has been considered in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** for potential impacts in the coastal region such as works in the Offshore Export Cable Corridor after Natural England's review of the current approach.
Natural England	HRA Screening Response 20/01/2023	Natural England advise that The Wash and North Norfolk Coast SAC should be screened into the HRA assessment for impacts to the Harbour seal feature due to connectivity based on telemetry data and known foraging ranges (see Carter *et al*. 2022).	Noted - The Wash and North Norfolk Coast SAC is screened into the HRA and assessed in section 8.3.7.
Natural England	HRA Screening Response 20/01/2023	Natural England advise that Berwickshire and North Northumberland Coast SAC should be screened into the HRA assessment for impacts on the Grey seal feature due to connectivity based on telemetry data and known foraging ranges (see Carter et al. 2022).	Noted - Berwickshire and North Northumberland Coast SAC is screened into the HRA and assessed in section 8.3.8.
Natural England	HRA Screening Response 20/01/2023	The Project has not specifically stated the foraging ranges that have been used to screen sites in or out for cetaceans or seals, we advise this is provided to ensure the most up to date figures are being used. For cetaceans, we advise that cetacean Management Units (MUs) are used to determine the connectivity to designated sites (further explanation on the use of the MUs is provided in IAMMWG, 2021). For bottlenose dolphin, there is evidence of movement from the Coastal East Scotland MU down the northeast coast of England as far as the Humber Estuary, therefore we consider that this population (and the associated Moray Firth SAC population) should be screened in. For seals, known foraging ranges and telemetry data (most recently updated in Carter et al. 2022) should be used to determine connectivity between the project ZOI and seals travelling outside the boundary of their designated sites. It does not appear that the Project has taken this approach. We consider that the project ZOI is within the known foraging range for the grey seal feature of the	Noted – population estimates for cetaceans and seals are based on the relevant UK MUs and up to date figures, including their foraging ranges. Further information is provided in **Volume 7, Appendix 11-2 (application ref: 7.11.11.2).** Further information is also provided within this document: Harbour porpoise is assessed and discussed further in section 8.3.5; Bottlenose dolphin is assessed and discussed further in section 8.3.9; Grey seal is assessed and discussed further in sections 8.3.6 and 8.3.8; and

Consultee	Date/Document	Comment	Applicant Responses
		Berwickshire and North Northumberland Coast SAC, and the harbour seal feature of the Wash and North Norfolk Coast SAC (Carter *et al.* 2022). Therefore, these sites should be screened in. For harbour porpoise, the correct reference population has been used. Similarly for the two seal species the NE England and SE England units have been used. For bottlenose dolphins associated with the Moray Firth SAC the MU that should be considered for this reference population is the Coastal East Scotland MU.	Harbour seal is assessed and discussed further in section 8.3.7.
Natural England	HRA Screening Response 20/01/2023	Barrier effects due to physical presence have not been screened in– NE previously recommended that this should be screened in (response from scoping report, advice dated 23rd August 22: 'barrier effects from physical presence should be considered further in the context of what is known about animal movements and activities in and around the array areas, such as telemetry data that may show seals transit through the area when foraging, before it is scoped in or out'). Consider screening these effects in as both grey and harbour seal telemetry data has shown evidence of individuals close to/ within the Offshore Development Area (Carter *et al.* 2020)	Noted, barrier effects have been screened in and assessed in the following sections: Harbour porpoise – sections 8.3.5.2.7 and 8.3.5.3.7; Bottlenose dolphin – sections 8.3.9.2.5 and 8.3.9.3.5; Grey seal – sections 8.3.6.3.7, 8.3.6.4.7, 8.3.8.3.7, and 8.3.8.4.7; and Harbour seal – sections 8.3.7.3.7 and 8.3.7.4.7.
Natural England	HRA Screening Response 20/01/2023	Disturbance at seal haul-out sites has not been screened in for any of the development phases however no rationale has been provided for screening it out. Either screen in disturbance at seal haul-out sites for project alone and in-combination assessment or include rationale for screening out.	Disturbance at seal haul-outs has been screened in and assessed in the following sections: Grey seal – sections 8.3.6.3.10, 8.3.6.4.10, 8.3.8.3.10, and 8.3.8.4.10; and Harbour seal – sections 8.3.7.3.10 and 8.3.7.4.10.
Natural England	HRA Screening Response 20/01/2023	EMF is not listed here whereas it is listed as being screened in as a direct effect in Table 4-6. We advise that the direct effects of EMF on cetaceans can be screened out, though the indirect effects on prey should be considered. Screen out direct EMF effects.	Noted, indirect effects are assessed in changes to prey resources which utilises the assessment from **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10**).
Natural England	HRA Screening Response 20/01/2023	The following is stated within the report 'If suitable underwater noise data is not available for noise levels associated with the underwater noise from the floating operational turbines, then a suitable proxy such as dredging will be used'. Clarification is needed on why dredging is considered a suitable proxy for this. Floating turbines are also not mentioned in the project description, or elsewhere in the report. Please clarify if this technology is being considered.	As outlined in **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** potential noise impacts from operational fixed turbines have been modelled based on the current data available and no proxy has been required. Floating turbines are not being considered for either of DBS East or DBS West and therefore not assessed.
Natural England	HRA Screening Response 20/01/2023	The text mentions the Harbour Porpoise North Sea MU is shown in Figure 4-3, but only the grey/harbour seal MUs are shown in this figure. Include figure of North Sea MU for harbour porpoise	The North Sea MU summer area and winter area in relation to the Projects is shown in **Figure 8-1**.

Consultee	Date/Document	Comment	Applicant Responses
Natural England	HRA Screening Response 20/01/2023	Natural England expect that seal presence in the array area, as well as the export cable corridor, will be characterised in the RIAA.	Information on the presence of seals from the relevant SAC has been presented in sections 8.3.6; 8.3.7 and 8.3.8.
Marine Mammal ETG	ETG Responses 20/02/2023	Natural England will confirm if the proposed approach of using the Greater North Sea MU in relation to bottlenose dolphin density estimates for the Preliminary Environmental Information Report (PEIR) is acceptable.	In response to Natural England's comments to the HRA Screening report we will assess the Moray Firth SAC based on the Coastal East Scotland (CES) MU which will be used for population estimates. The use of the CES MU for the impact assessment has been considered in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** for potential impacts in the coastal region such as works in the Offshore Export Cable Corridor after Natural England's review of the current approach.
Lincolnshire Wildlife Trust (LWT)	PEIR Responses 15/07/2023	LWT also highlight that there is significant potential for construction timelines to overlap with other noisy activities in the region, and therefore there is significant potential to exceed the area-based noise thresholds for the SNS SAC. These thresholds have already been close to being exceeded due to current, and much lower, levels of activity. We urge that collaboration between regulators and other developers (including those from other industries) will be paramount to ensuring that these thresholds are not exceeded, and no adverse impact on the harbour porpoise population of the SNS SAC occurs. Therefore, due to their likely requirement, the use of mitigation and noise abatement technologies should be explored as soon as possible.	A CEA has been carried out in section 11.8 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** and has included the latest information available for construction timelines to overlap with other noisy activities in the region. In relation to the SNS SAC the potential in combination will be assessed in **Volume 6, Report to Inform Appropriate Assessment Habitats Regulations Assessment (application ref: 6.1)**. As outlined in section 11.7 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, a SNS SAC Site Integrity Plan (SIP) would be prepared which will set out the approach to deliver any project mitigation, such as the requirement for any noise abatement technologies, or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the SNS SAC conservation objectives. The SIP would be an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the SNS SAC. **Volume 8, In Principle SIP (application ref: 8.26)** has been developed with the Development Consent Order (DCO) application and is based upon the best available

Consultee	Date/Document	Comment	Applicant Responses
			information and methodologies at the time of writing. Consultation will be undertaken during development of **Volume 8, In Principle SIP (application ref: 8.26)** with relevant stakeholders, including regulators and other developers and would be finalised prior to construction.
MMO	PEIR Responses 15/07/2023	In addition to this the MMO supports the development of a document or similar to manage noise within the North Sea. For the SNS SAC, this could be in the form of a SIP for piling and UXO clearance. The document will set out the approach to deliver any project mitigation or management measures to reduce the potential for any significant disturbance from noise and specifically disturbance to harbour porpoise in relation to the SNS SAC conservation objectives. The MMO highlights there is a number of industry wide discussions in relation to noise management and any changes to the approach to noise management will be discussed with the Applicants to be taken into account within their application.	As outlined in section 11.7 of **Volume 7, Chapter 11 Marine Mammals,** an **In Principle SIP (application ref: 8.26)** has been prepared. Consultation would be undertaken during development of the final SIP with relevant stakeholders, including regulators and other developers. The Applicants welcome discussions with the MMO on the industry wide discussions in relation to noise management and any changes to the approach to noise management that would need to be taken into account within their application. These discussions are set out in the ETG Responses 15/01/2024 below.
Natural England	PEIR Responses 15/07/2023	Regarding the HRA and the potential increase in vessel traffic during these projects, Natural England does not agree to screening out of disturbance to seal haul-out sites until likely construction ports are identified and potential disturbance can be assessed. Screen in disturbance to seal haul-out sites until construction ports are confirmed and potential disturbance can be assessed.	Acknowledged. This has been reviewed and updated in section 8.3.6, 8.3.7 and 8.3.8 to include potential impact on seal haul-out sites, taking in to account potential port locations known at this stage.
Natural England	PEIR Responses 15/07/2023	In the HRA screening, section 4.3.2.1; due to the potential increase in vessel traffic during these Projects, Natural England does not agree to screening out of disturbance to seal haul-out sites until likely construction ports are identified and potential disturbance can be assessed. Screen in disturbance to seal haul-out sites until construction ports are identified and potential disturbance can be assessed.	Acknowledged. This has been reviewed and updated in section 8.3.6, 8.3.7 and 8.3.8 to include potential impact on seal haul-out sites, taking in to account potential port locations known at this stage.
Natural England	PEIR Responses 15/07/2023	In the HRA screening, section 4.3.3.3; Figure 4-5 displays the MUs for bottlenose dolphins from the 2015 review. There have been updates and changes to the bottlenose dolphin MUs since then. Natural England request an update to the latest review (2023). Update figure to the latest review: IAMMWG. 2023. Review of Management Unit boundaries for cetaceans in UK waters (2023). JNCC Report 734, JNCC, Peterborough, ISSN 0963-8091. https://hub.jncc.gov.uk/assets/b48b8332-349f-4358-b080-b4506384f4f7	Acknowledged. This has been reviewed and updated in this report and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11).**
Dutch Reaction - Netherlands, with inputs provided by the Dutch Ministry of Infrastructure and Water	PEIR Responses 15/07/2023	We are not aware that any information on (best available techniques for) underwater noise reduction by applying mitigating measures has been included in your study. We hope this nevertheless will be included in an updated Environmetal Impact Assessment (EIA) and further construction process, as major effects are predicted for the harbour porpoise, minke whale and the grey seal due to underwater noise as a result of pile driving during the construction of Dogger Bank South Offshore Wind Farms. This was also a real concern for Dogger Bank Teesside A and B. The Netherlands mitigate this issue by setting requirements for maximum underwater noise exposure during pile	The EIA has presented the worst case scenario with no noise reduction at source to assess the potential effect. As outlined in section 11.7 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, a SNS SAC Site Integrity Plan (SIP) would be prepared which will set out the ap-proach to deliver any project mitigation, such as the re-quirement for any noise abatement technologies, or

Consultee	Date/Document	Comment	Applicant Responses
Management, the Ministry of Economic Affairs and Climate Policy, and the Ministry of Agriculture, Nature and Food Quality.		driving. Various noise mitigation measures can reduce noise exposure, for example using a bubble screen during pile driving. We hope that these suggestions can be taken into account in your further activities. Impacts on harbour porpoises and grey seals are transboundary as both populations do not keep to national boundaries. International cumulative effects should be included, as transboundary effects on the Dutch marine mammal population and Dutch Natura 2000 areas are expected. The Dogger Bank and Cleaver Bank Natura 2000 areas have both been designated for the protection of harbour porpoises and grey seals under the EU Habitats Directive. We also want to highlight that the migration routes of the grey seal between the United Kingdom and the Netherlands cross the area of the proposed wind farms. Moreover, the highest densities of harbour porpoises in the southern part of the North Sea can be found in and closely around the suggested project site according to previous analyses. We would value a thorough assessment as the proposed development is likely to affect our conservation objectives for these species.	management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the SNS SAC conservation objectives. The SIP would be an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place to reduce the significant disturbance of harbour porpoise in the SAC. Any measures implemented for the SNS SAC would be appropriate for the wider North Sea harbour porpoise population.
Natural England	ETG Responses 15/01/2024	There have had two summers now working on process where it has been pretty close to thresholds so although you may think this is precautionary, thresholds are close to getting breached. Levels of activity are only likely to increase. By time SIPs are coming to MMO it is too late for offshore windfarms to commit to things like NAS. Therefore the MMO feels current approach not going to hold for next Summer, but an approach Natural England is backing is for developers to commit to NAS upfront rather than to a menu of options. Test is to rule out adverse effects rather than risk based judgement and if measures in the SIP not needed that is fine, can remove. This is likely to be our advice going forward.	The Applicants take on board the advice regarding the mitigation measures, including that NAS should be committed to at the point of application. There are ongoing discussions with the consenting and engineering teams regarding the potential use of NAS, what that would mean for the procurement program, requirements and budgets. Updates as needed will be made to the Marine Mammal Mitigation Protocol (MMMP) and SIP, where relevant, once the approach has been agreed.
MMO	ETG Responses 15/01/2024	There has been a requirement for mitigation of many UXO clearance. Likely there will be a future limit on Projects of only three high order detonations at any one time. Don't know if this will change, there will be a lot of industry discussions. Beneficial to discuss procurement and requirements as may cause delays. Investigation needs to be done prior to any licence application.	Acknowledged. The Applicants have been having regular ongoing discussions regarding this throughout the entire team and are aware of the new draft UXO guidelines from the JNCC.
Natural England	ETG Responses 15/01/2024	Regarding for the in-combination assessment, although guidelines state low order is the best method, at this stage for the in-combination assessment, it is preferred to assess for high order as a worst case, but if everything is high order in practice.	Acknowledged. For the in -combination assessments, HO UXO will be assessed for 183 days. In addition, there have been large campaigns that have all been low order where a noise report should be submitted. If the Applicants are aware of any noise reports from other Projects being publicly available the relevant stakeholders would be notified.
		High number of the Humber Estuary grey seals potentially disturbed or potential TTS, this is not a realistic worse case, so worth exploring, worth looking at other approaches. Could commit to not undertaking certain activities. Or locate the ESP within the Array Areas. Avoid impact rather than mitigate. Figures seem high. Hornsea 4 not dissimilar so may be worth looking at to see how handled it.	Noted, Hornsea 4 ES approach has been reviewed for the Applicants' assessment. Only one piling event will happen in the Offshore Export Cable Corridor which has resulted in a reduction in numbers in section 8.3.6.3.2

Consultee	Date/Document	Comment	Applicant Responses
Natural England	ETG Responses 02/02/2024 (DAS/46435)	It is advised that mitigation measures including Noise Abatement Systems (NAS) are committed to in the draft Site Integrity Plan (SIP) at the point of application. Given the number of prospective offshore wind farms likely to be constructing at the same time as Dogger Bank South, noise impact reduction will be essential to ensure in-combination impacts do not exceed the thresholds for the Southern North Sea Special Area of Conservation (SNS SAC). It is highlighted that in the Project's own assessment results presented during the ETG show the thresholds will be exceeded n almost every scenario modelled. We acknowledge that the Project has included NAS as an option in the draft Site Integrity Plan (SIP) and intends to revisit whether it will be included post-consent, in consultation with NE and MMO. However, experience to date suggests that the feasibility for projects to implement NAS as mitigation post-consent if not already committed to it is extremely limited, due to the difference in timeframes for engagement and submission on the SIP and MMMP compared to Project financial milestones. Further, we consider that avoiding AEoI in the first instance should be prioritised over a risk based approach. Natural; England advise that a commitment to implement NAS is included pre-consent.	The Applicants take on board the advice regarding the mitigation measures, including that NAS should be committed to at the point of application. There are ongoing discussions with the consenting and engineering teams regarding the potential use of NAS, what that would mean for the procurement program, requirements and budgets. Updates as needed will be made to the MMMP and SIP, where relevant, once the approach has been agreed.
Natural England		Natural England also recommend that consideration is given to other mitigation commitments that could be made pre-application, such as limits on the number of piles installed in a 24 hour period within or across the arrays, and on concurrent piling across the arrays.	The number of piles installed per 24 hour period has been reduced since the PIER submission, see **Volume 7, Chapter 5 Project description (application ref: 7.5)** for more detail.
Natural England		Any evidence the Project is able to provide of successful low order campaigns to inform the Worst Case Scenario modelled would be welcomed. If evidence cannot be provided, high order clearance will need to be included in the assessment.	Noted. For the in combination assessment for the SNS SAC, high order clearance has been assessed for the full 186 days (section 8.3.5.5.1.3) and when other evidence is available to support low order alone clearance campaigns, it will be provided in the relevant documents post consent.
Natural England		With respect to impacts to the Humber Estuary SAC seal population from concurrent pin piling in the Offshore Export Cable Corridor, Natural England is concerned that 51.7% of the population is currently predicted to be impacted. Natural England recommend that a method statement detailing the data used and assumptions that have been made is provided for review. We suggest that further consideration may need to be given to a realistic Worst case Scenario and whether there are options to avoid or reduce the impacts, such as locating non-array structures further offshore or limiting the number of concurrent piles installed. We recommend looking at the assessment conducted by Hornsea Project 4 as their landfall and ECC are in a similar location. If the outputs remain the same, Natural England advise that population modelling for the grey seal population is carried out for cumulative disturbance.	There will be no concurrent piling in the Offshore Export Cable Corridor and no piling at the Array Areas and the Offshore Export Cable Corridor simultaneously so the impact on population has been reduced, see section 8.3.6.3.2. Population modelling has been undertaken; the results have been presented in section 8.3.6.3.2.1.1 and 8.3.6.3.2.2.1.
		Natural England advise that more detail is included in the Marine Mammal chapter of the ES on impacts the proposal may have on sandeels and therefore Harbour porpoise prey availability and interrelated effects. As the arrays are potential sandeel spawning sites, the whole ecological impact should be assessed in relation to conservation objective 3 for the SNS SAC.	This is described in sections 8.3.5.2.9.1 and 8.3.5.3.9.1.

8.3 Assessment of Potential Effects

6. Mitigation measures have been proposed where the assessment identifies that an aspect of the development is likely to give rise to significant environmental impacts and discussed with the relevant authorities and stakeholders in order to avoid, prevent or reduce impacts to acceptable levels.

7. For the purposes of the Habitat Regulations Assessment (HRA), two types of mitigation are defined:

- Embedded mitigation: consisting of mitigation measures that are identified and adopted as part of the evolution of the project design, and form part of the project design that is assessed in the HRA; and
- Additional mitigation: consisting of mitigation measures that are identified during the HRA process specifically to reduce or eliminate any predicted significant impacts. Additional mitigation is therefore subsequently adopted by the Applicants as the HRA process progresses.

8.3.1 Embedded Mitigation

8. This section outlines the embedded mitigation relevant to the marine mammal assessments, which has been incorporated into design of the Projects or constitutes standard mitigation measures for this topic (**Table 8-2**).

Table 8-2 Embedded Mitigation Measures

Parameter	Embedded Mitigation Measures	Where commitment is secured
Underwater Noise		
Soft-start and ramp-up (part of Marine Mammal Mitigation Protocol (MMMP) for piling activities)	Each piling event would commence with a soft-start at a lower hammer energy followed by a gradual ramp-up for at least 20 minutes to the maximum hammer energy required (the maximum hammer energy is only likely to be required at a few of the piling installation locations).	MMMP for Piling Deemed Marine Licence (DML) 1 & 2 - Conditions 15 & 20 - 22 DML 3 & 4-Conditions 13 & 18 - 20
Seasonal restrictions for	There will be no piling activity within the Offshore Export Cable Corridor during the winter season (October to March	DML 3 & 4 - Condition 24

Parameter	Embedded Mitigation Measures	Where commitment is secured
Marine Mammals	inclusive) to ensure that no potential significant disturbance occurs within the Southern Northern Sea Special Area of Conservation. This is detailed in **Volume 8, In Principle SIP (application ref: 8.26)** and would need to be managed alongside any other seasonal restriction in place for piling activities (e.g. for fish species).	
Concurrent piling	There will be no concurrent monopile installation for the ESP in the Offshore Export Cable Corridor with the Project Array Areas concurrently.	DML 3 & 4 - Condition 24
Vessel disturbance and collision risk		
Best practice to reduce vessel disturbance and collision risk	Vessel movements, where possible, will follow set vessel routes and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** is submitted as part of the DCO application to set out the details of the measures that will be taken in relation to collision risk, as required.	Project Environmental Management Plan (PEMP) DML 1 &2 - Condition 15 DML 3 & 4 - Condition 13 DML 5 - Condition 11
Water Quality		
Pollution Prevention Measures	Due to the presence and movements of construction and operation and maintenance vessels / equipment there is the potential for spills and leaks which could result in changes to water quality.	PEMP MPCP DML 1 & 2 - Condition 15 DML 3 & 4 - Condition 13

Parameter	Embedded Mitigation Measures	Where commitment is secured
	All vessels involved will be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. The production of one or more Project Environmental Management Plans (PEMPs) is a Condition of the five Deemed Marine Licences (DMLs). The final PEMP(s) would be in accordance with **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** and would detail all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed during the different phases of the Projects to minimise the risk of, and effects in, the event of an accidental spill. The final PEMP will identify all potential sources and types of accidental pollution for the relevant project phase and set out the proposed mitigation measures and will be developed in consultation with key stakeholders for approval by the MMO.The individual Projects and phases may require separate final PEMP(s). In addition, separate PEMPs may also be produced for individual packages.	DML 5 - Condition 11

8.3.2 Additional Mitigation

9. Mitigation will be required for the following activities, and will use the relevant JNCC guidelines as standard (the relevant guidelines are noted below);

- Unexploded Ordnance (UXO) clearance
    - Following the *JNCC guidelines for minimising the risk of injury to marine mammals from using explosives* (JNCC, 2010a[1]).
- Piling
    - Following the *Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise* (JNCC, 2010b).

10. While the JNCC guidelines will be used as a standard, they may be adapted to ensure that the predicted instantaneous and cumulative Permanent Threshold Shift (PTS) ranges are mitigated against, for all marine mammal species. It is expected that Acoustic Deterrent Devices (ADDs) will be used as part of the mitigation for both UXO clearance and piling. Mitigation and monitoring protocols will be developed for each of the above listed activities.

11. Mitigation and monitoring will be secured through the following management plans (**Table 8-3**).

Table 8-3 Additional mitigation

Parameter	Additional Mitigation Measures	Where commitment is secured
MMMP for Piling Activities		
MMMP for piling activities	The MMMP, produced in accordance with the content of **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** for piling will be developed in the pre-construction period and based upon best available information, methodologies, industry best	DML 1 & 2 - Condition 15 & 20 - 22

[1] The DRAFT JNCC guidelines for minimising the risk of injury to marine mammals from unexploded ordnance clearance in the marine environment (October 2023) is currently out for consultation and measures required post-consent will be up-dated accordingly once they are finalised.

Parameter	Additional Mitigation Measures	Where commitment is secured
	practice, latest scientific understanding, current guidance and detailed project design. The MMMP for piling will be developed in consultation with the relevant Statutory Nature Conservation Bodies (SNCBs) and the MMO, detailing the proposed mitigation to reduce the risk of any physical or permanent auditory injury (Permanent Threshold Shift (PTS)) to marine mammals during all piling operations. This will include details of the embedded mitigation, for the soft-start and ramp-up, as well as details of the proposed mitigation zone and any additional mitigation measures required in order to minimise potential impacts of any physical injury or PTS, for example, the activation of an Acoustic Deterrent Device (ADD) prior to the soft-start, as much as is practicable. **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** has been submitted with the DCO application.	DML 3 & 4 - Condition 13 & 18 - 20 DML 5 - Condition 11 & 14 - 16
Site Integrity Plan (SIP)		
Southern North Sea Special Area of Conservation (SAC) Site Integrity Plan (SIP)	In addition to the MMMPs for piling and UXO clearance, a Southern North Sea SAC SIP will be developed pre-construction, in accordance with the In Principle SIP (application ref: xxx), which will set out the approach to deliver any project mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise in relation to the Southern North Sea SAC conservation objectives. The SIP will be an adaptive management tool, which can be used to ensure that the most adequate, effective and appropriate measures, if required, are put in place. The SIP will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and MMO.	Site Integrity Plan DML 1 & 2 - Conditions 14 & 15 DML 3 & 4 - Conditions 16 & 17

12. A summary report will be provided following all activities as outlined above, to provide detail on the activities and mitigation undertaken. The summary reports will also provide detail on any marine mammal presence during each of the relevant activities.

8.3.3 Worst Case Scenario

13. The final design of DBS East and West Array Areas will be confirmed through detailed engineering design studies that will be undertaken post-consent. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst case scenarios have been defined in terms of the potential effects that may arise.

14. This approach to Environmental Impact Assessment (EIA), referred to as the Design Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine (2018). The Design Envelope for a project outlines the realistic worst case scenario for each individual impact, so that it can be safely assumed that all other scenarios within the Design Envelope will have less impact.

15. In addition to the design parameters set out in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, consideration is also given to how the Projects will be built as described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. In order to ensure that a robust assessment has been undertaken, all Development Scenarios and options have been considered to ensure the realistic worst case scenario for each topic has been assessed. Further details are provided in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

16. The realistic worst case scenarios for the likely significant effects scoped into the EIA for the marine mammal assessment are summarised in **Table 8-4.**

17. The maximum diameter of wind turbine included in the design envelope is 17m, with a maximum of 100 wind turbines in the DBS East or DBS West Array Area, a combined total maximum of 200 wind turbines for the Projects together which take into account currently available models and predicted technology developments.

Table 8-4 Realistic Worst Case Design Parameters

Impact	**Parameter**			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
Construction				
Construction would take approximately five years per site, therefore five years total if the Projects are built in isolation or concurrently. If built sequentially, with a maximum two year lag between construction starting it would take an approximate maximum of seven years to construct DBS East and DBS West.				
Impact 1 and 2: Underwater noise and vibration from piling	**Array Area** • Total Array Area assessed for ES - 427km^2 (349km^2 for Array Area + 78km^2 Construction Buffer Zone) • Up to 100 turbines • Up to four platforms (the Electrical Switching Platform (ESP) could be located within the Offshore Export Cable Corridor) **Offshore Export Cable Corridor** • Up to one ESP (which could be located within the Array Area)	**Array Area** • Total Array Area assessed for ES - 434km^2 (355km^2 for Array Area + 79km^2 Construction Buffer Zone) • Up to 100 turbines • Up to four platforms (the ESP could be located within the Offshore Export Cable Corridor) **Offshore Export Cable Corridor** • Up to one ESP (which could be located within the Array Area)	**Array Areas** • Total Array Area assessed for ES - 1008km^2 (874km^2 for Array Areas and Inter Platform Cabling Area + 134km^2 Construction Buffer Zone) • Up to 200 turbines • Up to eight platforms (the ESP could be located within the Offshore Export Cable Corridor) **Offshore Export Cable Corridor** • Up to one ESP (which could be located within the Array Area)	Construction Buffer Zone measures 1km surrounding each Array Area, and 500m surrounding the Inter Platform Cable Corridor. Construction vessels may occupy this zone but no permanent infrastructure would be installed within these areas. The ESP in all Development Scenarios could be located within the Array Area or Offshore Export Cable Corridor, but the total number of platforms would not exceed four for the In Isolation scenario or eight for the Concurrent / Sequential scenario.
	Foundations Options for wind turbine piled foundations: • One monopile per wind turbine foundation; or • Four pin piles per wind turbine foundation. Options for platform piled foundations: • One monopile per platform; or • Eight pin piles per platform.			N/A
	Piling *Monopile* Max piles per day – 4			In sequential scenario, max piles per day is identical to DBS East or DBS West in isolation, just spread over a longer time period.

Impact	Parameter			
	DBS East in isolation	DBS West in isolation	DBS West and DBS East concurrently or sequentially	Notes and rationale
	Diameter -15m Hammer energy – 6,000kJ hammer Duration per monopile – 320 minutes *Jacket pin pile* Max piles per day - 12 Diameter - 4m Hammer energy – 3,000kJ hammer Duration per jacket pile - 190 minutes			Max piles per day assumes two simultaneous monopile events or three simultaneous pin-pile events.
Impact 3: Underwater noise from other construction activities	Seabed clearance methods: Pre-lay grapnel run, boulder clearance, sand wave levelling, dredging			Noise from the vessel would be a higher impact, but each have been assessed.
	Cable installation methods: Jet-trenching / ploughing / dredging / mechanical trenching / mass flow excavation / rock cutting / burial sledge			
	Underwater noise modelling for all construction activities			See **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**
	Maximum number of export cables: 2 Maximum length of export cable: 376km Maximum length of Inter Platform cables: 115km Maximum length of Array cables: 325km	Maximum number of export cables: 2 Maximum length of export cable: 306km Maximum length of Inter Platform cables: 129km Maximum length of Array cables: 325km	Maximum number of export cables: 4 Maximum length of export cable: 682km Maximum length of Inter Platform cables: 342km Maximum length of Array cables: 650km	N/A
Impact 4 and 6: Underwater noise and disturbance from vessels, and vessel collision risk	Maximum number of construction vessels on site at any one time: up to 32 vessels (up to 26 in the Array Area and up to six in the Offshore Export Cable Corridor) and up to 3,857 round trips to port.	Maximum number of construction vessels on site at any one time: up to 32 vessels (up to 26 in the Array Area and up to six in the Offshore Export Cable Corridor) and up to 3,857 round trips to port.	Maximum number of construction vessels on site at any one time: up to 59 vessels (up to 47 in the Array Area and up to 12 in the Offshore Export Cable Corridor) and up to 7,510 round trips to port.	N/A
Impact 5: Barrier effect from underwater noise	As described for **Impact 1** above.			The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst case barrier impact.

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
Impact 7: Changes to prey resources	Impacts to prey species and habitat as described in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**			N/A
	Total area of disturbance within Array Areas – 11,207,591m² **Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 19,885,242m²**	**Total area of disturbance within Array Areas – 11,518,091m²** **Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 17,046,667m²**	**Total area of disturbance within Array Areas – 24,924,843m²** **Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – 36,861,507m²**	N/A
	Total Displaced sediment during sandwave levelling (Array Area, Inter-Platform Cables and Offshore Export Cables) - 33,567,300m³ Maximum volume of sandwave material to be dredged/relocated for Array Cables and Inter-Platform Cables – 445,500m³ Maximum volume of sandwave material to be dredged/relocated – 33,121,800m³ **Maximum volume of displaced sediment during cable trenching – 6,369,000m³** Array cable – 1,950,000m³ (325,000m length x 6m width x 1m depth) Inter-platform cables – 1,035,000m³ (115,000m length x 6m width x 1.5m depth) Export cable – 3,384,000m³ (376,000m length x 6m width x 1.5m depth) **Maximum volume of drill arisings – 37,197m³** Drill arisings from 57 large wind turbines = 34,382m³	**Total Displaced sediment during sandwave levelling (Array Area, Inter-Platform Cables and Offshore Export Cables) -29,762,372m³** Maximum volume of sandwave material to be dredged/relocated for Array Cables and Inter-Platform Cables – 459,473m³ Maximum volume of sandwave material to be dredged / relocated for Export Cables – 29,302,900m³ **Maximum volume of displaced sediment during cable trenching – 5,865,000m³** Array cable – 1,950,000m³ (325,000m length x 6m width x 1m depth) Inter-platform cables – 1,161,000m³ (129,000m length x 6m width x 1.5m depth) Export cable – 2,754,000m³ (306,000m length x 6m width x 1.5m depth) **Maximum volume of drill arisings – 37,197m³** Drill arisings from 57 large wind turbines = 34,382m³	**Total Displaced sediment during sandwave levelling (Array Cables, Inter-Platform Cables and Export Cables) - 63,428,644m³** Maximum volume of sandwave material to be dredged/relocated for Array Cables and Inter-Platform Cables – 1,003,944m³ Maximum volume of sandwave material to be dredged / relocated for Export Cables – 66,243,601m³ **Maximum volume of displaced sediment during cable trenching – 13,116,000m³** Array cable – 3,900,000m³ (650,000m length x 6m width x 1m depth) Inter-platform cables – 3,078,000m³ (342,000m length x 6m width x 1.5m depth) Export cable – 6,138,000m³ (682,000m length x 6m width x 1.5m depth) **Maximum volume of drill arisings – 73,790m³** Drill arisings from 113 large wind turbines = 68,160m³	Maximum burial depth for array and inter-platform cables is 1m. Maximum burial depth for offshore export cables is 1.5m. These depths have been assumed across the entire length of the cable type to determine the worst case volume of sediment disturbed. 6m trench width based on worst case pre-lay ploughing width.

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
	Drill arisings from four offshore platform monopile foundations = 2,815m^3	Drill arisings from four offshore platform monopile foundations = 2,815m^3	Drill arisings from eight monopile foundations = 5,630m^3	
Impact 8: Changes to water quality	Impacts to water quality as described in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** See worst case for temporary increases in SSC and re-mobilisation of contaminated sediments as described.			N/A
Impact 9: Disturbance at seal haul-out sites	122km from coast at closest point. For distances of seal haul out sites refer to **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**	100km from coast at closest point. For distances of seal haul out sites refer **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**	122km closest point for DBS East and 100km closest point for DBS West. For distances of seal haul out sites refer to **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**	Construction port/s will not be confirmed until nearer the start of construction. A list of indicative port options is given in Table 11-73, **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11).** As worst case, the assessment of vessel disturbance during transit from the Projects to Lowestoft is used as that is the greatest distance. There are well known seal-haul out sites along the coast, distances recorded from landfall area are: North of Skipsea: Filey Brigg 27km Ravenscar 50km Tess 95km South of Skipsea: Donna Nook 62km The Wash 118km
Operation and Maintenance				
	Up to 100 wind turbines Monopile diameter 15m	Up to 100 wind turbines Monopile diameter 15m	Up to 200 wind turbines Monopile diameter 15m	Underwater noise modelling for operational turbines.

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
Impact 1: Underwater noise from operational turbines	Underwater noise parameters described in Underwater Noise Modelling Report **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**.			Worst case assessment will be made based on the underwater noise modelling results.
Impact 2: Underwater noise from maintenance activities	Estimated timeframe for any cable repair, replacement or reburial works.			For short cables, replacements are a more likely option. Number of repairs is over the lifetime of the Projects (e.g. 30 years per Project)
	• Seven export cable repairs • Two inter-platform cable repairs • Nine array cable repairs	• Five export cable repairs • Two inter-platform cable repairs • Nine array cable repairs	• Twelve export cable repairs • Six inter-platform cable repairs • Seventeen array cable repairs	
Impact 3 and 5: Underwater noise from vessel and vessel collision	Maximum number of vessels on site at any one time: 20 Up to 239 annual round trips to port.	Maximum number of vessels on site at any one time: 20 Up to 239 annual round trips to port.	Maximum number of vessels on site at any one time: 21 Up to 474 annual round trips to port	
Impact 4: Barrier effects from underwater noise	Maximum impact ranges from operation and maintenance phase underwater noise assessments (as above).			The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst case barrier impact.
Impact 6: Changes to prey resources	Impacts to prey species and habitat as described in **Volume 7, Chapter 10 Fish** and **Shellfish Ecology (application ref: 7.10)** and **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)**.			The worst case scenario for maximum area of habitat loss / disturbance of seabed from jack-up vessel deployments, cable repair, replacement and reburial footprint.
	Array Areas Total Array Area assessed for ES – **427km^2** (349km^2 for Array Area + 78km^2 Construction Buffer Zone) Total area of habitat loss within the Array Area (foundations, scour protection, cable protection and cable crossings) – **887,801m^2** Total area of habitat loss within the Offshore Export Cable Corridor – **1,203,825m^2** Total area of disturbance within Array Areas – **11,207,591m^2** Array and Inter-platform Cables	**Array Areas** Total Array Area assessed for ES – **434km^2** (355km^2 for Array Area + 79km^2 Construction Buffer Zone) Total area of habitat loss within the Array Area (foundations, scour protection, cable protection and cable crossings) – **920,837 m^2** Total area of habitat loss within the Offshore Export Cable Corridor – **992,484m^2** Total area of disturbance within Array Areas – **11,518,091m^2** Array and Inter-platform Cables	**Array Areas** Total Array Area assessed for ES – **1,008km^2** (874km^2 for Array Areas and Inter Platform Cabling Area + 134km^2 Construction Buffer Zone) Total area of habitat loss within the Array Areas (foundations, scour protection, cable protection and cable crossings) – **2,053,218m^2** Total area of habitat loss within the Offshore Export Cable Corridor – **2,139,889m^2** Total area of disturbance within Array Areas – **24,924,843m^2** Array and Inter-platform Cables	

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
	Maximum area disturbed (trenching + sandwave levelling) – **9,900,000m²** Foundations and Vessel Impacts Maximum area disturbed from foundations, platforms, vessel jack-up locations and anchoring **– 1,307,591m²** **Offshore Export Cable Corridor** Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – **19,885,242m²** Total offshore cable length per cable – **188km** Maximum number of cables required – Two Maximum temporary disturbance area for cable installation – **7,510,800m²** (based on 376,000m distance x 20m width of temporary disturbance) Maximum seabed area disturbed by sandwave levelling – **12,282,010m²** Maximum total area impacted by anchoring – **22,061m²**	Maximum area disturbed (trenching + sandwave levelling) – **10,210,500m²** Foundations and Vessel Impacts Maximum area disturbed (Maximum area disturbed (foundations, platforms, vessel jack-up locations and anchoring) – **1,307,591m²** **Offshore Export Cable Corridor** Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – **17,046,667m²** Total offshore cable length per cable – **153km** Maximum number of cables required – Two Maximum temporary disturbance area for cable installation – **6,120,400m²** (based on 306,000m distance x 20m width of temporary disturbance) Maximum seabed area disturbed by sandwave levelling – **10,833,835m²** Maximum total area impacted by anchoring – **22,061m²**	Maximum area disturbed (trenching + sandwave levelling) – **22,309,875m²** Foundations and Vessel Impacts Maximum area disturbed (foundations, platforms, vessel jack-up locations and anchoring) **– 2,614,968m²** **Offshore Export Cable Corridor** Total temporary area disturbed for export cable installation (trenching, sandwave levelling, anchoring and foundation installation) – **36,861,507m²** Total offshore cable length per cable – **188km** for DBS East, **153km** for DBS West. Maximum number of cables required – Four Maximum temporary disturbance area for cable installation – **13,631,200m²** (based on 682,000m distance x 20m width of temporary disturbance) Maximum seabed area disturbed by sandwave levelling – **23,115.845m²** Maximum total area impacted by anchoring – **44,091m²**	
	Maximum estimated volume of displaced sediment during maintenance activities in the Array Areas – 1,666,500m³ Volume of displaced sediment from array cable repairs over Projects lifetime – 108,000m³ (Nine events x 12,000m³ per event) Volume of displaced sediment from inter-platform cable repairs - over	**Maximum estimated volume of displaced sediment during maintenance activities in the Array Areas – 1,666,500m³** Volume of displaced sediment from array cable repairs r Projects lifetime – 108,000m³ (Nine events x 12,000m³ per event) Volume of displaced sediment from inter-platform cable repairs - over	**Maximum estimated volume of displaced sediment during maintenance activities in the Array Areas – 3,345,000m³** Volume of displaced sediment from array cable repairs over Projects lifetime – 204,000m³ (17 events x 12,000m³ per event) Volume of displaced sediment from inter-platform cable repairs - over	

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
	Projects lifetime – 24,000m^3 (Two events x 12,000m^3 per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 1,534,500m^3 (51,150m^3 per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 84,000m^3** Volume of displaced sediment from export cable repairs over Projects lifetime – 84,000m^3 (seven events x 12,000m^2 per event)	Projects lifetime – 24,000m^3 (Two events x 12,000m^3 per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 1,534,500m^3 (51,150m^3 per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 60,000m^3** Volume of displaced sediment from export cable repairs over Projects lifetime – 60,000m^3 (Five events x 12,000m^2 per event	Projects lifetime – 72,000m^3 (Six events x 12,000m^3 per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 3,069,000m^3 (102,300m^3 per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 144,000m^3** Volume of displaced sediment from export cable repairs - over Projects lifetime – 144,000m^3 (12 events x 12,000m^2 per event)	
	See Operation Impact in **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)**			
Impact 7: Changes to water quality	Impacts to water quality (as described in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**). Temporary increases in SSC and any deterioration in water quality through the resuspension of contaminated sediment due to maintenance activities could result from periodic jack-up vessel deployment, and cable repair, replacement and reburial activities – same as temporary habitat loss / disturbance for prey above.			
Impact 8: Disturbance at seal haul-out sites	See above **Disturbance to seal haul-out sites**			
	O&M base location: Final decision to be made post-consent; Grimsby Port has been considered in the assessment as a worst case example due to proximity to sea haul-out sites.			
Decommissioning				
No final decision regarding the final decommissioning policy for the offshore project infrastructure including landfall, has yet been made. It is also recognised that legislation and industry best practice change over time. It is likely that offshore project infrastructure will be removed above the seabed and reused or recycled where practicable. The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the worst case scenario, the impacts will be no greater than those identified for the construction phase. A decommissioning plan for the offshore works would be submitted prior to any decommissioning commencing.				

8.3.4 Definition of Significance

18. The potential effects have been assessed for each of the designated sites for marine mammals for construction, operation and maintenance and decommissioning at DBS East and DBS West.

19. Assessments of the potential for adverse effects, at the population level, have been based on the JNCC *et al*. (2010) draft guidance for effects on European Protected Species (EPS), and the Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (ASCOBANS) agreement.

20. The JNCC *et al*. (2010) draft guidance provides some indication on how many animals may be removed from a population without causing detrimental effects to the population at Favourable Conservation Status (FCS). The JNCC *et al*. (2010) draft guidance also provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement.

21. JNCC *et al*. (2010) draft guidance considered 4% as the maximum potential growth rate in harbour porpoise, and the 'default' rate for cetaceans. Therefore, beyond natural mortality, up to 4% of the population could theoretically be permanently removed before population growth could be halted. In assigning 5% to a temporary effect, consideration is given to uncertainty of the individual consequences of temporary disturbance.

22. Permanent effects with a greater than 1% of the reference population being affected within a single year are considered to result in a significant effect. This is based on ASCOBANS and Department for Environment Food and Rural Affairs (Defra) advice (Defra, 2003; ASCOBANS, 2015) relating to impacts from fisheries by-catch (i.e. a permanent effect) on harbour porpoise. A threshold of 1.7% of the relevant harbour porpoise population above which a population decline is inevitable has been agreed with Parties to ASCOBANS, with an intermediate precautionary objective of reducing the impact to less than 1% of the population (Defra, 2003; ASCOBANS, 2015).

23. As a precautionary approach, and as there is no current guidance on what determines a significant temporary or permanent effect, the above information on the potential for population level effects has been used to inform the approach to defining potential for adverse effect for harbour porpoise, grey seal and harbour seal populations. The approach to define the potential for adverse effect on the integrity of the site, based on the potential effect to the overall populations, is therefore as follows;

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

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

24. The exception to this approach is the use of the Effective Deterrent Range (EDR) spatial approach for disturbance impacts upon harbour porpoise within the Southern North Sea (SNS) Special Area of Conservation (SAC) (see section 8.3.5), following the guidelines provided in JNCC *et al*. (2021).

8.3.5 Southern North SAC

8.3.5.1 Site Description

25. The SNS SAC has been recognised as an area with persistent high densities of harbour porpoise (JNCC, 2017; JNCC and Natural England, 2019) and is the largest designated site for harbour porpoise in UK and European waters at the time of designation.

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

27. The Projects' Array Areas are within the summer area of the SNS SAC, and the Offshore Export Cable Corridor (OECC) is within 18km of the winter area. Due to the seasonal restriction listed in **Table 8-2** there is no potential for impacts from piling (which has the largest impact range of all activities assessed) to overlap with the winter habitat. Therefore, assessments have only been conducted in relation to the summer habitat for the SNS SAC.

8.3.5.1.1 Qualifying Features

8.3.5.1.1.1 Harbour porpoise

28. Within the SNS area, harbour porpoise is the most common marine mammal species (Gilles *et al*. 2023). Heinänen and Skov, (2015) identified that within the North Sea, water depth and hydrodynamic variables are the most important factors in harbour porpoise densities in species areas, in both winter and summer seasons. The seabed sediments also play an important role in determining areas of high harbour porpoise density, as well as the number of vessels present in the area.

29. Distribution and abundance maps have been developed by Waggitt *et al.* (2019) for harbour porpoise and show a clear pattern of high density in the southern North Sea, and the coasts of south-east England, for both January and July. Examination of this data, including all 10km 'grids' that overlap with the Agreement for Lease (AfL) Area which is the area of the seabed leased by The Crown Estate to the Applicants. The 10km grids that overlaps the AfL Area indicates an average annual density estimate of:

- 0.59 individuals per km^2 for the DBS East AfL Area;
- 0.58 individuals per km^2 for the DBS West AfL Area;
- 0.56 individuals per km^2 for the OECC; and
- 0.415 individuals per km^2 for the total Offshore Development Area.

30. The Projects' Offshore Development Area is in SCANS-IV (Small Cetaceans in the European Atlantic and North Sea) survey block NS-C (Gilles *et al.* 2023) where:

- Abundance = 346,601 harbour porpoise (coefficient of variation (CV) = 0.228; 95% Confidence Limit (CL) = 23,346 - 56,118); and
- Density = 0.6027 harbour porpoise/ km^2 (CV = 0.228).

31. Data from the DBS East and DBS West site-specific surveys have also been used to generate abundance and density estimates for the AfL Areas with a 4km buffer (for further details see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**). The average of the winter months, summer months, and annual density has then been calculated based on the maximum calculated for each month. **Table 8-5** shows the densities for harbour porpoise.

Table 8-5 Seasonal Density Estimates for Harbour Porpoise from the APEM Ltd Survey

Season	DBS East absolute density estimates	DBS West absolute density estimates
Summer average	0.600	0.662
Winter average	0.442	0.625
Yearly average	0.521	0.643

32. The site-specific surveys indicate a seasonal pattern in the abundance of harbour porpoise, with higher numbers present in the summer months. There is no evident pattern of harbour porpoise distribution within the survey area, with no indication of a particular area of importance.

33. The worst case summer average density estimate of harbour porpoise from the site specific surveys (0.600 harbour porpoise/km^2 for DBS East and 0.662 harbour porpoise/km^2 for DBS West) have been used in the impact assessments.

34. The Inter-Agency Marine Mammal Working Group (IAMMWG) (2023) define three MUs for harbour porpoise. The Offshore Development Area is located in the North Sea (NS) MU.

35. The IAMMWG estimate of harbour porpoise abundance in the NS MU is 346,601 (CV = 0.09; 95% CL = 289,498 – 419,967) (IAMMWG, 2023). This is the reference population for harbour porpoise used in the assessments.

36. The SNS SAC Site Selection Report (JNCC, 2017a) identifies that the SNS SAC site supports approximately 18,500 individuals (95% CL = 11,864 - 28,889) for at least part of the year. However, JNCC and Natural England (2019) state that because this estimate is from a one-month survey in a single year (the SCANS-II survey in July 2005) it cannot be considered as an estimated population for the site. It is therefore not appropriate to use site population estimates in any assessments of effects for schemes on the site (i.e. HRA), as they need to take into consideration population estimates at the MU level, to account for daily and seasonal movements of the animals (JNCC and Natural England, 2019).

8.3.5.1.1.2 Conservation Objectives

37. The Conservation Objectives for the SNS SAC are designed to help ensure that the obligations of the Habitats Directive can be met. Article 6(2) of the Habitats Directive requires that there should be no deterioration or significant disturbance of the qualifying species or to the habitats upon which they rely.

38. The Conservation Objectives (JNCC and Natural England, 2019) for the SNS SAC 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:

- *Harbour porpoise is a viable component of the site;*
- *There is no significant disturbance of the species; and*
- *The condition of supporting habitats and processes, and the availability of prey is maintained*”.

39. These Conservation Objectives are:

"*a set of specified objectives that must be met to ensure that the site contributes in the best possible way to achieving FCS of the designated site feature(s) at the national and biogeographic level*" (JNCC and Natural England, 2019).

8.3.5.1.1.2.1 Conservation Objective 1: The Species is a Viable Component of the Site

40. This Conservation Objective is designed to minimise the risk of injury and killing or other factors that could restrict the survivability and reproductive potential of harbour porpoise using the SAC. Specifically, this objective is primarily concerned with operations that would result in unacceptable levels of those impacts on harbour porpoise using the SAC. Unacceptable levels can be defined as those having an impact on the FCS of the population of the species in their natural range.

41. Harbour porpoise are considered to be a viable component of the SAC if they are able to live successfully within it. The SNS SAC has been selected primarily based on the long term, relatively higher densities of porpoise in contrast to other areas of the North Sea. The implication is that the SAC provides relatively good foraging habitat and may also be used for breeding and calving. However, because the number of harbour porpoise using the site naturally varies there is no exact value for the number of animals expected within the site (JNCC and Natural England, 2019).

42. The Conservation Objectives (JNCC and Natural England, 2019) state that, with regard to assessing impacts, "*the reference population for assessments against this objective is the MU population in which the SAC is situate*".

43. Harbour porpoise are listed as EPS under Annex IV of the Habitats Directive, and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Under the Habitats Regulations, it is an offence if harbour porpoise are deliberately disturbed in such a way as to:

- Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or
- To affect significantly the local distribution or abundance of that species.

44. The term deliberate is defined as any action that is shown to be "*by a person who knows, in the light of the relevant legislation that applies to the species involved, and the general information delivered to the public, that his action will most likely lead to an offence against a species, but intends this offence or, if not, consciously accepts the foreseeable results of his action*".

45. In addition, Article 12(4) of the Habitats Directive is concerned with incidental capture and killing. It states that Member States "*shall establish a system to monitor the incidental capture and killing of the species listed on Annex IV (all cetaceans). In light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned*".

8.3.5.1.1.2.2 Conservation Object 2: There is no Significant Disturbance of the Species

46. The disturbance of harbour porpoise typically, but not exclusively, originates from operations that cause underwater noise, including activities such as seismic surveys, pile driving and sonar.

47. Disturbance is considered to be significant if it leads to the exclusion of harbour porpoise from a significant portion of the site for a significant period of time. The current SNCBs guidance for the assessment of significant noise disturbance on harbour porpoise in the SNS SAC (JNCC *et al.* 2020) is that:

"*Noise disturbance within an SAC from a plan / project individually or in-combination is considered to be significant if it excludes harbour porpoise from more than:*

- *20% of the relevant area of the site in any given day, or*
- *An average of 10% of the relevant area of the site over a season.*"

8.3.5.1.1.2.3 Conservation Objective 3: The Condition of Supporting Habitats and Processes, and the Availability of their Prey is Maintained.

48. Supporting habitats, in this context, means the characteristics of the seabed and water column. Supporting processes encompass the movements and physical properties of the habitat. The maintenance of these supporting habitats and processes contributes to ensuring prey is maintained within the site and is available to harbour porpoise using the SAC. Harbour porpoise are strongly reliant on the availability of prey species year round due to their high energy demands, and their distribution and condition may strongly reflect the availability and energy density of prey.

49. This Conservation Objective is designed to ensure that harbour porpoise is able to access food resources year round, and that activities occurring in the SNS SAC will not affect this.

8.3.5.1.2 Potential Effects Summary

50. The Array Areas are both located within the summer habitat of the SNS SAC, and therefore there is potential for Likely Significant Effects (LSE) on its designated feature harbour porpoise, during construction, operation and maintenance, or decommissioning of DBS East and DBS West. This resulted in the SNS SAC being screened into the assessment through **Volume 6, Appendix A - Habitats Regulations Assessment Screening** (**application ref: 6.1.1**).

51. For the purpose of the assessments, the potential effects considered in relation to the SNS SAC Conservation Objectives are outline in **Table 8-6**.

Table 8-6 Potential Effects of DBS East and DBS West in relation to the Conservation Objectives of the SNS SAC for Harbour Porpoise

Conservation Objective for harbour porpoise	Potential Effect
Harbour porpoise is a viable component of the site	Physical and permanent auditory injury from underwater noise will be mitigated but in line with current advice this is screened in.
	Significant disturbance and displacement as a result of increased underwater noise levels has the potential to have an adverse effect on harbour porpoise from the SNS SAC and will be considered further.
	Any potential increased collision risk with vessels could cause a potential LSE which will be considered further.
There is no significant disturbance of the species	Significant disturbance and displacement as a result of increased underwater noise levels has the potential to have an adverse effect on harbour porpoise from the SNS SAC and will be considered further.

8.3.5.2 Potential Effects During Construction

52. The potential effects during operation and maintenance that have been assessed for are:

- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during piling, and due to ADD activation prior to piling:
    - Permanent auditory injury (Permanent Threshold Shift (PTS)) due to impact piling; and

    - Disturbance due to impact piling.
- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during other construction activities, including seabed preparations, rock placement and cable installation:
    - Auditory injury due to other construction activities; and
    - Disturbance due to other construction activities.
- Impacts resulting from the deployment of construction vessels:
    - Underwater noise and disturbance from construction vessels:
    - Auditory injury due to construction vessels; and
    - Disturbance due to construction vessels.
- Barrier effects as a result of underwater noise;
- Vessel collision risk; and
- Changes to prey resources.

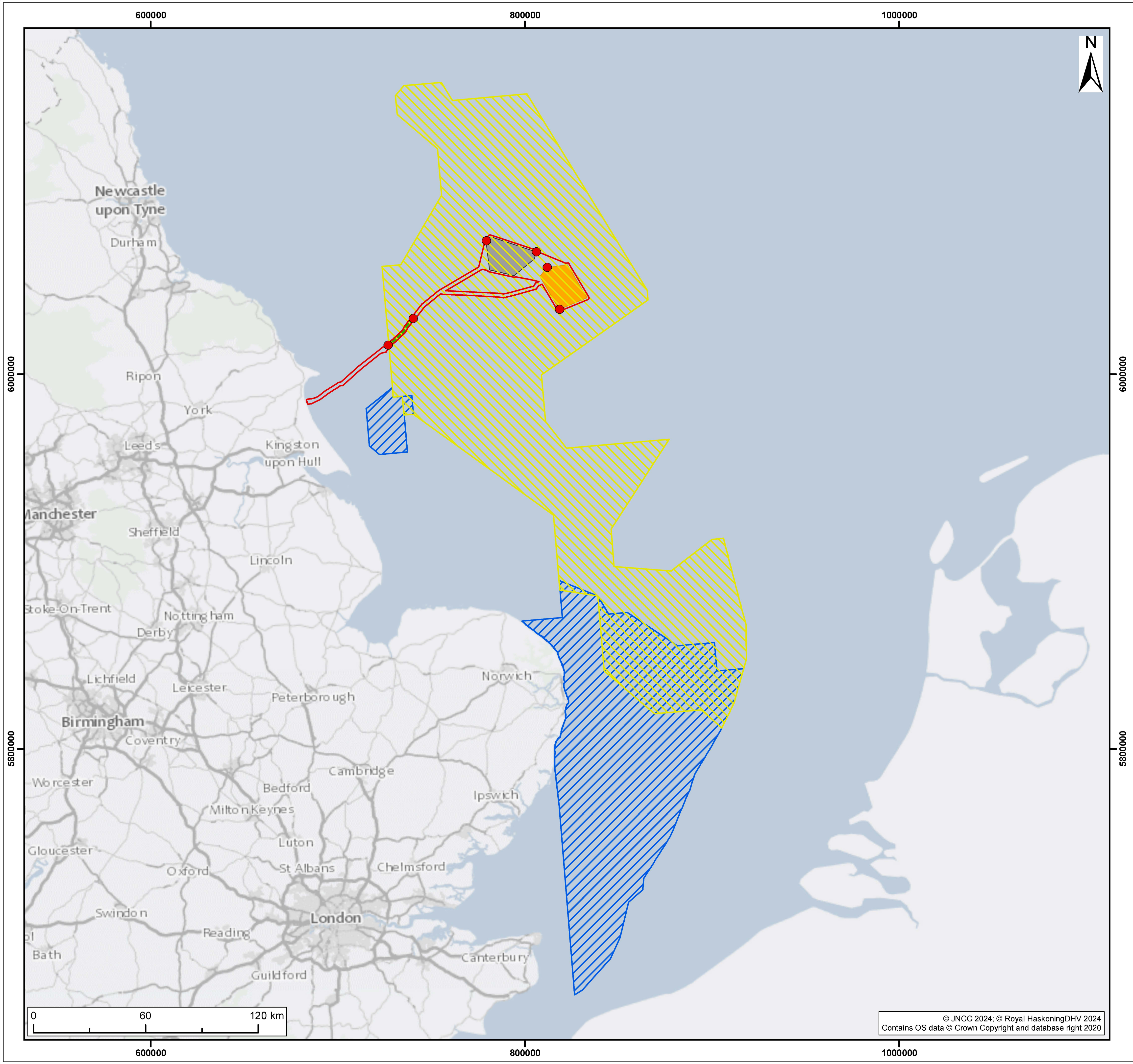
8.3.5.2.1 Impact 1: Permanent Auditory Injury (PTS) due to Impact Piling

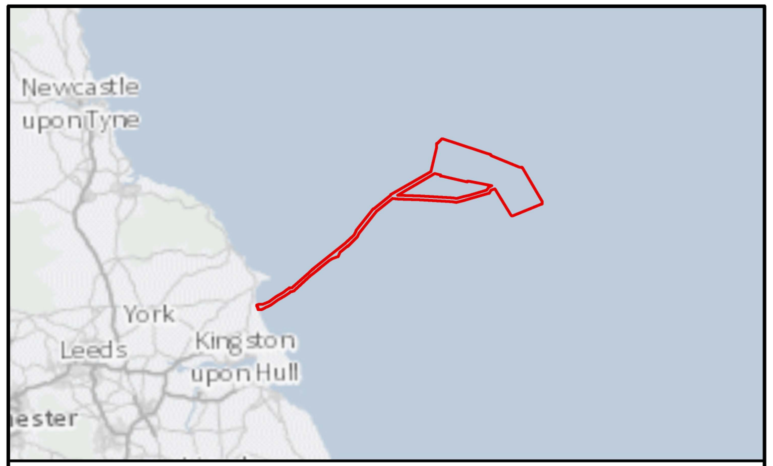
53. A range of foundation options are being considered for the Projects. Of these being considered, monopiles and jackets (pin-piles) may require piling. As a worst case scenario for underwater noise, it has been assumed that all foundations could be piled.

54. Impact piling is a source of high-level underwater noise. Underwater noise can cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals.

55. Underwater noise modelling was carried out by Subacoustech Environmental Ltd to estimate the noise levels likely to arise during noisy activities and determine the potential impacts on marine mammals using the INSPIRE v5.1 (Impulsive Noise Propagation and Impact Estimator) subsea noise propagation model.

56. The underwater noise modelling was undertaken at six representative locations to cover the extent of the Offshore Development Area (**Figure 8-1** and **Table 8-7**). These modelling locations include the deepest point of the Offshore Development Area (typically the worst case location as this is where piling tends to give the greatest noise propagation) (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).





Legend:

- Offshore Development Area
- RCP Search Area Corridor
- DBS East Array Area
- DBS West Array Area
- Southern North Sea Summer Area
- Southern North Sea Winter Area
- Underwater Noise Modelling Locations

S2	P01	02/04/2024	Suitable for Information	SB	LA	SB
SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR

Title:

Underwater noise modelling locations
in relation to the SNS summer and winter areas

Figure: 8-1 Drawing No: PC2340-RHD-OF-ZZ-DR-Z-0695

Co-ordinate system: WGS 1984 UTM Zone 31N | Page Size: A3 | Scale: 1:2,000,000

Project: Dogger Bank South Offshore Wind Farms

Report: Report to Inform Appropriate Assessment

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57. Should a harbour porpoise be very close to the source, the high peak pressure sound levels have the potential to cause physical injury, with any severe injury potentially leading to death, if no adequate mitigation is in place. High exposure levels from underwater noise sources can cause auditory injury or hearing impairment, taking the form of a permanent loss of hearing sensitivity (PTS), or a temporary loss in hearing sensitivity (TTS).

58. The potential for auditory injury is not just related to the level of the underwater sound, and its frequency relative to the hearing bandwidth of the animal but is also influenced by the duration of exposure. The level of impact on an individual is a function of the Sound Exposure Level (SEL) that an individual receives as a result of underwater noise.

59. The potential impact of underwater noise will depend on a number of factors which include, but are not limited to:

- The source levels of noise;
- Frequency relative to the hearing bandwidth of the animal (dependent upon species);
- Propagation range, which is dependent upon:
- Sediment/sea floor composition;
- Water depth;
- Duration of exposure;
- Distance of the animal to the source; and
- Ambient noise levels.

Table 8-7 Underwater noise modelling locations at DBS Offshore Development Area

Modelling locations	Latitude	Longitude	Depth (m)
DBS East - south location	54.35994	1.899883	36.52
DBS East – north-west location	54.56375	1.821029	18.62
DBS West – north-east location	54.64222	1.742604	21.15
DBS West - west location	54.71146	1.334179	33.65
OECC search area - north-east location	54.35944	0.695278	61.62
OECC search area – south-west location	54.23451	0.47481	57.72

60. The underwater noise modelling was based on the following worst case scenarios for monopiles and multi-leg foundations:

- A monopile foundation of 15m diameter, with a maximum blow energy of 6,000kJ; and
- A multi-leg foundation of 4m diameter, with a maximum blow energy of 3,000kJ.

61. To determine the potential for permanent auditory injury (PTS) the soft-start, hammer energy profile, total active piling duration, and strike rate are taken into account. The soft-start takes place over the first 30 minutes of piling, which includes low-energy blows (at the starting hammer energy) for 10 minutes, followed by a gradual increase (ramp-up) to the maximum hammer energy required to safely install the pile.

62. As a worst case scenario, it is assumed that all piles installed will require 100% of the maximum hammer energy. However, maximum hammer energy is only likely to be required at a few of the piling installation locations, and for shorter periods of time.

63. The low-energy blows, ramp-up, and piling duration used to assess cumulative sound exposure level (SEL_{cum}) for both monopiles and pin-piles are summarised in **Table 8-8**.

Table 8-8 Hammer energy and ramp up used for the monopile foundation modelling

Parameter	Starting hammer energy	Ramp-up			Maximum hammer energy
Monopile – worst-case					
Hammer energy / piling parameters	1,050kJ	1,750kJ	3,500kJ	5,250kJ	6,000kJ
No. of strikes	100	800	800	800	5,000
Duration	10 mins	20 mins	20 mins	20 mins	4 hours, 10 mins
Strike rate	10 bl/min	40 bl/min			20 bl/min
7,500 strikes over 5 hours 20 mins per pile / 15,000 strikes over 10 hours 40 mins for 2 piles					

Parameter	Starting hammer energy	Ramp-up			Maximum hammer energy
Jacket pin-pile					
Hammer energy / piling parameters	450kJ	750kJ	1,500kJ	2,250kJ	3,000kJ
No. of strikes	100	800	800	800	2,400
Duration	10 mins	20 mins	20 mins	20 mins	2 hours
Strike rate	10 bl/min	40 bl/min			20 bl/min
4,900 strikes over 3 hours 10 mins per pile / 19,600 strikes over 12 hours 40 mins for 4 piles					

64. The assessments are based on the latest Southall *et al.* (2019) thresholds and criteria for marine mammals. The thresholds indicate the onset of PTS, the point at which there is an increase in risk of permanent hearing damage in an underwater receptor (although not all individuals within the maximum PTS range will have permanent hearing damage, this is assumed as a worst case scenario).

65. The maximum impact ranges (and areas) are used to inform the assessments. The assessment below shows the annual and winter densities, **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** includes the assessment using the summer seasonal density for harbour porpoise.

66. The potential for PTS due to a single strike at the starting hammer energy (of 1,050kJ) is provided in the Environmental Statement (ES), and has informed **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** which has been submitted with the DCO application.

8.3.5.2.1.1 Assessment of Potential Effects of the Projects Alone

67. Underwater noise modelling predicted the effect ranges and areas for PTS from a single strike (Sound Pressure Level (SPL)) of the maximum hammer energy for the worst case location at each Project. These are presented in **Table 8-9**.

Table 8-9 The Predicted Effect Ranges for PTS from SPL_{peak} in Harbour porpoise, at the Worst case Modelling Location, for the Maximum Hammer Energies of Both Monopiles and Pin Piles at DBS East or DBS West in Isolation

Location	**Potential effect ranges (and areas) for PTS at the maximum hammer energy**	
	Monopile (6,000kJ)	**Jacket pin pile (3,000kJ)**
DBS East	740m (1.7km^2)	600m (1.1km^2)
DBS West	720m 1.6km^2)	580m (1.0km^2)
OECC	830m (2.1km^2)	670m (1.4km^2)

68. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS, due to a single strike at the maximum hammer energy, for both monopiles and jacket pin piles, is presented in **Table 8-10**.

Table 8-10 Assessment of the potential for instantaneous PTS due to a single strike of the maximum hammer energy for a monopile and jacket pin pile

Species	**Location**	**Assessment of effect**	**Potential adverse effect on site integrity**
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak}))			
Harbour porpoise	DBS East	1.02 (0.0002% of the NS MU)	**No** Less than 1% of the population will be affected. MMMP would reduce risk of PTS
	DBS West	1.1 (0.0003% of the NS MU)	
	OECC	1.3 (0.0003% of the NS MU)	
PTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	0.7 (0.0002% of the NS MU)	**No** Less than 1% of the population will be affected. MMMP would reduce risk of PTS
	DBS West	0.7 (0.0002% of the NS MU)	
	OECC	0.63 (0.0001% of the NS MU)	

69. The maximum potential number of harbour porpoise that could be at possible risk of PTS due to a single strike at the maximum hammer energy, for monopiles, without any mitigation is up to two individuals (0.0003% of the NS MU reference population). The maximum potential number of harbour porpoise that could be at possible risk of PTS from due to a single strike at the maximum hammer energy, for jacket pin piles, without any mitigation is one individual (0.0002% of the NS MU reference population, based on the SCANS-IV density estimate) (**Table 8-10**).

8.3.5.2.1.2 PTS from Cumulative Exposure from a Single Piling Location

70. The SEL_{cum} is a measure of the total received noise over the whole piling operation. The SEL_{cum} range indicates the distance from the piling location a receptor would have to be, if it were to start fleeing in a straight line from the noise source, for that receptor to not receive a noise exposure in excess of the criteria threshold; and if the receptor were to start fleeing from a location closer to the modelled range, it would receive a noise exposure above the criteria threshold (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** for further details).

71. **Table 8-11** presents the underwater noise modelling results for the predicted effect ranges and areas for PTS due to the cumulative exposure of monopiles and jacket pin piles at the worst case location.

Table 8-11 The Predicted Effect Ranges for PTS in all Marine Mammal Species, at the Worst Case Modelling Location, for the Cumulative Exposure of both Monopiles and Pin Piles

Location	Potential effect ranges (and areas) for PTS due to cumulative exposure	
	Monopile (6,000kJ)	**Jacket pin pile (3,000kJ)**
Cumulative exposure from a single pile installation	**One monopile**	**One jacket pin pile**
DBS East	10km (240km^2)	7.2km (130km^2)
DBS West	9.0km (200km^2)	6.3km (100km^2)
OECC	13km (510km^2)	9.5km (260km^2)

Location	Potential effect ranges (and areas) for PTS due to cumulative exposure	
	Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
Cumulative exposure from multiple sequential pile installations in 24 hours	**Two sequential monopiles**	**Four sequential jacket pin piles**
DBS East	11km (250km^2)	7.9km (140km^2)
DBS West	9.3km (200km^2)	6.9km (110km^2)
OECC	-	11km (320km^2)

72. An assessment of the maximum number of harbour porpoise that could be at risk of cumulative PTS, for both sequential monopiles and jacket pin piles, is presented in **Table 8-12**.

Table 8-12 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period

Location	Assessment of effect	Potential adverse effect on site integrity
PTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum})		
DBS East	144.0 (0.04% of the NS MU)	**No** Less than 1% of the population will be affected. MMMP would reduce risk of PTS
DBS West	132.0 (0.04% of the NS MU)	
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})		
DBS East	84.0 (0.02% of the NS MU)	**No** Less than 1% of the population will be affected. MMMP would reduce risk of PTS
DBS West	72.6 (0.02% of the NS MU)	
OECC	211.2 (0.06% of the NS MU)	

73. The number of harbour porpoise that could potentially be at risk of PTS due to cumulative exposure to two sequential monopiles in a 24 hour period is up to 144 individuals in the Array Areas and 357 individuals in the OECC, all resulting in less than 1% of the North Sea Population (**Table 8-12**).

74. The effective implementation of the MMMP for piling will reduce the risk of cumulative PTS to harbour porpoise during piling at the Projects. This mitigation alongside less than 1% of the population being affected, means there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury (PTS) from increased underwater noise during construction (piling) of the Projects alone.**

8.3.5.2.1.3 Assessment of Potential Effects of the Projects Together

75. The concurrent piling scenario assumes that animals are within potential effect ranges for a much longer period (i.e. they would be travelling from one pile location to another which piling is ongoing). Therefore, cumulative effect ranges are much larger than for the cumulative exposure ranges of one pile at a time. See **Volume 7**, **Appendix 11-3 (application ref: 7.11.11.3)** for further information.

76. The potential effect ranges are not possible to model under this scenario, as there are two starting points for receptors, and it is not possible to determine the potential range at which they need to be in order to not be at risk of effect. Therefore, the following assessment is based on the potential areas of effect only.

77. Where the potential effect areas are not large enough to interact with each other (i.e. they do not meet), the results for the respective locations and scenarios are used (the results of the modelling for the south and north locations are used to inform the assessment, to align with the modelling locations used for the simultaneous modelling).

78. **Table 8-13** presents the underwater noise modelling results for the predicted effect areas for PTS due to the cumulative exposure of concurrent monopiles and jacket pin piles at the DBS East, DBS West and the OECC.

79. The modelling includes:

- Two monopile installations at two locations simultaneously in the DBS East and DBS West Array Areas totalling a maximum of four in 24 hours; and
- Four jacket pin pile installations at three locations simultaneously in the DBS East and DBS West Array Areas and the OECC totalling a maximum of twelve in 24 hours.

Table 8-13 Summary of the Impact Areas for the Concurrent Installation of Monopile or Jacket Pin pile Foundations at multiple locations across DBS Array Areas, for Marine Mammals using the Impulsive Southall et al. (2019) criteria assuming a fleeing animal.

Location	**Potential effect areas for PTS (weighted SEL_{cum})**	
	PTS from two concurrent monopile installations (two sequential at DBS East at the same time as two sequential at DBS West)	**PTS from three concurrent pin pile installations (four sequential at DBS East at the same time as four sequential at DBS West & four sequential at the Offshore Export Cable Corridor)**
In-combination	1,400km^2	3,700km^2

80. An assessment of the maximum number of harbour porpoise that could be at risk of instantaneous PTS, due to a sequential piling event, for both monopiles and jacket pin piles, is presented in **Table 8-14**.

Table 8-14 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 hour Period. Alongside an assessment of the Potential for PTS due to the Cumulative Exposure of two concurrent Monopiles at DBS East and the OECC

Species	**Location**	**Assessment of effect**	**Potential adverse effect on site integrity**
Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)			
Harbour porpoise	DBS East, and DBS West	942.0 (0.266% of the NS MU)	**No** Less than 1% of the population will be affected. MMMP would reduce risk of PTS

Species	Location	Assessment of effect	Potential adverse effect on site integrity
Three concurrent installations at DBS East, DBS West, and OECC, with four sequential jacket pin piles at each location (total of 12 jacket pin piles installed in one day)			
Harbour porpoise	DBS East, DBS West and OECC	2442.0 (0.704% of the NS MU)	**No** Less than 1% of the population will be affected. MMMP would reduce risk of PTS

81. The effective implementation of the MMMP for piling will reduce the risk of PTS to harbour porpoise during piling at the Projects. This mitigation alongside less than 1% of the population being affected, means there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury (PTS) from increased underwater noise during construction (piling) of the Projects together.**

8.3.5.2.2 Impact 2: Disturbance or Behavioural Effects from Underwater Noise During Piling

82. The range of possible behavioural reactions that may occur as a result of exposure to noise include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment and, in severe cases, panic, or stranding, sometimes resulting in injury or death (Southall *et al*. 2007).

83. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of marine mammals, therefore it is not possible to conduct underwater noise modelling to predict impact ranges.

84. The current advice from the SNCBs is that an EDR of 26km around piling locations for monopiles (without noise abatement), and 15km for pin piles (with and without noise abatement) is used to determine the area that harbour porpoise may be disturbed from in relevant SAC (JNCC *et al.* 2020). The Array Areas are located wholly within the SNS SAC, and therefore this approach has been followed for this assessment. Not all harbour porpoise within these potential disturbance areas based on EDRs will be disturbed, however as a worst case scenario 100% disturbance of harbour porpoise in the areas has been assumed.

8.3.5.2.2.1 Assessment of Potential Effects of the Projects Alone

85. The estimated number of harbour porpoise and percentage of the NS MU reference population that could be disturbed as a result of underwater noise during piling at DBS East or DBS West based on the site-specific (as worse case) density is presented in **Table 8-15.**

86. For one piling event at a time, the potential impact for the 26km EDR for monopiles is 0.40% (or less) of the MU population anticipated to be affected and 7.86% of the SNS SAC summer area, and for the 15km EDR for jacket pin piles 0.13% or less of the reference population anticipated to be temporarily disturbed with 2.62% of the SNS SAC summer area disturbed (**Table 8-15**).

Table 8-15 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for a Single Piling Events at DBS East or DBS West

EDR	Source	Assessment of effect	Potential adverse effect on site integrity
Monopiles (EDR – 26km, Impact area 2,123.7km^2)	DBS East	1,274.2 (0.367% of the NS MU) (7.86% of SNS SAC summer area)	**No** Less than 5% of the population affected Less than 20% of the summer area
	DBS West	1,401.6 (0.404% of the NS MU) (7.86% of SNS SAC summer area)	
	OECC	1,401.6 (0.404% of the NS MU) (5.83% of SNS SAC summer area)	

EDR	Source	Assessment of effect	Potential adverse effect on site integrity
Jacket pin piles (EDR – 15km, Impact area 706.9km^2)	DBS East	424.1 (0.122% of the NS MU) (2.62% of SNS SAC summer)	**No** Less than 5% of the population affected Less than 20% of the summer area
	DBS West	466.5 (0.134% of the NS MU) (2.62% of SNS SAC summer)	
	OECC	466.5 (0.134% of the NS MU) (2.62% of SNS SAC summer)	

87. The application of a dose-response curve allows for an evidence-based estimate which accounts for the fact that the likelihood of an animal exhibiting a response to a stressor or stimulus will vary according to the dose of stressor or stimulus received (Dunlop *et al.* 2017). Therefore, unlike the traditional threshold assessments commonly used, a dose-response analysis assumes that not all animals in an impacted area will respond (with behavioural disturbance response in this case). For the purposes of this assessment, the dose is the received single-strike SEL (SEL_{SS}). The use of SEL_{SS} in a dose-response analysis, where possible, is considered to be best practice in the latest guidance provided by Southall *et al.* (2021).

88. To estimate the number of animals disturbed by piling, SEL_{SS} contours at 5dB increments (generated by the noise modelling) (see **Volume 7**, **Appendix 11-3 (application ref: 7.11.11.3)**) were overlain on the relevant species density surfaces to quantify the number of animals receiving each SEL_{SS}, (**Volume 7, Figures 11-1 to 11-3 (application ref: 7.11.1)**) and subsequently the number of animals likely to be disturbed based on the corresponding dose-response curve. This analysis was applied to monopiles only as a worst-case. For harbour porpoise, due to the wide range of the 5dB contours from the Projects propagating over a larger area than the site-specific surveys the SCANS IV density estimates for each block potentially affected were used for the analysis as a worst case (Gilles *et al.* 2023)[2]. The dose-response relationship used for harbour porpoise was developed by Graham *et al.* (2017) using data collected during Phase 1 of piling at Beatrice offshore wind farm (OWF). This dose response relationship is displayed in **Plate 8-1** Following the development of this dose-response relationship, further study revealed that the responses of harbour porpoises to piling noise diminishes over the construction period (Graham *et al.* 2019). Therefore, the use of the dose-response relationship related to an initial piling event for all piling events in this assessment can be considered conservative.

[2] Note that the SCANS-IV density for the project block NS-C is approximate to the site specific density at 0.6027 animals per km^2.

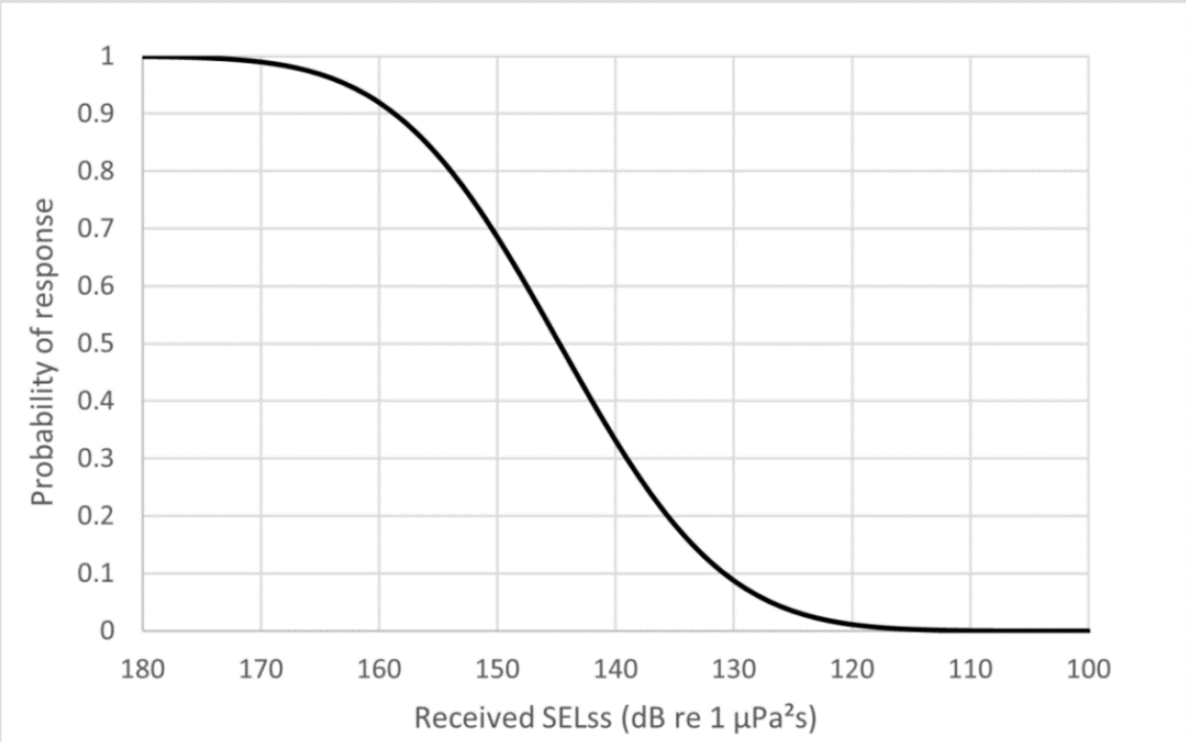


Plate 8-1 Dose-response relationship developed by Graham et al. (2017) used for harbour porpoise in this assessment

89. **Table 8-16** presents the estimated numbers and percentage of population of harbour porpoise from the dose response curves that could be potentially disturbed as a result of underwater noise during piling.

Table 8-16 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East, DBS West, and the OECC in isolation Based on the Dose-Response Approach

Location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance due to a single, maximum energy monopile strike (SEL_{SS})		
DBS East	4,295.5 (1.24% of the NS MU reference population) (7.86% of SNS SAC summer area)	**No** Less than 5% of the population affected.

Location	Assessment of effect	Potential adverse effect on site integrity
DBS West	5,097.7 (1.47% of the NS MU reference population) (7.86% of SNS SAC summer area)	Less than 20% of the summer area
OECC	7,940.5 (2.29% of the NS MU reference population) (5.83% of SNS SAC summer area)	

90. The estimated numbers (and percentage of the relevant reference populations) of harbour porpoise disturbed as a result of underwater noise during piling after ADD duration of 80 minutes is presented in **Table 8-17**.

Table 8-17 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles or Jacket Pin Piles at DBS East or DBS West in isolation

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes as required for monopiles at DBS East, DBS West & Offshore Export Cable Corridor, and jacket pin piles at DBS East, and Offshore Export Cable Corridor			
Harbour porpoise	DBS East	97.7 (0.03% of the NS MU reference population) (0.528% of SNS SAC summer area)	**No** Less than 5% of the population affected Less than 20% of the summer area
	DBS West or OECC	107.5 (0.03% of the NS MU reference population) (0.581% of SNS SAC summer area)	

91. The population effected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in isolation.**

8.3.5.2.2.2 Assessment of Potential Effects of the Projects Together

92. The estimated number of harbour porpoise and percentage of the NS MU reference population that could be disturbed as a result of underwater noise during piling for a single piling event is the same as DBS East or DBS West in isolation. Therefore, in this section, the focus is on concurrent and simultaneous piling.

93. The estimated number of harbour porpoise and percentage of the NS MU reference population that could be disturbed as a result of underwater noise during piling at DBS East and DBS West together is presented in **Table 8-18**.

94. For two simultaneous piling events (based on the worst case density), the potential impact for the 26km EDR for monopiles, is 0.80% (or less) of the reference population and 15.71% of the SNS SAC summer area. For the 15km EDR for jacket pin piles the potential impact is 0.40% of the reference population and 7.85% of the SNS SAC summer area (**Table 8-18**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 8-18 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for Simultaneous Piling Events

EDR*	Assessment of effect	Potential effect on site integrity
EDR of 26km for mono-piles, at two simultaneous locations (4,247.4km^2)	2,803.3 (0.808% of the NS MU) (15.71% of SNS SAC summer area)	**No** Less than 5% of the population affected Less than 20% of the summer area
EDR of 15km for jacket pin piles, at three simultaneous locations (2,120.6km^2)	1,399.6 (0.403% of the NS MU) (7.85% of SNS SAC summer area)	**No** Less than 5% of the population affected Less than 20% of the summer area

** Not taking into account any overlap between disturbance areas between the piling locations*

95. The dose response approach was also used to consider this impact. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADDs which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

96. The results presented in **Table 8-19** indicate there is no potential for an adverse effect for a monopiles at DBS East and DBS West.

Table 8-19 Number of Individuals (and % of Reference Population) That Could be Disturbed During Piling at DBS East and DBS West Together Based on the Dose-Response Approach

Species	Project location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance at maximum energy monopile strike (SEL_{SS}) at two locations (DBS East and DBS West together)			
Harbour porpoise	DBS East and DBS West	9,393.2 harbour porpoise (2.7% of the NS MU reference population) (15.72% of SNS SAC summer area)	**No** Less than 5% of the population affected Less than 20% of the summer area

97. The estimated numbers (and percentage of the relevant reference populations) of harbour porpoise disturbed as a result of underwater noise during piling after ADD duration of 160 minutes for monopiles **Table 8-20**.

Table 8-20 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles at DBS East or DBS West together

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes (160 minutes) as required for two monopiles at DBS East and / or DBS West			
Harbour porpoise	DBS East	195.4 (0.056% of the NS MU reference population) (1.06% of SNS SAC summer area)	**No**

Species	Location	Assessment of effect	Potential adverse effect on site integrity
	DBS West	215.0 (0.062% of the NS MU reference population) (1.16% of SNS SAC summer area)	Less than 5% of the population affected Less than 20% of the summer area
	DBS East and DBS West together	205.2 (0.06% of the NS MU reference population) (1.11% of SNS SAC summer area)	

98. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in together.**

8.3.5.2.3 Impact 3a: Auditory Injury from Underwater Noise During other Construction Activities

99. Potential sources of underwater noise during construction activities, other than piling, include seabed preparation, dredging, trenching, cable installation and rock placement. The cable installation methods that are currently being considered are ploughing, jetting, trenching or cutting, also surface laid with cable protection where burial is not possible. Dredging and cable installation activities have the potential to generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals.

100. There are no clear indications that underwater noise caused by the installation of sub-sea cables poses a high risk of harming marine mammals (Oslo and Paris Convention for the Protection of the Marine Environment (OSPAR), 2009). However, behavioural responses of marine mammals to dredging, an activity emitting comparatively higher underwater noise levels, are predicted to be similar to those during cable installation (OSPAR, 2009).

101. The noise levels produced during dredging and cable installation activities can vary, for example, with (Jones and Marten, 2016; Robinson *et al.* 2011; Theobald *et al.* 2011):

- Dredger type; and
- Cable installation method.

102. As well as environmental conditions, including:

- Sediment type;
- Water depth;
- Salinity;
- Thermoclines; and
- Ambient noise levels.

103. These factors will influence the distance at which sounds can be detected.

104. Reviews of published sources of underwater noise during dredging activity and cable installation activities (e.g. Thomsen *et al.* 2006; Theobald *et al.* 2011; Todd *et al.* 2015), indicate that the sound levels that marine mammals may be exposed to are typically below auditory injury thresholds (PTS) exposure criteria (as defined in Southall *et al.* 2019). Using the non-impulsive weighted SEL_{cum} PTS thresholds from Southall *et al.* (2019) resulted in estimated PTS impact ranges of <100m for all marine mammal species for each non-piling construction activity. These values mean that animals would have to stay within these very small ranges for 24 hours before they experienced injury, which is an extremely unlikely scenario as it is far more likely that any marine mammal within the injury zone would move away from the vicinity of the vessel and the construction activity. Therefore, the potential risk of any auditory injury in marine mammals as a result of construction activities is highly unlikely.

105. The thresholds for temporary loss in hearing sensitivity (TTS) could be exceeded during dredging. However, only if marine mammals remain in close proximity to the active dredger for extended periods, which is highly unlikely (Todd *et al.* 2015).

106. If the response to underwater noise from other construction activities is displacement from the area, it is predicted that marine mammals will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance effects on marine mammals.

107. To determine the potential risk for TTS from underwater noise during dredging, trenching, cable laying and rock placement, site specific underwater noise modelling was undertaken to estimate the noise levels likely to arise during noisy activities (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) and determine the potential effects on marine mammals.

108. The results of the underwater noise modelling (**Table 8-21**) present predicted TTS impact ranges for harbour porpoise with the largest being 0.99km for rock placement and 0.23km for dredging, based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum} (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). This also includes the area of impact should all activities be undertaken simultaneously.

Table 8-21 Predicted impact ranges (and areas) for TTS rom 24 hour cumulative exposure during other construction activities

Criteria and threshold (Southall *et al.* 2019)	Cable laying	Dredging (backhoe and suction (individually))	Trenching	Rock placement	All activities
SEL_{cum} Weighted (153 dB re 1 μPa²s) Non-impulsive	0.11km (0.038 km²)	<0.1km (<0.03 km²)	0.23km (0.17km²)	0.99km (3.08km²)	3.318 km²

8.3.5.2.3.1 Assessment of Potential Effects of the Projects Alone

109. The number of marine mammals that could be impacted as a result of underwater noise during construction activities other than piling has been assessed based on the number of animals that could be present in each of the modelled impact ranges (**Table 8-21**).

110. The potential for auditory injury effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, not consistent throughout the offshore construction period for the Projects and would be limited to only part of the overall construction period and area at any one time.

111. Given the small number of individuals affected (**Table 8-22**), there would be **no adverse effect of from other construction activities either alone or taking place simultaneously on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects in isolation.**

Table 8-22 Maximum Number of Individuals (and % of Reference Population) That Could Be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for Each Individual Activity And For All Activities At The Same Time At DBS East or DBS West

Species	Potential Impact	Location	Maximum number of individuals (% of reference population) for TTS for each individual activity	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Potential adverse effect on site integrity
Harbour porpoise	Cumulative SEL for: - Cable laying - Trenching - Dredging	DBS East or DBS West or the OECC	0.11 (0.00003% of NS MU reference population)	2.2 (0.0006% of NS MU reference population)	**No** Less than 1% of the population affected.
	Cumulative SEL for: Rock placement	DBS East or DBS West or the OECC	2.0 (0.0006% of NS MU reference population)		

8.3.5.2.3.2 Assessment of Potential Effects of the Projects Together

112. As a worst-case, the maximum number of harbour porpoise from each Project (**Table 8-22)** has been assessed to indicate the maximum number of harbour porpoise that could be impacted from the Projects together, if they are developed concurrently (**Table 8-23**).

113. The underwater noise impacts from non-piling noise will be significantly less than that of impact piling and will be localised and short term. Any potential disturbance would be temporary and therefore unlikely to significantly affect marine mammal populations.

114. Given the small number of individuals affected (**Table 8-23**), there would be **no adverse effect of from other construction activities either alone or taking place simultaneously on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects together.**

Table 8-23 Maximum Number of Individuals (And % Of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for All Activities at The Same Time at The Projects

Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Potential adverse effect on site integrity
Harbour porpoise	DBS East & West including OECC	4.4 (0.0013% of NS MU)	**No** Less than 1% of the population affected.

8.3.5.2.4 Impact 3b: Disturbance from Underwater Noise During Other Construction Activities

115. Harbour porpoise within the potential disturbance area is considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

116. If the response is displacement from the area, it is predicted that harbour porpoise will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance effect on harbour porpoise.

117. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources).

118. Studies undertaken during the construction of two Scottish OWFs (Beatrice OWF and Moray East OWF) (Benhemma-Le Gall *et al*. 2021), found that the probability of harbour porpoise being present increased with distance from the vessels and construction activities, and decreased with increasing vessel presence and background noise. During the period of turbine installation at Beatrice OWF, a significant reduction in harbour porpoise presence was detected even while no piling was taking place. Various construction activities were undertaken during this turbine installation phase, including jacket installation, turbine and cable installations, with some activities occurring simultaneously, which led to high levels of vessel traffic within the OWF site.

119. A reduction in harbour porpoise presence was detected at up to 12km from impact pile driving, and up to 4km from construction related vessels (**Plate 8-2**). With construction vessels at 2km from Cetacean Porpoise Detector (CPOD) locations, harbour porpoise activity decreased by up to 35.2%, with construction vessels at 3km from the CPODs, there was a decrease of up to 24%, and at 4km from construction vessels, there was an increase of 7.2%. Outside of the piling period, the study found that the presence of harbour porpoise decreased by 17% with SPLs of 57dB (above ambient noise).

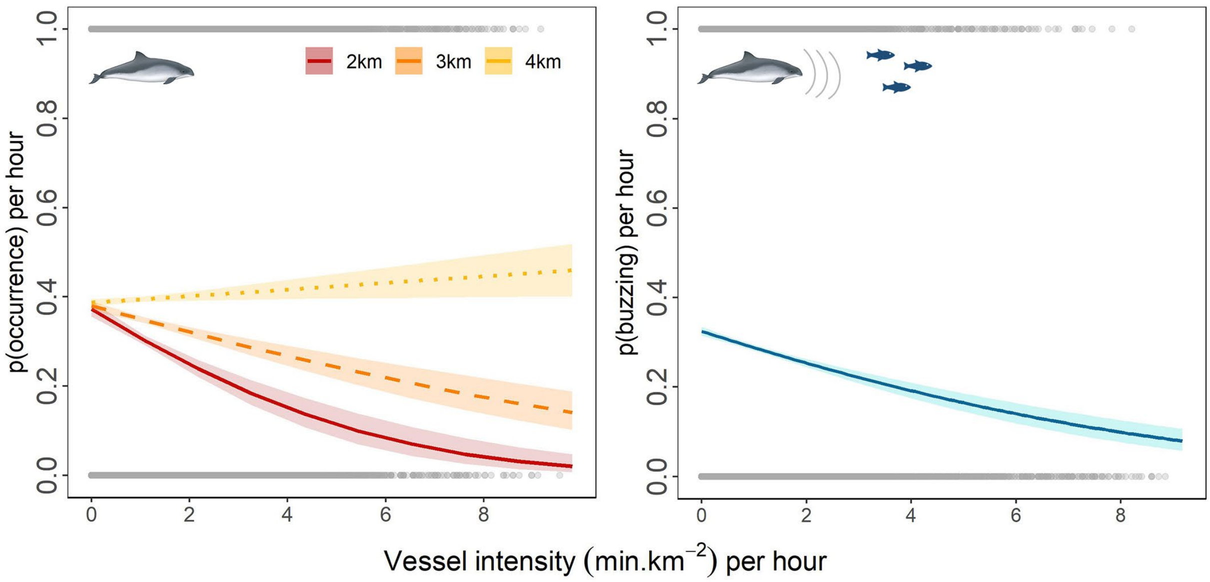


Plate 8-2 [Left] The Probability of Harbour Porpoise Presence in Relation to Vessel Activity (Red = Mean Vessel Distance of 2km, Orange = Mean Vessel Distance of 3km, Yellow = Mean Vessel Distance of 4km, and [Right] the Probability of Buzzing Activity Per Hour i

120. While the study did not define which activities were taking place to cause the disturbance, it was while a number of construction vessels were on site (Benhemma-Le Gall *et al.* 2021). Therefore, this reported 4km reduction in harbour porpoise presence has been used as a potential disturbance range for all other construction activities in this assessment.

8.3.5.2.4.1 Assessment of Potential Effects of the Projects Alone

121. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range (with an effect area of 50.27km^2) is presented in **Table 8-24**. This is a precautionary approach as it is unlikely that all marine mammal species would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place in the Offshore Development Area.

122. Given the small number of individuals and SNS SAC summer area affected (**Table 8-24**), there would be **no adverse effect of from other construction activities either alone or taking place simultaneously on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects in isolation.**

Table 8-24 Assessment of The Potential for Disturbance Due to Other Construction Activities, for One and Multiple Activity Taking Place at Any One Time Either DSB East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Disturbance for each individual activity (50.27km²)			
Harbour porpoise	DBS East	30.2 (0.009% of the NS MU)	**No** Less than 5% of population disturbed
	DBS West or OECC	33.2 (0.01% of the NS MU)	
Disturbance for multiple construction activities (201.06km²)			
Harbour porpoise	DBS East	120.6 (0.035% of NS MU)	**No** Less than 5% of the population disturbed
	DBS West or OECC	132.7 (0.038% of NS MU)	

8.3.5.2.4.2 Assessment of Potential Effects of the Projects Together

123. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range at the Projects together for up to eight vessels (with an effect area of 402.12km²) is presented in **Table 8-25**. The assessment has been undertaken on the worst case density within the Offshore Development Area for harbour porpoise.

Table 8-25 Assessment of The Potential for Disturbance Due to Other Construction Activities Taking Place at Any One Time at DBS East and DBS West Together (using the worst case density from DBS West)

Species	Maximum number of individuals (% of reference population) for disturbance for all activities at the same time	Potential adverse effect on site integrity
Harbour porpoise (402.16km²)	265.4 (0.077% of NS MU)	**No** Less than 5% of population disturbed

124. The potential for disturbance that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, not consistent throughout the offshore construction period, and would be limited to only part of the overall construction period and area at any one time.

125. With both DBS East and DBS West being developed together there is the potential for construction in more than one area at any given time, but the disturbance effects are expected to remain limited. The duration for the offshore construction period, including piling and export cable installation, is approximately five years for the Projects being constructed concurrently and seven years when constructed sequentially. However, noisy construction activities would not be underway constantly throughout this period.

126. Given the small number of individuals affected (**Table 8-25**), there would be **no adverse effect of from other construction activities either alone or taking place simultaneously on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects together.**

8.3.5.2.5 Impact 4a: Auditory Injury from Underwater Noise due to the Presence of Vessels

127. Vessels onsite will generally be associated with piling and other construction activities during the construction period as assessed in section 8.3.5.2.1 to 8.3.5.2.4. However, as a precautionary approach and to take into account vessels that could be in the wind farm site when these activities are not being conducted, the potential for PTS or TTS and disturbance from underwater noise and presence of vessels has also been assessed separately.

128. During the construction phase there will be an increase in the number of vessels in the Offshore Development Area. The indicative peak maximum number of vessels any one time has been estimated at 32 for DBS East or DBS west alone or 59 together (**Table 8-4**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

129. Vessel movements to and from any port will be incorporated within existing vessel routes. Therefore, any increase in disturbance as a result of underwater noise from vessels during construction will be predominantly within the Array Areas. As outlined in **Volume 7, Chapter 14 Shipping and Navigation (application ref: 7.14)**, between a total of 4,480 transits to port per each five-year period during the construction phase for the Offshore Development Area.

130. The vessels in the Offshore Development Area will be slow moving (or stationary), and most noise emitted is likely to be of a lower frequency. Noise levels reported by Malme *et al.* (1989) and Richardson, Miller and Greene, (1999) for transiting large surface vessels indicate that physiological damage to auditory sensitive marine mammals is unlikely. The potential risk of permanent auditory injury (PTS) in marine mammals as a result of vessel noise is highly unlikely, as the sound levels are well below the threshold for PTS (Southall *et al.* 2019).

131. A study of the noise source levels from several different vessels (Jones *et al.* 2017) indicates that for a cargo vessel of 126m in length (on average), travelling at a speed of 11 knots (on average) would generate a mean sound level of 160dB re 1 μPa @ 1m (with a maximum sound level recorded of 187dB re 1 μPa @ 1m). The levels could be sufficient to cause local disturbance to marine mammals in the immediate vicinity of the vessel, depending on ambient noise levels.

132. Thomsen *et al.* (2006) reviewed the effects of ship noise on harbour porpoise and seal species. The review concluded that ship noise around 0.25kHz could be detected at distances of 1km and ship noise around 2kHz could be detected at around 3km.

133. To determine the potential risk for PTS and TTS from underwater noise of vessels underwater noise modelling was undertaken (see **Volume 7**, **Appendix 11-3 (application ref: 7.11.11.3)**) to determine the potential effects on marine mammals. Underwater noise modelling was undertaken for medium and large vessels. Medium vessels are less than 100m in length, while large vessels are over 100m.

8.3.5.2.5.1 Assessment of Potential Effects of the Projects Alone

134. Impact ranges for PTS and TTS for large and medium vessels for all species are less than 100m (see **Volume 7**, **Appendix 11-3 (application ref: 7.11.11.3)**). Results and assessments are based on risk of TTS.

135. The results of the underwater noise modelling indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24-hours, to be exposed to noise levels that could induce TTS. As a precautionary approach the potential impact area for all vessels on site at the same time has also been determined (**Table 8-26**).

Table 8-26 Predicted Impact Ranges (and Areas) For Auditory Injury From 24 Hour Cumulative Exposure for Construction Vessels

Species	Criteria and threshold (Southall *et al.*.2019)	Large vessel	Medium vessels	Up to 32 vessels
Harbour porpoise	SEL_{cum} Weighted (153 dB re 1 μPa^{2}s) Non-impulsive	<0.1km (<0.03km^2)	<0.1km (<0.03km^2)	0.96km^2

136. The number of marine mammals that could be impacted as a result of underwater noise from construction vessels has been assessed based on the number of animals that could be present in each of the modelled impact ranges (**Table 8-27**).

137. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours for any potential risk of PTS (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). Therefore, PTS as a result of construction vessels is highly unlikely and has not been assessed further.

138. There is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours in a day (**Table 8-27**). Although auditory injury as a result of construction vessels is highly unlikely, it has been assessed as precautionary approach.

139. Given the small number of individuals affected (**Table 8-27**), there would be **no adverse effect of auditory injury from the presence of vessels on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects in isolation.**

Table 8-27 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
One vessel			
Harbour porpoise	DBS East, DBS West, OECC	0.02 (0.00001% of the NS MU)	**No** Less than 1% of population affected
Up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the OECC]			
Harbour porpoise	DBS East, DBS West, OECC	0.6 (0.0002% of the NUS MU)	**No** Less than 1% of population affected

8.3.5.2.5.2 Assessment of Potential Effects of the Projects Together

140. The number of marine mammals that could be impacted as a result of underwater noise from construction vessels has been assessed based on the number of animals that could be present in each of the modelled impact ranges applied to the number of vessels that could be on site at any one time (**Table 8-28**).

141. The potential for auditory injury that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Projects of five to seven years and would be limited to only part of the overall construction period.

Table 8-28 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West Together

Species	Location	Maximum number of individuals (% of reference population) for up to 59 vessels	Potential adverse effect on site integrity
Harbour porpoise	DBS East, DBS West, and OECC	1.2 (0.0003% of NS MU)	**No** Less than 1% of population affected

142. Therefore, there would be **no adverse effect of underwater noise (auditory injury) from the presence of vessels on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects together.**

8.3.5.2.6 Impact 4b: Disturbance from Underwater Noise due to the Presence of Vessels

143. Harbour porpoise within the potential disturbance area is considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

144. There is the potential for sensitive species with high metabolic requirements, such as the harbour porpoise, to be more vulnerable to anthropogenic stressors such as vessel noise, forcing individuals to make trade-off decisions between using energy to leave the area or remaining in exposed areas (Benhemma-Le Gall *et al.* 2021). This additional energy use may have biological consequences in the short and long-term (Pirotta *et al.* 2014), and harbour porpoise have been shown to be displaced by vessel activity up to 7km away depending on vessel type (Wisniewska *et al.* 2016). In a 2012 study, high-speed planning vessels (small boats, jet skis, etc.) caused the most negative reactions in this species (Oakley *et al.* 2017).

145. Whilst short to medium term behavioural responses have been recorded from vessel disturbance, there are no long-term or population level effects recorded to date.

146. Modelling by Heinänen and Skov, (2015) indicates that the number of ships represents a relatively important factor determining the density of harbour porpoise NS MU during both seasons, with markedly lower densities with increasing levels of traffic. A threshold level in terms of impact seems to be approximately 20,000 ships per year (approximately 80 vessels per day within a 5km^2 area). This equates to 50 vessels per day in 25km^2 (approximately two vessels per km^2).

147. Taking into account the maximum number of up to 32 vessels that could be in the wind farm site during construction, the number of vessels would not exceed the Heinänen and Skov, (2015) threshold.

148. With the maximum number of 32 vessels potentially working within DBS East or DBS West plus the Offshore Export Cable Corridor at one time, instead of adding a 4km disturbance range around each vessel, a 4km buffer has been added around each Array Area. This accounts for the maximum of 26 vessels in each Array Area at any one time, therefore accounting for the overlap in disturbance areas for 26 vessels present in each Array Area (as shown on **Plate 8-3**). A further assessment has been undertaken to account for a maximum of six vessels in the Offshore Export Cable Corridor at one time, totalling at a maximum of 32 vessels at any one time.

149. To assess for vessel disturbance in the Offshore Export Cable Corridor, there would be a maximum of six vessels at one time, therefore a 4km impact range has been added per vessel. For six vessels, the total effect range for the potential of disturbance from vessel activity is 301.56km^2.

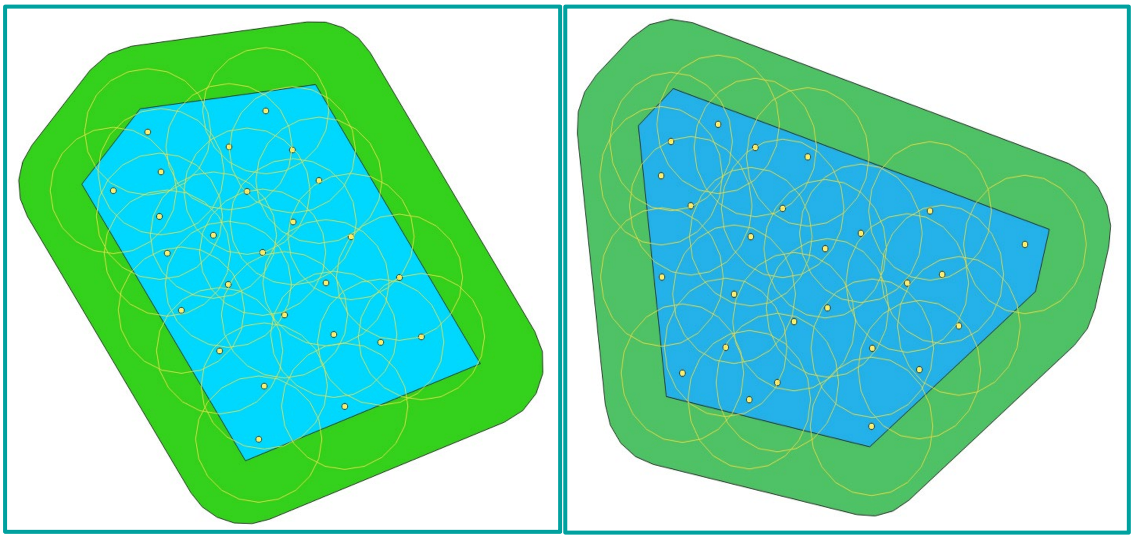


Plate 8-3 East (left) and DBS West (right) Array Area (blue), with 26 vessel (yellow dots), 4km buffer circles (yellow) and 4 km buffer around Array Area (green)

8.3.5.2.6.1 Assessment of Potential Effects of the Projects Alone

150. Further information on the modelling and assessments for disturbance from underwater noise due to the presence of vessels for the Projects in isolation can be found in section 11.6.1.4.5 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

151. Impact ranges for vessel disturbance within DBS East and DBS West is shown in **Table 8-29**.

Table 8-29 Impact ranges for vessel disturbance

Area	Impact Area
DBS East Array Area	696.01km^2
DBS West Array Area	708.90km^2
OECC	301.56km^2

Table 8-30 Maximum Number of Individuals (and % of Reference Population) That Could be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Potential adverse effect on site integrity
One Vessel			
Harbour porpoise	DBS East	30.2 (0.008% of the NS MU)	**No** Less than 5% of population affected
	DBS West or OECC	33.2 (0.008% of the NS MU)	
Up to 26 vessels			
Harbour porpoise	DBS East	417.6 (0.120% of the NS MU)	**No** Less than 5% of population affected
	DBS West	467.9 (0.134% of the NS MU)	
Up to six vessels			

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Potential adverse effect on site integrity
One Vessel			
Harbour porpoise	OECC	199.0 (0.057% of the NS MU)	**No** Less than 5% of population affected

152. **Table 8-31** presents the number of individuals that could be temporarily disturbed by the vessel transits. For the potential of disturbance of one vessel transiting from DBS West to Lowestoft as worst case of the potential construction ports, as it is the furthest away from the DBS West Array Area. The disturbance range has been calculated by adding a 4km buffer to a moving vessel from an estimated transit. This means that the assessment assumes marine mammals would be disturbed from the area of vessel transit for an extended period of time following the vessels passing. This is a highly precautionary approach as it is more likely that any marine mammal that is disturbed would return to the area shortly following the vessels transit.

153. The total number of transits for DBS East or DBS West is 3,857 during the five-year construction period, this equates to 772 transits per year, or three vessels per 24 hour period. With the vessel traveling at 10 knots during the transit it would take less than 15 hours. It is also very unlikely for three vessels to be transiting side by side, therefore the assessment is based on one vessel in transit providing a disturbance range of 1,200km^2.

154. With less than 5% of the population affected (**Table 8-30** and **Table 8-31**), there would be **no adverse effect from disturbance due to underwater noise from the presence of vessels on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects in isolation.**

Table 8-31 Maximum number of individuals (and % of reference population) that could be disturbed as a result of underwater noise associated with transiting vessels during construction at DBS East or DBS West in isolation

Species	Maximum number of individuals (% of reference population) for one vessel	Potential adverse effect on site integrity
Harbour porpoise	792.0 (0.228% of the NS MU)	**No** Less than 5% of population affected

8.3.5.2.6.2 Assessment of Potential Effects of the Projects Together

155. Further information on the modelling and assessments for disturbance from underwater noise due to the presence of vessels for the Projects together can be found in section 11.6.1.4.5 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

156. The maximum number of construction vessels on site at any one time will be up to 59 vessels, with 12 of those vessels being within the Offshore Export Cable Corridor. This would equate to up to 47 vessels across the Projects Array Areas at any one time. Therefore, the same approach as outlined for DBS East or DBS West in isolation has been taken; with the assessment of vessel disturbance within the Array Areas being based on each Array Area with 4km buffer.

157. Impact ranges for vessel disturbance for the Projects together is shown in **Table 8-32**.

Table 8-32 Potential impact ranges for vessel disturbance at DBS East and DBS West together

Area	Impact Area
DBS East and DBS West Array Area	1,404.910km^2
OECC	603.19km^2

158. The potential impact is assessed in **Table 8-33**.

Table 8-33 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East and DBS West Together

Species	Location	Maximum number of individuals (% of reference population) for up to 59 vessels	Potential adverse effect on site integrity
Harbour porpoise	DBS East and DBS West Array Areas	1,084.5 (0.31% of the NS MU)	**No** Less than 5% of population affected
	OECC	398.1 (0.114% of the NS MU)	

159. **Table 8-31** presents the number of individuals that could be temporarily disturbed by the vessel transits. For the potential of disturbance of one vessel transiting from DBS West to Lowestoft as worst case. The impact ranges that are used are highly precautionary and unlikely as the vessel will be moving and the disturbance range will be moving with the vessel.

160. The number of vessels that are planned to transit if DBS East and DBS West are constructed together is 7,510 which totals an average of 1,502 vessels per year during a worst case five-year construction period. Therefore, the maximum number of vessels that will be transiting per a 24 hour periods is six. As stated within section 8.3.5.2.6.1 vessels transiting together is very unlikely therefore the assessment has been based on one vessel transiting presented in **Table 8-31**.

161. There would be **no adverse effect from disturbance due to underwater noise from the presence of vessels on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects together.**

8.3.5.2.7 Impact 5: Barrier Effects as A Result of Underwater Noise During Construction

8.3.5.2.7.1 Assessment of Potential Effects of the Projects Alone

162. Underwater noise during construction could have the potential to create a barrier effect, preventing movement of harbour porpoise between important feeding and / or breeding areas, or potentially increasing swimming distances if harbour porpoise avoid the area and go around the noise.

163. The greatest potential barrier effect for harbour porpoise could be from underwater noise during piling. There is unlikely to be the potential for any barrier effects from underwater noise from other construction activities and vessels.

164. Harbour porpoise can greatly be affected when travelling to foraging areas, and due to the fact that they have high daily energy demands, it is vital for them to find enough prey to meet these daily energy requirements. Therefore, any barrier effects that could restrict harbour porpoise accessing foraging areas could have implications for individuals.

165. Piling would not be constant during the piling phases and construction periods. There will be gaps between the installations of individual piles, and if installed in groups there could be time periods when piling is not taking place as piles are brought out to the site. There will also be potential delays for weather or other technical issues.

166. There are unlikely to be any significant long-term impacts from any barrier effects, as any areas affected would be relatively small in comparison to the range of harbour porpoise and would not be continuous throughout the offshore construction period. There will also be periods when piling is not taking place as piles are brought out to the site. In additional, there will also be potential delays for weather or other technical issues.

167. The maximum duration of any barrier effects would be for the maximum piling duration for a single pile, based on worst case scenarios, including soft-start, ramp-up and ADD activation assessed in section 8.3.5.2.2.1. Therefore, there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of harbour porpoise as they travel large distances daily, and would therefore would be able to locate prey in other foraging areas. It is also predicted that harbour porpoise would return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary.

168. Therefore, is unlikely to be any significant long-term impacts from any barrier effects, as any areas affected would be relatively small in comparison to harbour porpoise and would not be continuous throughout the offshore construction period.

169. Any potential barrier effects as a result of underwater noise during construction have been assessed as having **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

8.3.5.2.7.2 Assessment of Potential Effects of the Projects Together

170. The maximum duration of any barrier effects would be for the maximum piling duration for two concurrent piles, based on worst case scenarios, including soft-start, ramp-up and ADD activation as assessed in section 8.3.5.2.2.2.

171. Taking into account that piling would not be constant, that harbour porpoise are wide ranging and would be able to compensate by travelling to other foraging areas within their ranges as described in section 8.3.5.2.7.1. Harbour porpoise will mostly return to the area once the piling has completed.

172. Therefore, any potential barrier effects as a result of underwater noise during construction have been assessed as having **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.**

8.3.5.2.8 Impact 6: Increased Collision Risk with Vessels During Construction

173. Marine mammals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al.* 2007). Therefore, increased vessel movements, especially those outside recognised vessel routes, can pose an increased risk of vessel collision to harbour porpoise.

174. Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80m in length causing the most damage to marine mammals. Vessels travelling at high speeds are considered to be more likely to collide with marine mammals, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al*. 2001).

175. Harbour porpoises are small and highly mobile, and given their responses to vessel noise, are expected to largely avoid vessel collisions (Polacheck and Thorpe, 1990; Thomsen *et al.* 2006). The Heinänen and Skov (2015), report indicates a negative relationship between the number of ships and the distribution of harbour porpoise in the North Sea, suggesting that the species could exhibit avoidance behaviour which reduces the risk of strikes.

176. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Lusseau, 2006, 2003; Nowacek *et al.* 2001). **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

177. Approximately 4% of all harbour porpoise post-mortem examinations from the Baltic, North East Atlantic, Irish and North Seas (ASCOBANS area) are thought to have evidence of interaction with vessels (Evans *et al.* 2011).

8.3.5.2.8.1 Assessment of Potential Effects of the Projects Alone

178. To estimate the potential collision risk of vessels associated with the Projects during construction, the potential risk rate per vessel has been calculated for all relevant species (**Table 8-34**), which is then used to calculate the risk to marine mammal species due to the increased number of vessel movements during construction.

179. The increased number of vessel movements has been based on the estimated 3,857 return vessel trips during the five-year construction period for each Array Area, and 772 per year for either DBS East or DBS West in isolation.

180. The number of marine mammals at risk of collision, per vessel, in UK waters, has been estimated based on the total number of each marine mammal species in UK waters and the total number vessels present in UK waters. The potential collision risk rate of each species is based on the Cetacean Strandings Investigation Programme (CSIP) and the Scottish Marine Animal Strandings Scheme (SMASS) data.

Table 8-34 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collisions with Vessels

Species	Number of strandings	Number of post-mortems where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from vessels	Collision risk rate (%) (number attributed to vessels strike / other physical trauma as proportion of total known cause of death)
Harbour porpoise	6599	1535	71	16	0.0567

181. The number of marine mammals (percentage of the relevant reference population) at risk of collision from the increased number of vessel movements during the construction period of the Projects has been used to determine the possible magnitude of the permanent effect (**Table 8-35**).

182. With less than 1% of the population effected (**Table 8-35**), there would be **no adverse effect from increased collision risk with vessels on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects in isolation.**

Table 8-35 Predicted Number of harbour porpoise at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (AEoI Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West in Isolation and Together

	DBS East or DBS West in Isolation	DBS East or DBS West together
Collision risk rate[3]	0.0567	
Estimated total number of individuals in UK waters[4]	200,714	
Estimated number of individuals at risk within UK waters	11,376	
Annual number of vessel transits in UK and RoI for 2015[5]	3,852,030	
Number of marine mammals at risk of collision per vessel in UK waters	0.00295	
Number annual vessel transits associated with construction	772	1,502
Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	Up to 3 per year (2.3)	Up to 5 every year (4.4)
% reference population	0.0007% of the NS MU	0.0013% of the NS MU
Potential adverse effect on site integrity	**No** – Less than 1% of population affected	**No** – Less than 1% of population affected

[3] Where species specific data is not available, the species group data is used
[4] Based on the (IAMMWG, 2023) UK population estimates for cetacean species
[5] Latest publicly available data

8.3.5.2.8.2 Assessment of Potential Effects of the Projects Together

183. As a precautionary worst case the number of marine mammals that could be at increased risk of collision with construction vessels, if DBS East and DBS West are constructed concurrently has been based on the estimated maximum number of construction vessels for both Array Areas (**Table 8-4**).

184. To estimate the potential collision risk of vessels associated with DBS East and DBS West Array Areas during construction together, the potential risk rate per vessel has been calculated for all relevant species, which is then used to calculate the risk to marine mammal species due to the increased number of vessel movements during construction (**Table 8-35**).

185. The increased number of vessel movements has been based on the estimated 1,502 return vessel trips per year during the five-year construction period for DBS East and DBS West together and a total of 7,510 over the five years of construction.

186. The number of marine mammals (up to 25) at risk of collision from the increased number of vessel movements during the five year construction period of the Projects together has been used to determine the potential magnitude of the permanent effect (0.007% of the NS MU).

187. This is highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, considering the existing number of vessel movements in the area, and that vessels within the wind farm would be stationary for much of the time or very slow moving. Taking into account the disturbance from vessels, the actual risk is likely to be negligible for harbour porpoise.

188. Therefore, with less than 1% of the population affected (**Table 8-35**), there would be **no adverse effect from increased collision risk with vessels on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise at the Projects in isolation.**

8.3.5.2.9 Impact 7: Changes to Prey Resources

The potential effects on prey species during construction can result from:

- Physical seabed disturbance;
- Increased SSC and sediment re-deposition;
- Remobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Changes in fishing activity.

189. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. Any reductions in prey availability would be small scale, localised and temporary. It is considered highly unlikely that potential reductions in prey availability as a result of construction activities at the Projects would result in detectable changes to harbour porpoise populations.

190. Harbour porpoise feed on schooling fish such as herring, whiting, sprat, sandeel, etc. They feed on a wide range of prey species and have relatively large foraging ranges (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

191. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment on changes in prey availability are localised and short in duration. Therefore, there will be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability during construction for the Projects in isolation or together**.

8.3.5.2.9.1 Physical Seabed Disturbance

192. During construction activities, such as foundation installation, seabed preparation (including sandwave levelling, and boulder removal), cable installation, cable protection, vessel moorings and jack-up vessel legs, there is the potential to cause physical disturbance or temporary loss of seabed habitat (see **Volume 7, Chapter 9 Benthic and Intertidal Ecology (application ref: 7.9)** and **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

193. This can cause indirect impacts to marine mammals, as any habitat loss in the sediments, would not have a direct effect on marine mammals but can cause changes in prey availability.

8.3.5.2.9.1.1 Assessment of Potential Effects of the Projects Alone

194. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS East is approximately 31.1km². The footprint for all generation asset construction works, including the array and Inter-Platform Cables, and offshore platforms and foundations, is 11.2km² for DBS East. The footprint for the construction of all transmission assets, including the Offshore Export Cable installation is 19.8km².

195. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of DBS West is 28.5km². The footprint for all generation asset construction works, including the DBS West Array Area, array and Inter-Platform Cables, and offshore platforms, is 11.5km². The footprint for the construction of all transmission assets, including the Offshore Export Cable installation, is 17km².

196. Of the two Projects, DBS East represents the worst case scenario in isolation. The assessment of temporary habitat disturbance and direct damage in isolation will therefore assume this worst case scenario for both Projects. The disturbance would be temporary during the approximately five years of construction for either site with the majority of disturbance occurring during installation of foundations and cables.

197. Given the scale of the impact the significance of effect from physical seabed disturbance for fish species is assessed as minor adverse (not significant in EIA terms) in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10).** With regard to sandeel, **Volume 6, Appendix B Sandeel Habitat Potential in the Dogger Bank SAC and Southern North Sea SAC (application ref: 6.1.2)** presents information on potential sandeel habitat within the SNS SAC and area of seabed that could be affected by the Projects. The area potentially affected will be a very small percentage of the habitat available within the SAC, approximately 0.08% of the medium and high potential habitat within the SAC could be affected by temporary disturbance and 0.006% by direct damage. It should be noted however, that this represents 'potential' sandeel only and these habitats cover the majority of the UK waters outside of the SNS SAC boundary. The percentages of habitat affected are therefore somewhat arbitrary and harbour porpoise are able to utilise the wider sea. As per the ES conclusion for all fish receptors, the area of habitat affected is minimal considered in the context of the amount of similar available habitat in the wider area. In addition, the UK government had decided to prohibit the fishing of sandeels within English waters of International Council for the Exploration of the Sea (ICES) Area 4 (North Sea) effective from 26 March 2024[6]. This measure will go a considerable way towards ensuring greater resilience for species which rely upon sandeels, including harbour porpoise.

[6] https://www.gov.uk/government/consultations/consultation-on-spatial-management-measures-for-industrial-sandeel-fishing/outcome/government-response

198. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from physical seabed disturbance) during construction for the Projects in isolation.

8.3.5.2.9.1.2 Assessment of Potential Effects of the Projects Together

199. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of both Projects is 61.8km². This represents approximately 0.23% of the total Fish and Shellfish Ecology Study Area[7] . The footprint for all generation asset construction works, including the Array Areas, array and Inter-Platform Cables, and offshore platforms, is 25km². The footprint for all offshore transmission works, including the Offshore Export Cable installation, is 36.8km².

200. Given the scale of the impact the significance of effect from physical seabed disturbance for fish species is assessed as minor adverse (not significant in EIA terms) for the Projects together as well as in isolation in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10).** Hence, with regard to sandeels, the potential area of habitat affected within the sites is a small fraction of the available habitat, see **Volume 6, Report to Inform Appropriate Assessment Habitats Regulations Assessment Part 2 of 4 (application ref 6.1)**.

201. The impact would be the same as the Projects in isolation in section 8.3.5.2.9.1.1 with more detail described in **Volume 6, Appendix B (application ref: 6.1.2)**. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from physical seabed disturbance) during construction for the Projects together**.**

8.3.5.2.9.2 Increased SSC and Sediment Re-Deposition

202. The following construction activities may lead to the potential for increased suspended sediment concentrations (SSC) in the water column and subsequent sediment re-deposition:

- Seabed preparation;
- Foundation installation;
- Drilling operations; and

[7] Defined as the ICES rectangles 37F1, 37F2, 38F1 and 38F2 and the Offshore Export Cable Corridor would be located within ICES Rectangles 36F0, 36E9, 37E9, 37F0, 37F1, 38F0 and 38F1 as presented in **Volume 7, Figure 10-1 (application ref: 7.10.1)**

- Cable installation.

203. Activities such as seabed disturbances from jack-up vessels and placement of cable protection are not expected to increase the SSCs to the extent to which it would cause an impact to benthic or fish receptors.

8.3.5.2.9.2.1 Assessment of Potential Effects of the Projects Alone

204. Increases in suspended sediment are expected to cause localised and short-term increases in SSC at the point of discharge. Released sediment may then be transported by tidal currents in suspension in the water column. Due to the small quantities of fine-sediment released, the fine-sediment is likely to be widely and rapidly dispersed. This would result in only low SSCs and low changes in seabed level when the sediments are deposited.

205. Given the changes discussed above, the significance of effect for fish species is assessed as minor adverse (not significant in EIA terms) in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** for all species and eggs and / or larvae at DBS East and DBS West in isolation. For sandeels, the potential area of habitat affected within the SAC is a small fraction of the available habitat, see **Volume 6, Report to Inform Appropriate Assessment Habitats Regulations Assessment Part 2 of 4 (application ref 6.1)**.

206. Given the low SSC and seabed level changes and area of habitat affected effects on potential prey species, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from increased SSC and sediment re-deposition) during construction for the Projects in isolation.

8.3.5.2.9.2.2 Assessment of Potential Effects of the Projects Together

207. Due to the low SSC changes, the significance of effect for fish species is assessed as minor adverse (not significant in EIA terms) for the Projects together (see **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

208. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from increased SSC and sediment re-deposition) during construction for the Projects together.

8.3.5.2.9.3 Remobilisation of Contaminated Sediments

209. Re-mobilisation of sediments has the potential to release toxic substances (e.g. mercury and arsenic) into the water column, that may adversely impact fish and shellfish species.

210. **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** indicates that the likely nature of the seabed sediments within the Offshore Development Area significantly reduces the potential for contaminants to accumulate and this is reflected in the data collected for which indicates that for all parameters, sediment contaminant concentrations are low.

8.3.5.2.9.3.1 Assessment of Potential Effects of the Projects Alone

211. Fish are not considered sensitive to most natural contaminants present within seabed sediments, provided the concentration of contaminants remain within environmental protection standards. There is evidence to suggest that contaminant uptake through gills is poor, and that lower trophic levels are more susceptible to increased contaminant concentrations (De Gieter *et al.* 2002).

212. Given the localised, short-term disturbance of sediments, and the low likelihood of contamination within the Offshore Development Area, the significance of effect for fish species is assessed as minor adverse (not significant in EIA terms) in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**.

213. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from remobilisation of contaminated sediments) during construction for the Projects in isolation.

8.3.5.2.9.3.2 Assessment of Potential Effects of the Projects Together

214. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** for DBS East and West together predicts that both the level of suspended sediment release (expected to be localised, short-term, and episodic) and the levels of potential contaminants will be low.

215. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from remobilisation of contaminated sediments) during construction for the Projects together.

8.3.5.2.9.4 Underwater Noise and Vibration

216. Potential sources of underwater noise and vibration during construction include piling, increased vessel traffic, seabed preparation, rock placement and cable installation. Of these piling is considered to produce the highest levels of underwater noise and therefore has the greatest potential to result in adverse impacts on fish.

217. High levels of underwater noise can cause physiological (mortality, permanent injury or temporary injury), behavioural (startled movements, swimming away from noise source, change migratory patterns or cease reproductive activities) and environmental (changes to prey species or feeding behaviours) impacts on fish species.

8.3.5.2.9.4.1 Assessment of Potential Effects of the Projects Alone

218. For fish with a swim bladder involved in hearing, TTS onset is likely to occur at an exposure to 186dB SEL_{cum}, across an area of 4,100km² for each pile installed. Injury is not determined as likely to occur until exposure to 203dB SEL_{cum}, and mortality until 207dB SEL_{cum}. Recoverable injury is therefore possible to occur across an area of up to 560km² (2.09% of the Fish and Shellfish Ecology Study Area). Mortality is likely to be limited to an area of 97km² (see in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**). Note that sandeel do not have a swim bladder and are not considered sensitive to underwater noise.

219. When considering noise associated with construction and vessel activities, the significance of effect on fish and shellfish is considered negligible within the context of the Fish and Shellfish Ecology Study Area (see **Volume 7, Figure 10-1 (application ref: 7.10.1)**). Each of the activities presenting recoverable injury thresholds of <50m from the noise source following a minimum of 48 hours of exposure. Considering the motility of most fish and shellfish species, and that vessel movement and construction activity will move around the site over the period, it is not considered likely that this will result in notable impacts to any receptor groups.

220. In **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**; the low magnitude of impact of underwater noise at DBS East or DBS West along with the medium sensitivity for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a minor adverse effect in EIA terms. The impacts associated with noise and vibration are negligible in EIA terms for all other fish and shellfish receptor groups.

221. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from underwater noise and vibration) during construction for the Projects in isolation.

8.3.5.2.9.4.2 Assessment of Potential Effects of the Projects Together

222. The cumulative area of exposure to 186dB SEL_{cum} increases to a total of 15,000km² for the Projects together. However, injury is not determined as likely to occur until exposure to 203dB SEL_{cum}, and mortality until 207dB SEL_{cum}. Impacts that will result in recoverable injury are predicted to occur across an area of up to 730km² (2.72% of the fish and shellfish ecology Study Area). Mortality is likely to be limited to an area of 270km² (see **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

223. The low magnitude of impact in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** for underwater noise and vibration at DBS East and DBS West together with the medium sensitivity for fish and shellfish with a swim bladder used in hearing results in the assessment that impacts associated with noise and vibration have a minor adverse effect. All other fish and shellfish receptor groups present low magnitude of impact, resulting in the assessment that effects associated with noise and vibration are negligible.

224. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from underwater noise and vibration) during construction for the Projects together.

8.3.5.2.9.5 Changes in Fishing Activity

225. Fishing activity within the Array Areas may be reduced due to the presence of safety zones during construction. This may also alter the level of fishing in other areas through displacement of fishing activities. However, it is not expected that this change in fishing levels would affect the overall population level of fish species in the wider area. It would also be a short-term and temporary affect during construction. The magnitude is therefore assessed as low in EIA terms within **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**.

226. The low magnitude of impact for DBS East and DBS West in isolation with the low sensitivity of effect for all fish and shellfish receptor groups, results in the assessment that reduced fishing pressure within the Array Areas and increased fishing pressure outside of the Array Area has a minor adverse effect (not significant in EIA terms).

227. Therefore, there will be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential changes in prey availability (from changes in fishing activity) during construction for the Projects in isolation or together.

8.3.5.3 Potential Effects During Operation and Maintenance

8.3.5.3.1 Impact 1a: Auditory Injury due to Operational Wind Turbine Noise

228. The operational wind turbines would operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The Projects operation and maintenance period is 32 years maximum, i.e. 30 years per Project with a maximum two year lag if Projects are installed sequentially. The underwater noise levels emitted during the operation of the turbines are low and not expected to cause physiological injury to marine mammals but could cause behavioural reactions if the animals are in the immediate vicinity of the wind turbines (Sigray and Andersson, 2011; Tougaard et al. 2009b).

229. The main source of underwater noise from operational wind turbines will be mechanically generated vibration from the rotating machinery in the wind turbines, which is transmitted into the sea through the structure of the wind turbine tower and foundations (Nedwell *et al.* 2003; Tougaard *et al.* 2020). Noise levels generated above the water surface are low enough that no significant airborne sound will pass from the air to the water (Godin, 2008).

230. Measurements made at three different OWFs in Denmark and Sweden at ranges between 14m and 40m from the foundations found that the sound generated due to operational wind turbines was only detectable over underwater ambient noise at frequencies below 500Hz (Tougaard *et al. 2009b).*

231. (Tougaard *et al.* 2020) reviewed the available measurements of underwater noise from different wind turbines during operation and found that source levels were at least 10–20dB lower than ship noise in the same frequency range. A simple multi-turbine model indicated that cumulative noise levels could be elevated up to a few kilometres from a wind farm under very low ambient noise conditions. However, the noise levels were well below ambient levels unless very close to the individual wind turbines in locations with high ambient noise from shipping or high wind speeds.

232. The underwater noise from operational wind turbines is described as continuous and non-impulsive and is characterized by one or more tonal components that are typically at frequencies below 1kHz (Madsen *et al.* 2006). There is the potential for proposed larger wind turbines to have greater noise levels compared to smaller wind turbines currently in operation (Stöber and Thomsen, 2021). This increase in size of operational wind turbines at the Projects have been taken into account in the underwater noise modelling (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

8.3.5.3.1.1 Assessment of Potential Effects of the Projects Alone

233. The number of harbour porpoise that could be impacted as a result of underwater noise from operational wind turbines has been assessed based on the number of animals that could be present in the modelled impact area (**Table 8-36**).

234. Using the non- impulsive weighted SEL_{cum} PTS and TTS thresholds from Southall *et al.* (2019) resulted in estimated PTS and TTS impact ranges of <100m for harbour porpoise for as a result of underwater noise from operational wind turbines. These values mean that animals would have to stay within these very small ranges for 24 hours before they experienced injury, which is an extremely unlikely scenario as it is far more likely that any harbour porpoise within the injury zone would move away from the vicinity of the operational wind turbines.

Table 8-36 Predicted Impact Ranges (And Areas) for PTS or TTS from 24 hour Cumulative Exposure of Underwater Noise from Operational Turbines

Species	Impact	Operational wind turbine	Area of impact for up to 100 Wind turbines
Harbour porpoise	PTS or TTS	<0.1km ($0.031km^2$)	$3.1km^2$

235. There is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that harbour porpoise would have to remain less than 100m from a turbine for 24 hours in a day (**Table 8-36**). However, as a precautionary approach the number of harbour porpoise that could be at risk of auditory injury has been estimated (**Table 8-37**). As outlined previously this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been rounded up to 100m.

236. More than one wind turbine will be operating at the same time, and therefore an assessment of the potential for auditory injury, due to all operational wind turbines, is required. As the potential auditory effect ranges are the same for the range of wind turbines included in the DBS East or DBS West Design Envelope, the worst case would be for a total of 100 operational wind turbines.

237. The potential impact for any auditory injury as a result of underwater noise from 100 operational wind turbines at DBS East or DBS West, is not significant for harbour porpoise with less than 0.01% of the reference populations exposed to any long-term impact (**Table 8-37**).

238. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury from increased underwater noise from operational wind turbines at the Projects in isolation.

Table 8-37 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory injury as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East and DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Potential adverse effect on site integrity
Harbour porpoise	DBS East	1.9 (0.0005% of NS MU)	**No** Less than 1% of the population at risk of auditory injury.
	DBS West	2.0 (0.0005% of NS MU)	

8.3.5.3.1.2 Assessment of Potential Effects of the Projects Together

239. The number of harbour porpoise that could be impacted as a result of underwater noise from operational wind turbines at DBS East and DBS West together has been assessed based on the number of animals that could be present in the modelled impact area when applied across the worst case number of operational wind turbines (**Table 8-4**).

240. The predicted impact ranges for TTS from 24 hour cumulative exposure of underwater noise from operational turbines is <0.1km and the potential impact area for the 200 operational wind turbines at DBS East and DBS West together is up to 6.28km^{2}.

241. An assessment of the maximum number of individuals that could be at risk of auditory injury, due to the underwater noise associated with all operational wind turbines is presented in **Table 8-38**.

242. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury from increased underwater noise from operational wind turbines at the Projects together.

Table 8-38 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory injury as a Result of Underwater Noise Associated with Operational Turbines at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for 200 wind turbines (*highest density in the Projects*)	Potential adverse effect on site integrity
Harbour porpoise	4.1 (0.001 % of NS MU)	**No** Less than 1% of the population at risk of auditory injury.

8.3.5.3.2 Impact 1b: Disturbance due to Operational Wind Turbine Noise

243. The underwater noise levels emitted during the operation of the turbines are low and not expected to cause physiological injury to marine mammals but could cause behavioural reactions and disturbance if the animals are in the immediate vicinity of the wind turbine (Sigray and Andersson, 2011; Tougaard *et al.* 2009b).

244. Modelling of noise effects of operational offshore wind turbines suggest that marine mammals are not considered to be at risk of displacement by operational wind farms (Marmo *et al.* 2013). Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

245. Based on the review of currently available data on marine mammals and operational wind farms, it was concluded that there is no long term disturbance or displacement of harbour porpoise around operational wind farms (Diederichs *et al.* 2008; Lindeboom *et al.* 2011; Marine Scotland 2012; McConnell *et al.* 2012; Russell *et al.* 2014; Scheidat *et al.* 2011; Teilmann *et al.* 2006; Tougaard *et al.* 2005, 2009a, 2009b). Touggard *et al.* 2009b have recorded behaviour responses from harbour porpoise at distances up to a few hundred meters away (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

246. Harbour porpoise have been observed to forage within operational wind farm sites (Lindeboom *et al.* 2011), indicating no restriction to movements in operational OWF sites.

247. Consequently it is not considered that the noise levels associated with operational wind turbines represents a significant effect.

248. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from operational wind turbine noise at the Projects in isolation or together.

8.3.5.3.3 Impact 2a: Auditory Injury from Underwater Noise Associated with Operation and Maintenance Activities

249. The requirements for any potential operation and maintenance work, such as additional rock placement or cable re-burial, are currently unknown. However, the work required, and associated effects to marine mammals would be less than those during construction. **Table 8-4** provides estimates (as outlined in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**) for potential cable repairs and reburial during the operational period.

250. The effects from additional cable laying and protection are temporary in nature and will be limited to relatively short periods during the operation and maintenance phase. Disturbance responses are likely to occur at significantly shorter ranges than construction noise. Any disturbance is likely to be limited to the area in and around where the actual activity is taking place. The requirements for any potential maintenance work are currently unknown. However, the work required, and the impacts associated with underwater noise and disturbance from activities during operation and maintenance would be less than those during construction.

251. As there is expected to be less noisy activities during the operation phase than is required during construction (see section 8.3.5.2.3), it is likely to cause less disturbance.

252. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury from underwater noise associated with operation and maintenance activities at the Projects in isolation or together.

8.3.5.3.4 Impact 2b: Disturbance from Underwater Noise Associated with Operation & Maintenance Activities

8.3.5.3.4.1 Assessment of Potential Effects of the Projects Alone

253. As a precautionary approach, 4km has also been used as a potential disturbance range for maintenance activities and vessels, based on construction activities (see section 8.3.5.2.4).

254. The potential disturbance from maintenance activities occurring at the same time has also been assessed based on maximum impact area of 50.27km^2 for each activity with up to 31 individuals (0.009% of the NS MU) potential being disturbed.

255. For four activities happening at the same time, the maximum impact area was 201.08km^2 with up to 133 individuals (0.0385 of the NS MU) (see section 8.3.5.2.4) potentially being disturbed.

256. The potential for disturbance that could result from underwater noise during maintenance activities, including cable laying and protection would be localised and temporary to where and when the work is being undertaken.

257. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from underwater noise associated with operation and maintenance activities at the Projects in isolation.

8.3.5.3.4.2 Assessment of Potential Effects of the Projects Together

258. If the Projects were operating at the same time, there could potentially be a maximum of eight maintenance activities and vessels occurring at once, resulting in a maximum impact range of 402.12km^2; with up to 266 individuals (0.0775 of the NS MU) potentially being disturbed (see 8.3.5.2.3.2).

259. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from underwater noise associated with operation and maintenance activities at the Projects together.

8.3.5.3.5 Impact 3a: Auditory Injury from Underwater Noise due to the Presence of Vessels

260. During the operation and maintenance phase there will be an increase in the number of vessels in the Array Area s. The maximum number of vessels that could be on the Array Area s at any one time has been estimated at up to a total of 20 vessels per Project (**Table 8-4**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

8.3.5.3.5.1 Assessment of Potential Effects of the Projects Alone

261. The results of the underwater noise modelling (in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24-hours, to be exposed to noise levels that could induce auditory injury, based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

262. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours for any potential risk of PTS (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). Therefore, PTS as a result of construction vessels is highly unlikely and has not been assessed further.

263. There is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours in a day. Although auditory injury as a result of vessels is highly unlikely, it has been assessed as precautionary approach.

264. During operation, there may be up to 20 vessels in DBS East Array Area or DBS West Array Area at any one time, compared to the 26 vessels that would be within the Array Area s during construction. Therefore, the potential effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than of those during construction (see section 8.3.5.2.3). As a precautionary approach the potential impact area of 0.6km^2 for up to 20 vessels in the Offshore Development Area at the same time has been determined.

265. There would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury from underwater noise associated with operation and maintenance vessels at the Projects in isolation (**Table 8-39**).

Table 8-39 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation

Species	**Location**	**Maximum number of individuals (% of reference population) for up to 20 vessels**	**Potential adverse effect on site integrity**
Harbour porpoise	DBS East, DBS West, OECC and Offshore Development Area	0.4 (0.0001% of NS MU)	**No** Less than 1% of the population at risk of auditory injury

8.3.5.3.5.2 Assessment of Potential Effects of the Projects Together

266. During operation, there may be up to 21 vessels in the Offshore Development Area simultaneously at any one time, compared to the 59 vessels that would be on site during construction. Therefore, the potential effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than of those during construction (see section 8.3.5.2.5).

267. The potential impact range for any auditory injury as a result of up to 21 vessels has been assessed as 0.63km^2 in the Array Area using the worst case density across the Offshore Development Area is not significant for harbour porpoise, with less than 1% of the reference populations exposed to any temporary impact (**Table 8-40**).

268. There would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to auditory injury from underwater noise associated with operation and maintenance vessels at the Projects together.

Table 8-40 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East and DBS West Together

Marine mammal species	Maximum number of individuals (% of reference population) for up to 21 vessels	Potential adverse effect on site integrity
Harbour porpoise	0.4 (0.0001% of the NS MU)	**No** Less than 1% of the population at risk of auditory injury.

8.3.5.3.6 Impact 3b: Disturbance from Underwater Noise due to the Presence of Vessels

8.3.5.3.6.1 Assessment of Potential Effects of the Projects Alone

269. If the behavioural response is displacement from the area, it is predicted that harbour porpoise will return once the activity has been completed and any impacts from underwater noise as a result of construction vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant effect on harbour porpoise.

270. No additional mitigation is required or proposed for underwater noise from construction vessels.

271. As a worst case the maximum number of harbour porpoise from the Projects has been assessed to indicate the maximum number that could be impacted from DBS East and DBS West, if they are developed in isolation or together is the same as that shown in **Table 8-39** and **Table 8-40**.

272. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects in isolation or together.

8.3.5.3.6.2 Assessment of Potential Effects of the Projects Together

273. See section 8.3.5.3.6.1.

274. There would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects in isolation or together.

8.3.5.3.7 Impact 4: Barrier Effects as A Result of Underwater Noise During Operation and Maintenance

8.3.5.3.7.1 Assessment of Potential Effects of the Projects Alone

275. No barrier effects as a result of underwater noise during operation and maintenance are anticipated at DBS East and DBS West in isolation or together.

276. TTS / fleeing response as a result of underwater noise from operational turbines has been assessed as having a range of less than 100m (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

277. As outlined in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, the indicative separation distance between turbines would be a minimum of 0.83km therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine and there would be adequate room for marine mammals to move through the wind farm arrays at DBS East and / or DBS West.

278. As described in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, monitoring was conducted at the Horns Rev and Nysted OWFs in Denmark in 1999 and 2006 during operation (Diederichs *et al.* 2008). The data showed that numbers of harbour porpoise within Horns Rev were slightly reduced compared to the wider area during the first two years of operation and found no effect on numbers after two years of operation. Though, it was not possible to conclude that the OWF was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard *et al.* 2009a).

279. Lindeboom *et al.* 2011 documented that harbour porpoise have been observed to foraging within operational wind farm sites indicating that the underwater noise does not cause a barrier, especially when feeding and provides evidence to show that there are no restrictions to movements of harbour porpoise in operational OWF sites.

280. Therefore, there would be no significant effects and no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential barrier effects from underwater noise during operation and maintenance for the Projects in isolation.

8.3.5.3.7.2 Assessment of Potential Effects of the Projects Together

281. See section 8.3.5.3.7.1.

282. There would be no significant effects and no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to potential barrier effects from underwater noise during operation and maintenance for the Projects together.

8.3.5.3.8 Impact 5: Increased Collision Risk with Vessels During Operation and Maintenance

283. It is estimated that the maximum number of vessels that could be required on site at any one-time during operation and maintenance could be up to 20 at the DBS Offshore Development Area. which is considerably less than the 35 vessels that could be on site during construction. However, as a precautionary approach the assessment for construction has been used for the operational and maintenance assessment, as a worst case scenario. **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

284. At either DBS East or DBS West, there may be up to 239 vessel round trips, or up to 474 transits, which is significantly less than the round trips required for construction. The assessment of collision risk, as presented for the construction and operational phase (section 8.3.5.2.8.1 and 8.3.5.2.8.2; **Table 8-35**), is based on the total Offshore Development Area, within which additional vessels may be present, and is not based on the number of vessels present within that area. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

285. In line with the construction assessment, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to increased collision risk from operation and maintenance vessels for the Projects in isolation and together.

8.3.5.3.9 Impact 6: Changes to Prey Resources

286. Any effect on prey species has the potential to affect harbour porpoise. As outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, the potential impacts on fish species during operation and maintenance can result from:

- Permanent Habitat Loss;
- Temporary Habitat Loss, Physical Disturbance of The Seabed, Increased Suspended Sediment and Sediment Deposition;
- Underwater Noise;
- EMF; and
- Changes in Fishing Activity.

287. Any impacts on prey species have the potential to affect marine mammals. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** found no difference in the significance of effect on receptors when assessed for DBS East and / or DBS West in isolation or together.

8.3.5.3.9.1 Long Term Habitat Loss

288. Habitat loss will occur during the lifetime of DBS East and DBS West as a result of structures, scour and external cable protection installed on the seabed. The introduction of hard substrate, such as wind turbine towers, foundations and associated scour and cable protection would increase habitat heterogeneity through the introduction of hard substrates in an area predominantly characterised by soft sediment habitats.

289. Long term habitat loss has not been assessed as a direct effect on harbour porpoise, as any impacts of habitat loss would only cause an indirect effect in terms of changes to prey availability.

290. As outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** total long term habitat loss would be up to 2.09km^2 for DBS East and the OECC, and up to 1.91km^2 at DBS West and the OECC. This is considered minimal in the context of the amount of similar available habitat in the wider area. Overall, due to the presence of comparable habitats identified throughout the DBS East and DBS West offshore sites and the wider region, and the localised spatial extent of impacts, the significance of effect is assessed as minor adverse for prey species in EIA terms. For sandeels, the significance of effect is assessed as the same as other prey species, due to the long term habitat loss being very small. **Volume 6, Appendix B (application ref: 6.1.2)** presents the areas of potential sandeel habitat within the SNS SAC which could be affected by the Projects. As per the ES conclusion for all fish receptors, the area of habitat affected is minimal considered in the context of the amount of similar available habitat in the wider area.

291. Therefore, there would therefore be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from permanent habitat loss resulting from the introduction of hard substrates) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.3.9.2 Temporary Habitat Disturbance Through Maintenance of Wind Turbine Foundations, Scour Protection and Cables

292. The introduction of various man-made structures such as foundations and scour protection in soft sediment areas increases and changes habitat availability and type, potentially resulting in locally altered biodiversity as species are able to establish and thrive in previously hostile environments (Birchenough and Degraer, 2020). The colonisation of such species may cause indirect effects on fish and shellfish populations if the structures act as artificial reefs, as well as direct impacts due to the potential of foundations acting as Fish Aggregation Devices (FAD).

293. The introduction of new hard substrate in areas that are predominantly sandy or soft sediments may cause positive effects through potential habitat enhancement (Roach and Cohen, 2020).

294. The realistic worst case scenario for the area of seabed potentially impacted by temporary habitat disturbance and direct damage associated with the operational phase is less than that assessed for the construction phase. It is expected that there would be a medium-term recovery (1 – 7 years) from any loss of habitat, disturbance to spawning and nursery areas (or the loss of individuals) as a result of activities occurring during the operational phase. The effect would result in a change that is noticeable but remains within the natural variation of background conditions for the given effect. Therefore, the significance of effect is assessed as negligible to minor adverse for prey species in EIA terms (**Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

295. Therefore, there would therefore be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from temporary habitat disturbance through maintenance of wind turbine foundations, scour protection and cables) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.3.9.3 Increased SSCs and Sediment Deposition

296. Increases in SSC within the water column and subsequent deposition onto the seabed may occur as a result of operation and maintenance activities. Disturbance caused by jack up vessel legs or anchors, as well as cable reburial and / or repair may result in small volumes of sediment being re-suspended. These increases could affect prey species. However, the volumes of sediment disturbed from such activities, as well as the overall duration of the disturbance, would be significantly less compared to construction. For construction, the assessment concluded that there will be no adverse effect on the integrity of the SNS SAC from the Projects in isolation or together from this impact (see section 8.3.5.2.9.2).

297. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from increased SSCs and sediment deposition) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.3.9.4 Re-Mobilisation of Contaminated Sediments

298. Contaminants in the area have not been reported at significantly elevated levels that would be a cause for concern. The works are not predicted to result in any change that is noticeable from the natural variation in background conditions. Any effects from the remobilisation of contaminated sediments and sediment redeposition are likely to be less than during the construction. For construction, the assessment concluded that there will be no adverse effect on the integrity of the SNS SAC from the Projects in isolation or together from this impact (see section 8.3.5.2.9.3).

299. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from re-mobilisation of contaminated sediments) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.3.9.5 Underwater Noise During Operation and Maintenance

300. Sources of underwater noise during operation and maintenance include operational wind turbines, maintenance activities, such as cable repairs, replacement and protection, and vessels.

301. Underwater noise modelling has been conducted to predict the potential impacts of these noise sources and activities on different types of fish groups (based on Popper *et al.* 2014) (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

302. The underwater noise modelling results indicate that the maximum predicted impact ranges for operational turbines, cable laying, trenching, rock placement and vessels is less than 0.05km for all fish species.

303. Given the limited footprint of underwater noise, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from underwater noise) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.3.9.6 Electromagnetic Fields (EMF)

304. The Projects will transmit energy produced along the network of inter-array and platform link cables, linking the individual wind turbines and the turbines to the offshore substation. As energy is transmitted, the cables emit low-energy EMF. The electrical and magnetic fields generated increase proportionally to the amount of electricity transmitted.

305. Cables have a minimum burial depth of 0.5m, substantially reducing the levels of EMF in the surrounding area. Where cable burial is not possible due to hard substrate, protection will be added to reduce the levels of EMF.

306. There will be no direct effects of EMF on harbour porpoises, but EMF has the potential to interfere with the navigation of sensitive migratory and pelagic species by affecting the speed and / or course of their movements (see **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** for further information).

307. Given the small area around the inter-array cables where the presence of EMF may be detected by fish and shellfish. Contact with EMF will be limited and in the context of the wider available habitat the significance of effect is negligible to minor adverse in EIA terms.

308. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from EMF) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.3.9.7 Changes in Fishing Activity

309. As outlined in **Volume 7, Chapter 13 Commercial Fisheries (application ref: 7.13)**, there is potential for commercial fishing activity to be displaced from within the wind farm site, due to presence of the subsurface structures. However, the Array Areas is located in an area with relatively low fishing intensity.

310. Therefore, any changes to prey resources as a result of changes to fishing activity during operational phase of the Project would be negligible to harbour porpoises in EIA terms.

311. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to changes in prey availability (from changes in fishing activity) during the operation and maintenance phase of the Projects in isolation or together.

8.3.5.4 Potential Effects During Decommissioning

312. Potential effects on harbour porpoise associated with decommissioning have not been assessed in detail, as further assessments will be carried out ahead of any decommissioning works to be undertaken, taking account of known information at that time, including relevant guidelines and requirements. A detailed decommissioning programme will be provided to the regulator prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

313. Decommissioning would most likely involve the removal of the accessible installed components comprising:

- All of the wind turbine components; part of the foundations (those above seabed level); and
- The sections of the infield cables close to the offshore structures, as well as sections of the export cables.

314. The process for removal of foundations is generally the reverse of the installation process. There would be no piling, and foundations may be cut to an appropriate level.

315. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise which would not occur).

316. The potential effects on harbour porpoise during decommissioning would be the same or less than those assessed for construction. Therefore, there would be **no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise in relation to the decommissioning phase of the Projects in isolation or together**.

8.3.5.5 Potential In-combination Effects

317. The in-combination assessment considers other schemes and activities where the predicted effects have the potential to combine with the potential effects during construction of the Projects. The construction phase has been assessed as the worst case for potential in-combination effects.

318. The schemes screened into the in-combination assessment for harbour porpoise are those that are located in the relevant MUs. Full information on the screening of effects considered for the in-combination assessment is provided in **Volume 7, Appendix 11-5 CEA Screening (application ref: 7.11.11.5)**. The in-combination screening for harbour porpoise considers the same schemes as considered in the cumulative screening, as the SNS SAC is in the NS MU, therefore all schemes occurring in the NS MU have been considered in the assessment.

319. The marine mammal in-combination assessment will consider schemes, which have sufficient information available to undertake the assessment, and will include the potential effects of:

- Underwater noise;
- Barrier Effects
- Vessel interaction; and

- Changes to prey resources (including habitat loss).

320. The in-combination screening identified that there is the potential for cumulative effects on harbour porpoise as a result of disturbance from underwater noise during piling and other construction activities, Due to the low noise levels associated with operational OWFs, as the BEIS[8] (2020) RoC HRA for the SNS SAC stated that there would no potential for significant effect from the operation of OWFs, alongside the construction of OWFs (BEIS, 2020), therefore all operational impacts have been screened out.

321. Further information is provided in **Volume 7, Appendix 11-5 CEA Screening (application ref: 7.11.11.5)**.

8.3.5.5.1 Impact 1 Disturbance from Underwater Noise

322. The potential sources of in-combination underwater noise which could disturb harbour porpoise, and which are screened into the assessment are:

- Piling at other OWFs;
- Other construction activities at OWFs (such as vessels, cable installation works, dredging, seabed preparation and rock placement);
- Other construction activities at other marine renewable schemes (e.g. wave and tidal) (such as vessels, cable installation works, dredging, seabed preparation and rock placement);
- Aggregate extraction and dredging;
- Oil and gas installation / decommissioning schemes;
- Seismic surveys;
- Subsea cables and pipelines;
- Other marine industries, such as gas storage, offshore mines, and carbon capture;
- High resolution geophysical surveys (such as for OWFs); and
- UXO clearance.

323. The approach to the assessment for in-combination disturbance from underwater noise has been based on the approach for the assessment of disturbance for those same activities as presented in section 8.3.5.2.2.

[8] BEIS is now known as the Department for Energy Security and Net Zero as of the 8th February 2023

324. The commitment to the mitigation measures agreed through the final MMMP (in accordance with **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)**) for piling would reduce the risk of physical injury or permanent auditory injury (PTS) in harbour porpoise. In light of this, and taking account of the type, scale and extent of potential effects arising from the Projects assessment, it concluded no adverse effect on integrity for harbour porpoise due to physical injury or PTS from construction (see section 8.3.5.2.1).

325. It is intended that this approach to assessing the potential effects of disturbance from underwater noise will reduce some of the uncertainties and complications in using the different assessments from HRAs, based on different noise models, thresholds and criteria, as well as different approaches to density estimates.

8.3.5.5.1.1 In-combination Impact 1a: Assessment of Underwater Noise from Piling at Other OWFs

326. One of the greatest potential noise sources during OWF construction is from pile driving. The in-combination assessment considers the potential disturbance of marine mammals during piling for DBS East and DBS West, with the piling at other OWF schemes screened into the in-combination assessment (see section 11.7, **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**), where there is the potential for concurrent piling within the SNS SAC summer area.

327. The CEA screening (see **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**) identified five UK OWFs with the potential for construction to take place at the same time as the construction of DBS East and / or DBS West within the SNS SAC summer area, taking into account the relevant spatial areas for each species. The worst case scenario would be if the following OWFs were constructed concurrently with sequential piling in 2027 to 2031:

- Dudgeon Extension;
- East Anglia Hub;
- Hornsea Project Three;
- Hornsea Project Four; and
- Outer Dowsing;

328. The potential piling period for DBS East and DBS West has been based on the widest likely range of offshore construction and piling dates, dependent on the construction scenario, as a precautionary approach. It should be noted that while the schemes included within the in-combination have the potential for piling to overlap with DBS East and DBS West, there is a great deal of uncertainty on when OWFs could be piling. This assessment is therefore considered the worst-case.

329. Where possible, the CEA screening (see **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**) included consideration of the realistic potential for cumulative impacts during construction at DBS East and DBS West. For example, it is assumed that where OWF developers have more than one OWF, they are unlikely to develop more than one site at a time.

330. The commitment to the mitigation agreed through the final MMMP for piling would reduce the risk of physical injury or permanent auditory injury (PTS) for all marine mammals.

331. The assessment for harbour porpoise is based on the approach to disturbance as per the current advice from the SNCBs (JNCC *et al.* 2020) on the assessment of effect on the harbour porpoise designated SACs.

332. The potential impact area during single pile installation, based on the 26km EDR for harbour porpoise, with a potential disturbance area of 2,123.7km^2.

333. It should be noted that the potential areas of disturbance assume that there is no overlap in the areas of disturbance between different schemes and are therefore highly conservative.

334. The approach to the in-combination (see section 11.7, **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**) for piling at OWFs is based on the potential for single piling at each OWF at the same time as single piling at DBS East and / or DBS West. This approach allows for some of the OWFs not to be piling at the same time, while others could be simultaneously piling. This is considered to be the most realistic worst case scenario, as it is highly unlikely that all other OWFs would be simultaneously piling at exactly the same time as piling at DBS East and / or DBS West.

335. It is important to note the actual duration for active piling time which could disturb marine mammals is only a very small proportion of the potential construction period, of up to approximately 54 days for DBS East or West in isolation and approximately 108 days for DBS East and DBS West if constructed concurrently, based on the estimated maximum duration to install individual piles.

336. For harbour porpoise, the potential worst case scenario of other OWFs piling at the same time as DBS East and / or DBS West is assessed in

337. **Table** 8-42. Less than 5% of the reference population could potentially be disturbed, however, this is very precautionary, as it is unlikely that all other OWF schemes could be piling at exactly the same time as piling at DBS East and / or DBS West.

338. In practice, the potential temporary effects would be less than those predicted in this assessment as there is likely to be a great deal of variation in timing, duration, and hammer energies used throughout the various OWF project construction periods. In addition, not all individuals would be displaced over the entire potential disturbance range (26km) used within the assessments. For example, the study of harbour porpoise at Horns Rev (Brandt *et al.* 2011), indicated that at closer distances (2.5 to 4.8km) there was 100% avoidance, however, this proportion decreased significantly moving away from the pile driving activity and at distances of 10km to 18km avoidance was 32% to 49% and at 21km the abundance was reduced by just 2%.

339. The tables in this section are colour coded for project scenario to make the results more presentable (**Table 8-41**).

Table 8-41 Protect scenario colour code

With DBS East	Green
With DBS West	Blue
With Offshore Export Cable Corridor (Seal SACs only)	Grey
The Projects (DBS East and DBS West) together	Dark blue
Without the Projects	Orange

Table 8-42 Quantitative assessment for the potential disturbance of harbour porpoise from single piling (26km) at other OWFs at the same time as piling at the Projects

Project	Harbour porpoise density (/km^2)	Maximum number of individuals potentially disturbed
Single piling at other OWFs that could be piling at the same time as the Projects		
DBS East	0.6	1,279.9
DBS West or OECC	0.66	1,401.6
Dudgeon Extension Project	0.888	1,885.8
East Anglian One North	0.607	1,289.1
Hornsea Project Three	0.76	1,614.0
Hornsea Project Four	1.019	2,164.1
Outer Dowsing	2.375	5,043.8
Total number of harbour porpoise with DBS East		**13,271.0 (3.83% of the NS MU)**
Total number of harbour porpoise with DBS West / OECC		**13,398.4 (3.87% of the NS MU)**
Total number of harbour porpoise with the Projects together		**14,678.3 (4.64% of the NS MU)**
Total number of harbour porpoise without the Projects		**11,996.8 (3.46% of the NS MU)**

8.3.5.5.1.1.1 Spatial assessment

340. The estimated maximum, minimum and average spatial overlap with the SNS SAC summer area is outlined in **Table 8-43**.

Table 8-43 Estimated maximum, minimum and average overlaps with the SNS SAC summer area from single piling (26km) at other OWFs on the same day as piling at the Projects.

In-combination assessment scenario	Maximum overlap with summer area (km²)	Minimum overlap with summer area (km²)	Average overlap with summer area (km²)	Maximum overlap with the summer area (%)
DBS East	2,123.7	1,976.48	2,050.0	7.86
DBS West	2,123.7	1,976.48	2,050.0	7.86
DBS OECC*	2,087.8	1,061.85	1,574.8	7.72
Dudgeon Extension Project	355.7	0	177.85	1.32
East Anglian One North	1,167.9	305.43	736.66	4.32
Hornsea Project Three	1,809.56	0	904.78	6.70
Outer Dowsing	1,718.95	143.83	931.39	6.63
Hornsea Project Four	2,123.7	1,551.8	1,837.75	7.86
Total for summer area with DBS East	**9,299.5**	**3,977.5**	**6,635.5**	**34.42**
Total for summer area with DBS West	**9,299.5**	**3,977.5**	**6,635.5**	**34.42**
Total for summer area with the Projects together	**11,423.2**	**5,954.0**	**8,688.6**	**42.27**
Total for summer area without the Projects	**7,175.8**	**2,001.0**	**4,588.4**	**26.56**

** The OECC would not pile on the same day as DBS East or DBS West*

341. The assessment indicates that more than 20% of the summer area could be affected, based on the maximum, minimum and average potential overlaps for all OWFs, for both monopile scenarios at DBS East and / or DBS West.

342. It is also important to note that the in-combination assessments are based on the worst case for all possible OWFs. As schemes develop and programmes are established there will be changes to the potential piling periods for each OWF scheme. There will also be limitations on the fabrication of wind turbines and the vessels available to install the wind turbine foundations. Therefore, it is unlikely that all OWFs would or could be all piling at the same time.

343. However, as discussed in section 8.3, mitigation measures for DBS East and / or DBS West are presented in **Volume 8, In Principle Site Integrity Plan for the Southern North Sea Special Area of Conservation (application ref: 8.26)** and will be reviewed in the final SIP prior to construction.

344. In line with the conclusions of the Habitats Regulations Assessment (The Crown Estate, 2022) it is expected that all other OWFs will also have to produce a SIP to ensure that the spatial threshold is not exceeded and there is no significant disturbance and no adverse effect on the integrity of the SNS SAC. This could include the use of noise abatement and reduction measures (which would reduce the EDR to 15km), and / or seasonal restrictions and agreements on when OWF piling could be undertaken.

345. It is also important to note that the in-combination assessments are based on the worst case for all possible OWFs. As schemes develop and programmes are established there will be changes to the potential piling periods for each OWF scheme. There will also be limitations on the fabrication of wind turbines and the vessels available to install the wind turbine foundations. Therefore, it is unlikely that all OWFs would or could be all piling at the same time.

346. With the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, it is likely that an adverse effect on the integrity of the SNS SAC will be avoided and this assessment will be reviewed and presented post consent with the most up do date information prior to construction.

8.3.5.5.1.1.2 Seasonal average

347. Seasonal averages have been calculated by multiplying the average effect on any given day in each season by the proportion of days within the season on which piling could occur (i.e. taking into account the average of effect / area of overlap with the SNS SAC and number of days piling per season). Looking at all of the schemes, and potential piling locations, there is no overlap. Therefore, calculations for estimates seasonal average of effect is presented in **Table 8-44.**

348. This has been put into the context of the maximum number of piling days for DBS East and / or DBS West per season:

- Up to 52 days for the monopiling scenario at DBS East or DBS West in isolation; and / or
- Up to 108 days for the monopiling scenario at DBS East and DBS West together;

349. As a worst-case, no allowance has been made for downtime as a result of technical issues and no assumptions have been made for reloading of piling vessels with foundations. The assessment assumes that all piling will be undertaken on the same days as piling at DBS East and / or DBS West, therefore this is the maximum number of days on which it is possible for in-combination piling to include DBS East and / or DBS West with the maximum spatial overlap of all schemes.

Table 8-44 Estimated seasonal averages for the SNS SAC Summer Area from single piling at other OWF which could be piling at the same date as DBS East and / or DBS West

In-combination assessment scenario	Maximum Number of Days	Average overlap with the season (%)
DBS East	52	2.16
DBS West	52	2.16
DBS OECC*	1[9]	0.03
Dudgeon Extension Project	34	0.12

[9] For the worst case scenario this piling day has been counted twice to account for the fact that it may be in either the array(s) or in the ECC.

In-combination assessment scenario	Maximum Number of Days	Average overlap with the season (%)
East Anglian One North	160	2.38
Hornsea Project Three	58	1.06
Hornsea Project Four	92	3.42
Outer Dowsing	47	0.89
Total number of days with DBS East	**445**	**10.02**
Total number of day with DBS West	**445**	**10.02**
Total number of day with the Projects together	**499***	**12.18**
Total for summer area without the Projects	**391**	**7.87**

**The OECC would not pile on the same day as DBS East or DBS West*

350. The assessment indicates that based on the worst case scenarios, the 10% seasonal average threshold could be exceeded for the summer area for DBS East or DBS West in isolation. The assessment also indicates based on the worst case scenarios, the 10% seasonal average threshold could be exceeded for the summer area for DBS East, DBS West and the OECC together.

351. However, as discussed in section 8.3, mitigation measures for DBS East and / or DBS West are presented in **Volume 8, In Principle Site Integrity Plan for the Southern North Sea Special Area of Conservation (application ref: 8.26)** and will be reviewed for final assessments will be calculated and submitted in the final SIP prior to construction.

8.3.5.5.1.2 In-combination Impact 1b: Assessment of Underwater Noise from other Activities (other than Piling) at other OWFs

Disturbance from other construction activities at OWFs

352. All OWFs with construction dates that have the potential to overlap with the construction dates for DBS East and / or DBS West have the potential for other construction activities (such as seabed preparation, dredging, trenching, cable installation, rock placement and vessels) to occur at the same time as other construction activities at the Projects.

353. OWFs screened in for other construction activities that could have an in-combination effect with other construction activities at the Projects are:

- Five Estuaries;
- North Falls;
- Norfolk Vanguard; and
- Sheringham Shoal Extension

354. While the other OWFs that have been assessed under the in-combination piling assessment have the potential for overlapping construction phases, as well as those listed above, they are already assessed under a worst case of piling overlaps. As the disturbance areas for piling are significantly larger than the disturbance areas for other construction activities, an assessment of piling at those schemes would produce a much higher potential for effect than an assessment for in-combination effects with other construction activities.

355. As disturbance ranges for piling do not overlap within the SNS SAC, it is unlikely disturbance ranges for other construction activities will overlap, therefore these OWFs are not included in the assessment.

356. During the construction of DBS East and / or DBS West, there is the potential for overlap with the non-piling construction activities at other OWFs. Noise sources which could cause potential disturbance during OWF construction activities, other than pile driving, can include vessels, seabed preparation, cable installation works and rock placement.

357. The in-combination includes all schemes that could have non-piling construction activities during the DBS East and / or DBS West construction period.

358. The potential disturbance from OWFs during non-piling construction activities, such as vessel noise, seabed preparation, rock placement and cable installation, has been based on the disturbance area for construction activities taking place at DBS East and / or DBS West.

359. For harbour porpoise, based on the worst case scenario, for all OWFs that could be constructing at the same time as piling at DBS East and / or DBS West, is 1.1% of the reference population could be potentially disturbed (**Table 8-45**).

Table 8-45 Quantitative assessment for in-combination disturbance for harbour porpoise due to construction activities at other OWFs

Project	Harbour porpoise density (/km²)	Area of Effect (km²)	Maximum number of individuals potentially disturbed during single piling
DBS East	0.6	2,123.7	1,279.9
DBS West or OECC*	0.66	2,123.7	1,401.6
Five Estuaries	1.82	201.08	366.0
North Falls	1.74	201.08	349.9
Norfolk Vanguard	1.26	201.08	253.4
Sheringham Shoal Extension	0.599	201.08	120.4
Total number of harbour porpoise with DBS East			**2,369.6 (0.68% of the NS MU)**
Total number of harbour porpoise with DBS West / OECC			**2,491.3 (0.72% of the NS MU)**
Total number of harbour porpoise with the Projects together			**3,771.2 (1.1% of the NS MU)**
Total number of harbour porpoise without the Projects			**1,089.7 (0.31% of the NS MU)**

**The OECC would not pile on the same day as DBS East or DBS West*

360. It should be noted that while the schemes included within the in-combination assessment for disturbance from other OWFs constructing at the same time were done so based on the current knowledge of their possible construction or activity windows, and it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the marine mammals that could be at risk of disturbance during the five year offshore construction period of the Projects.

8.3.5.5.1.3 In-combination Impact 1c: Assessment of Disturbance from other Industries and Activities

361. During the construction period for DBS East and / or DBS West, there is the potential for disturbance to marine mammals associated with other potential noise sources, including:

- Geophysical surveys;
- Aggregate extraction and dredging;
- Oil and gas installation / decommissioning schemes;
- Seismic surveys;
- Subsea cable and pipelines;
- Other marine renewable schemes (such as wave and tidal schemes);
- Disposal sites; and
- UXO clearance.

362. For the installation of oil and gas infrastructure, marine renewable schemes, and disposal sites, all potential schemes have been screened out. Further information on the CEA screening (and these results) are provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

363. To represent the presence of harbour porpoise in the wider MU quantitative assessment in this section are based on the estimates of harbour porpoise density from the North Sea Assessment Unit of 0.55 harbour porpoise/ km^2 (CV = 0.17) (Gilles *et al.* 2023).

8.3.5.5.1.3.1 Disturbance from Geophysical Surveys

364. It is currently not possible to estimate the number of potential OWF geophysical surveys that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West. Analysis of the activities reported to the Marine Noise Registry (MNR), indicated in the year 2021 in the North Sea, there was a total of 30 sub-bottom profiler surveys carried out for a total of 257 days. The amount undertaken in 2021 suggests an average of less than one geophysical survey at any one time within a year.

365. Assessments for the RoC HRA for the SNS SAC (BEIS, 2020), modelled the potential for disturbance due to the use of a Sub-Bottom Profiler (SBP), and results indicated that there is the potential for a possible behavioural response in harbour porpoise at up to 3.77km (44.65km^2) from the source. The current guidance for assessing the significance of noise disturbance for harbour porpoise SACs (JNCC *et al.* 2020) recommends the use of an EDR of 5km (78.54km^2) for geophysical surveys.

366. Following the current SNCB guidance for the assessment of geophysical surveys disturbance on harbour porpoise, it should be assessed as a moving source, rather than a stationary one (i.e. the distance at which a survey vessel could travel in one day, with a 5km buffer area). It is difficult to determine what the potential area of effect would be when taking into account it is a moving source (as it is difficult to predict how far a vessel may survey in a day).

367. Based on survey vessels travelling at a speed of 4.5 to 5 knots, up to 199km could be surveyed in one day. This however does not take into account the survey downtime for line changes, weather, or other technical reason. A review of seismic surveys within the UK indicated that surveys were being undertaken for approximately 52% of the time (BEIS, 2020). Taking this into account, up to 103.5km of surveys could be undertaken in one day, resulting in a potential disturbance area of 1,113.5km^2 with the 5km EDR buffer applied. This is highly precautionary as it is unlikely that the whole survey area would be within the SNS SAC.

368. It is currently not possible to estimate the location or number of potential OWF geophysical surveys that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West. It is therefore assumed, as a worst case scenario, that there could potentially be up to one geophysical surveys in North Sea at any one time, during construction of DBS East and / or DBS West during the summer season.

369. For up to one geophysical surveys undertaken at the same time as construction of the Projects, with no other in-combination activities, up to 0.94% of the NS MU population may be disturbed (**Table 8-46**).

Table 8-46 Quantitative assessment for in-combination disturbance of marine mammals due to one geophysical survey at OWFs

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
DBS East	0.6	2,123.7	1,279.9 (0.37% of the NS MU)
DBS West or OECC*	0.66	2,123.7	1,401.6 (0.4% of the NS MU)
One geophysical survey	0.55	1,113.5 (per survey)	612.4 (0.18% of the NS MU)
Total number of harbour porpoise (DBS East in isolation)			**1,892.3 (0.54% of the NS MU)**
Total number of harbour porpoise (DBS West in isolation)			**2,014.0 (0.57% of the NS MU)**
Total number of harbour porpoise (DBS East and DBS West together)			**3,293.9 (0.94% of the NS MU)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.5.5.1.3.1.1 Spatial assessment

370. As it is currently not possible to estimate the location or number of potential OWF geophysical surveys that could be undertaken at the same time as construction of the Projects, and due to the smaller area of the summer area of the SNS SAC in comparison to the North Sea area that has been assessed above, it is assumed, as a worst case scenario, that there could potentially be up to one geophysical survey in the summer area of the SNS SAC at any one time, during construction of the Projects.

371. If one geophysical survey was undertaken within the SNS SAC summer area (with an area of 1,113.5km^2), at the same time as piling at DBS East and / or DBS West (maximum overlap area of 2,123.7km^2 for monopiles), the potential maximum area of disturbance could be 3,237.2km^2, which would be approximately 11.8% of the summer area if DBS East or DBS West was constructed in isolation.

372. If DBS East and DBS West were constructed together, the maximum area of disturbance would be 4,247.4km^2 and with one geophysical survey in the summer area of the SNS SAC, the potential maximum area of disturbance could be 5,360.9km^2 which would total in 19.3% of the summer area and therefore doesn't exceed the spatial threshold (20%) (**Table 8-47**).

Table 8-47 Estimated spatial overlaps with SNS SAC summer area with geophysical surveys on the same day as single piling at DBS East and / or DBS West

In-combination assessment scenario	Maximum overlap of spatial area for monopiling at DBS (%)
DBS East	7.59
DBS West	7.59
DBS OECC*	5.83
One geophysical survey	4.12
Total percentage of one geophysical survey and DBS East or West in isolation	**11.8**
Total percentage of one geophysical survey and DBS East and West together	**19.3**

** The OECC would not pile on the same day as DBS East or DBS West*

8.3.5.5.1.3.1.2 Seasonal average

373. The seasonal averages have been calculated by multiplying the maximum area on any one day which for seismic could be 183 days and piling for DBS East or West in isolation is 54 days, the seasonal average would be 4.13% of effect.

374. If DBS East and DBS West were constructed together, the piling days would increase to 108, and the seasonal average for disturbance effect would be 8.63%.

375. The assessment indicates that in the case of monopiles at DBS East and / or DBS West, along with geophysical surveys, the potential disturbance is less than 10% of the summer seasonal threshold of the SNS SAC that could be affected, due to geophysical surveys being undertaken on the same day as piling at the Projects (**Table 8-48**).

Table 8-48 Estimated seasonal averages with SNS SAC summer area with geophysical surveys on the same day as single piling at DBS East and / or DBS West

In-combination assessment scenario	Maximum overlap with seasonal area (%)	Maximum number of days	In-combination assessment scenario (%)
DBS East	7.59	54	2.16
DBS West	7.59	54	2.16
DBS OECC*	5.83*	1	0.03
One geophysical survey	4.12	183	4.12
Total percentage of one geophysical survey and DBS East or West in isolation	**17.5**	**183**	**6.31%**
Total percentage of one geophysical survey and DBS East, West and the OECC together	**25.3***	**183**	**8.47%**

**The OECC would not pile on the same day as DBS East or DBS West*

376. However, with the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of disturbance due to underwater noise (other than piling) from the Projects in-combination with geophysical surveys.

8.3.5.5.1.3.2 Disturbance from aggregate extraction and dredging

377. As a precautionary approach, a total of six aggregate extraction and dredging schemes are included in the in-combination assessment for the potential in-combination disturbance.

378. As outlined in the BEIS (2020) RoC HRA for the SNS SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600m of the activities (Diederichs *et al.* 2010). As a worst case assessment, a disturbance range of 600m for up to six operational aggregate schemes at the same time as the Projects' construction. A disturbance range of 600m would result in a potential disturbance area of 1.13km^2 for each project, or up to 6.8km^2 for all six aggregate schemes.

379. For the potential for in-combination disturbance from aggregate and dredging schemes undertaken at the same time as construction of the Projects, with no other in-combination activities, up to 0.001% of the NS MU population may be disturbed (**Table 8-49**).

380. None of the screened in aggregate schemes are within (or within 600m of) the summer area of the SNS SAC. Therefore, an assessment against the spatial and seasonal thresholds has not been undertaken.

Table 8-49 Quantitative assessment for in-combination disturbance of harbour porpoise due to aggregate and dredging schemes

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
DBS East	0.6	2,123.7	1,279.9 (0.37% of the NS MU)
DBS West or OECC*	0.66	2,123.7	1,401.6 (0.4% of the NS MU)
Aggregate and dredging schemes (1.13km^2 disturbance area per project)	0.55	6.8	3.74 (0.001% of the NS MU)
Total number of harbour porpoise (DBS East or West in isolation)			**1,405.34 (0.4% of the NS MU)**
Total number of harbour porpoise (DBS East and West together)			**2,685.24 (0.771% of the NS MU)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.5.5.1.3.3 *Disturbance from seismic surveys*

381. It is currently not possible to estimate the number of potential seismic surveys that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West. Analysis of MNR reports indicates that in the North Sea during 2021 there were 20 seismic surveys carried out for a total of 475 days. This gives a potential for just over one seismic survey to be undertaken at any one time in the North Sea, therefore it has been assumed that at any one time, up to two seismic surveys could be taking place at the same time within the Projects.

382. This assessment for the potential disturbance due to seismic surveys is based on the potential impact area during seismic surveys, with an EDR of 12km (452.4km^2 per survey, or 904.8km^2 for two surveys). However, as stated above for geophysical surveys, under the JNCC *et al.* 2020 guidelines for assessing effects at harbour porpoise designated sites, seismic surveys should be considered as a moving source.

383. Following the same approach as undertaken for geophysical surveys above, and using 12km EDR, the total disturbance area for a seismic survey would be 2,936.4km^2 (or 5,872.8km^2 for two surveys).

384. For two seismic surveys, undertaken at the same time as construction of DBS East and / or DBS West, up to 1.7% of the NS MU population may be disturbed (**Table 8-50**).

Table 8-50 Quantitative assessment for in-combination disturbance of harbour porpoise due to up to two seismic surveys

Potential in-combination effect	**Marine mammal density (/km^2)**	**Potential in-combination effect area (km^2)**	**Maximum number of individuals potentially disturbed (% of reference population)**
DBS East	0.6	2,123.7	1,279.9 (0.37% of the NS MU)
DBS West or OECC*	0.66	2,123.7	1,401.6 (0.40% of the NS MU)
Up to two seismic surveys	0.55	5,812.8	3,197.04 (0.92% of the NS MU)
Total number of harbour porpoise (DBS East in isolation)			**4,476.9 (1.29% of the NS MU)**

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Total number of harbour porpoise (DBS West in isolation)			**4,598.6 (1.32% of the NS MU)**
Total number of harbour porpoise (DBS East and DBS West together)			**5,878.5 (1.69% of the NS MU)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.5.5.1.3.3.1 Spatial assessment

385. It is likely that only one seismic survey will be undertaken within the summer area (with an impact area of 2,936.4km²), at the same time as piling a monopile at DBS East or DBS West; the potential area of disturbance could be 5,061.1km² which would be 18.5% of the summer area.

386. If DBS East and DBS West were constructed together, the potential area of disturbance would be 7,183.8km² which would equate to 26.04% of the summer area potentially disturbed which exceeds the summer threshold. This exceeds the spatial threshold of 20%, however once the SIP is finalised this will reduce the spatial effect (**Table 8-51**).

387. In line with the conclusions of the Plan Level HRA (The Crown Estate, 2022) **Volume 8, In Principle Site Integrity Plan for the Southern North Sea Special Area of Conservation (application ref: 8.26)** has been developed for the Projects, which will set out the approach to deliver any Project-level mitigation or management measures, and will be reviewed in the final SIP prior to construction to ensure that the spatial threshold is not exceeded.

Table 8-51 Estimated spatial overlaps with SNS SAC summer area with seismic surveys on the same day as single piling at DBS East and / or DBS West

In-combination assessment scenario	Maximum overlap of spatial area for monopiling at DBS (%)
DBS East	7.59
DBS West	7.59
DBS OECC*	5.83

In-combination assessment scenario	Maximum overlap of spatial area for monopiling at DBS (%)
One seismic survey	10.86
Total percentage of one seismic survey and DBS East or West in isolation	**18.5**
Total percentage of one seismic survey and DBS East and West together	**26.04**

** The OECC would not pile on the same day as DBS East or DBS West*

8.3.5.5.1.3.3.2 Seasonal average

388. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which seismic surveys could occur on the same day as construction at the Projects.

389. Any seismic could be 183 days and piling for DBS East or West in isolation is 54 days, the seasonal average would be 13.1% of effect. However, this would be very unlikely as even if it was six month project, no downtime is considered for bad weather and equipment malfunctions, or technical issues.

390. If DBS East and DBS West were constructed together, the piling days would increase to 108, and the seasonal average for disturbance effect would be 15.4%, which exceeds the 10% seasonal threshold. Mitigation measures in the SIP will ensure any seasonal effect will be below the threshold (**Table 8-52**).

Table 8-52 Estimated seasonal averages with SNS SAC summer area with seismic surveys on the same day as single piling at DBS East and / or DBS West

In-combination assessment scenario	Maximum overlap with seasonal area (%)	Maximum number of days	In-combination assessment scenario (%)
DBS East	7.59	54	2.16
DBS West	7.59	54	2.16
DBS OECC*	5.83*	1	0.03

In-combination assessment scenario	Maximum overlap with seasonal area (%)	Maximum number of days	In-combination assessment scenario (%)
One seismic survey	10.86	183	10.86
Total one seismic survey and DBS East or West in isolation	**18.45**	**183**	**13.05**
Total one seismic survey and DBS East, West and the OECC together	**26.04***	**183**	**15.21**

**The OECC would not pile on the same day as DBS East or DBS West*

391. The assessment indicates that more than 10% of the summer season of the SNS SAC could be affected, due to seismic surveys being undertaken on the same day as piling at DBS East and/ or DBS West.

392. In line with the conclusions of Plan Level HRA (The Crown Estate, 2022), **Volume 8, In Principle Site Integrity Plan for the Southern North Sea Special Area of Conservation (application ref: 8.26)** has been developed for the Projects, which will set out the approach to deliver any Project-level mitigation or management measures, and will be reviewed in the final SIP prior to construction to ensure that the spatial threshold is not exceeded.

8.3.5.5.1.3.4 Disturbance from subsea cables and pipelines

393. Only four subsea pipelines have been screened into the in-combination assessment; which all are currently at scoping stage and therefore there is limited information available on potential effects and disturbance ranges for which to inform the in-combination assessment with DBS East and / or DBS West.

394. The disturbance ranges that could be generated during the cabling works and vessels would be up to 4km (with a disturbance area of 50.3km^2), for harbour porpoise. This has been used to inform the assessments for pipeline schemes, as activities would be similar, in the absence of any additional information for the schemes screened in for assessment.

395. For disturbance from pipeline schemes, and no other in-combination activities, up to 0.008% of the NS MU population may be disturbed (**Table 8-53**).

Table 8-53 Quantitative assessment for in-combination disturbance of marine mammals due to subsea cable and pipeline schemes

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
DBS East	0.6	2,123.7	1,279.9 (0.37% of the NS MU)
DBS West or OECC*	0.66	2,123.7	1,401.6 (0.40% of the NS MU)
Pipeline schemes	0.55	50.3	27.7 (0.008% of the NS MU)
Total number of harbour porpoise (DBS East in isolation)			**1,307.6 (0.378% of the NS MU)**
Total number of harbour porpoise (DBS West in isolation)			**1,429.3 (0.408% of the NS MU)**
Total number of harbour porpoise (DBS East and DBS West together)			**2,709.2 (0.78% of the NS MU)**

**The OECC would not pile on the same day as DBS East or DBS West*

396. There are no current proposed cable or pipeline schemes which overlap with the summer area of the SNS SAC therefor special and seasonal assessments have not been conducted at this stage.

8.3.5.5.1.3.5 Disturbance from UXO Clearance

397. As for piling, the potential risk of PTS in marine mammals from in-combination effects has been screened out from further consideration in the CEA (see section 11.7, **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**); if there is the potential for any PTS, suitable mitigation would be put in place to reduce any risk to marine mammals. Therefore, the in-combination effects only consider potential disturbance effects.

398. This assessment has been based on the potential for disturbance due to UXO clearance activities for other schemes, cumulatively with the construction of DBS East and / or DBS West.

399. It is currently not possible to estimate the number of potential UXO clearance events that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West. In 2021 there were six cases of UXO detonations reported to the MNR in the North Sea, these occurred over a total of 16 days. This amount gives an average of less than one UXO detonation to occur within a year at any one time in the North Sea. It is therefore highly unlikely that more than one UXO high-order detonation would occur at exactly the same time or on the same day as another UXO detonation, even if they had overlapping UXO clearance operation durations. The in-combination assessment is therefore based on potential for disturbance from one UXO high-order detonation without mitigation (worst-case), and one low-order detonation.

400. The potential effect area of 2,123.7km² per project, based on 26km EDR for UXO high order detonation, and 78.5km² for low-order detonation, following the current SNCB guidance for the assessment of effect to harbour porpoise in the SNS SAC.

401. However, as outlined in the BEIS (2020) RoC HRA, due to the nature of the sound arising from the detonation of UXO, i.e. each blast lasting for a very short duration, marine mammals, including harbour porpoise, are not predicted to be significantly displaced from an area, any changes in behaviour, if they occur, would be an instantaneous response and short-term. Existing guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010a).

402. **Table 8-54** presents the potential in combination area and the potential maximum number of harbour porpoises disturbed.

Table 8-54 Quantitative assessment for in-combination disturbance of harbour porpoise due to up to one low order and one high order UXO clearance.

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
DBS East	0.6	2,123.7	1,279.9 (0.37% of the NS MU)
DBS West or OECC*	0.66	2,123.7	1,401.6 (0.40% of the NS MU)
One high order UXO Clearance	0.55	2.123.7	1,168.0 (0.33% of the NS MU)

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
One low order UXO Clearance	0.55	78.5	43.2 (0.014% of the NS MU)
Total number of harbour porpoise (DBS East in isolation)			**2,491.1 (0.72% of the NS MU)**
Total number of harbour porpoise (DBS West in isolation)			**2,612.8 (0.75% of the NS MU)**
Total number of harbour porpoise (DBS East and DBS West together)			**3,892.7 (1.12% of the NS MU)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.5.5.1.3.5.1 Spatial assessment

403. If one high-order UXO detonation was undertaken within the summer area (with an area of 2,123.7km²), at the same time as a monopile at the Projects, the potential average area of disturbance could be 4,247.4km² which would be approximately 15.5% of the summer area potentially disturbed.

404. If DBS East and DBS West were constructed together, and with one high order UXO clearance happening in the summer area, the disturbance range would be 6,371.1km² which equates to 23.3% of the summer area to be potentially disturbed, which exceeds the 20% spatial threshold. If DBS East and DBS West were to be constructed together, the measures in the SIP would ensure the any spatial effect would be below the threshold.

405. For one low-order detonation with a monopile at the Projects, the potential average area of disturbance could be 2,123.7 and 78.5km² which totals at 2,202.2km² equates to 7.9% of (the summer area to be potentially disturbed due to a monopile at DBS East or DBS West and with low-order UXO clearance.

406. If DBS East and DBS West are constructed together, and one low order UXO clearance occurred in the summer area on the same day as a monopile at both DBS East and DBS West, the total area for disturbance would be 4,325.9km² which equates to 15.5% of the summer area to be potentially disturbed (**Table 8-55**),

407. The displacement of harbour porpoise would not exceed 20% of the summer spatial area component of the SNS SAC if DBS East and DBS West were piling at the same time and with one high order UXO clearance on any given day.

Table 8-55 Estimated spatial overlaps with SNS SAC summer area with UXO clearance on the same day as single piling at DBS East and / or DBS West

In-combination assessment scenario	Maximum overlap of spatial area for monopiling at DBS (%)
DBS East	7.59
DBS West	7.59
DBS OECC*	5.83
One high order UXO Clearance	7.86
One low order UXO Clearance	0.29
Total percentage of one high order and one low order UXO clearance and DBS East or West in isolation	**15.7**
Total percentage of one high order and one low order UXO clearance and DBS East and West together	**23.3**

**The OECC would not pile on the same day as DBS East or DBS West*

408. With the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, there would be no significant disturbance from the Projects in-combination with UXO clearance activities at other OWF schemes.

8.3.5.5.1.3.5.2 Seasonal average

409. The seasonal averages have been calculated by multiplying the maximum area on any one day by the proportion of days within the season on which UXO clearance could occur on the same day as monopiling at the Projects.

410. Any UXO clearance (high order or low order) could be undertaken for 183 days and piling at DBS East or West in isolation is up to 54 days; the seasonal average would be 10.1% of effect for high order UXO clearance, 2.5% for low order (**Table 8-56**) and 10.4% for both types of UXO clearance on the same day as piling at DBS East or DBS West.

411. If DBS East and DBS West were constructed together, the piling days would increase to 108, and the seasonal average for disturbance effect would be 12.3% for high order UXO and 4.8% for one low order UXO event and 12.6% if both high-order and low-order were to occur on the same day (**Table 8-56**).

412. The assessment indicates that more than 10% of the summer season of the SNS SAC could be affected, due to UXO clearance if any high order detonations are being undertaken on the same day as piling at DBS East and / or DBS West. This exceeds the seasonal threshold therefore mitigation will be implemented in the SIP to ensure any effect on the SNS SAC summer season would be less than 10%.

Table 8-56 Estimated seasonal averages with SNS SAC summer area with UXO clearance on the same day as single piling at DBS East and / or DBS West

In-combination assessment scenario	Maximum overlap with seasonal area (%)	Maximum number of days	In-combination assessment scenario (%)
DBS East	7.59	54	2.24
DBS West	7.59	54	2.24
DBS OECC*	5.83*	1	0.03
One high order UXO Clearance	7.86	183	7.86
One low order UXO Clearance	0.29	183	0.29
Total for high-order and one low-order UXO clearance and DBS East or West in isolation	**15.7**	**183**	**10.4**

In-combination assessment scenario	Maximum overlap with seasonal area (%)	Maximum number of days	In-combination assessment scenario (%)
Total for one high-order and one low-order UXO clearance and DBS East and West together	**23.3***	**183**	**12.6**

**The OECC would not pile on the same day as DBS East or DBS West*

413. However, with the use of appropriate mitigation and management measures defined through the SIP process, and managed by the MMO, there would be no significant disturbance from the Projects in-combination with UXO clearance activities at other OWF schemes.

8.3.5.5.1.4 Summary of In-combination Impact 1: Assessment of Underwater Noise

414. Each of the above described noise sources with the potential for disturbance on harbour porpoise are quantitively assessed together in **Table 8-57**.

415. For harbour porpoise, for noisy activities with the potential for in-combination disturbance effects together with piling at the Projects of less than 6% of the population at risk of disturbance.

416. Based on the worst case scenarios and very precautionary approach, there is the potential for less than 48% of the summer area to be disturbed on any one day, and less than 34% to be disturbed over the season if DBS East or DBS West were constructed in isolation in-combination with the other schemes (**Table 8-57**). If the Projects were constructed together, there is potential for up to 55% of the summer area to be disturbed and up to 36% to be disturbed over the season in-combination with the other schemes (**Table 8-57**).

417. It should be noted that the largest impacts estimated in the in-combination assessment are due to possible effects from seismic surveys (which are unrelated to the Projects or any OWF) and high-order UXO clearance. In the assessment two seismic and one high order UXO clearance has been calculated daily as it is unknown how many days these activities would occur, however every day in the summer season is very unlikely, so therefore this is the worst possible scenario.

418. Behavioural effects from UXO clearance, if they occur, would be an instantaneous response and short-term. Guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010) and therefore could be excluded from the total.

419. Mitigation measures required for UXO clearance include the use of low-order clearance techniques, which could include a small donor charge, rather than full high-order detonation which is only used as a last resort. It is therefore highly unlikely that more than one UXO high-order detonation would occur at exactly the same time or on the same day as another UXO high-order detonation, even if they had overlapping UXO clearance operation durations. The in-combination is therefore based on potential for disturbance from one UXO high-order detonation without mitigation (worst case), as well as one low-order clearance event.

Table 8-57 Quantitative assessment for all noisy activities with the potential for in-combination disturbance effects for harbour porpoise

Potential in-combination effect	Maximum number of individuals potentially disturbed (% of reference population)	Potential in-combination effect area (km^2)[10]	Spatial impact area of the SNS SAC[10]	Seasonal effect of the SNS SAC[10]
DBS East	1,279.9 (0.37% of the NS MU)	2,123.7km^2	7.86%	2.16%
DBS West	1,401.6 (0.40% of the NS MU)	2,123.7km^2	7.86%	2.16%
DBS OECC*	1,401.6 (0.40% of the NS MU)	2,087.8km^2	7.72%	0.03%

[10] Construction activities at other OWF's, aggregates and dredging, subsea cables and pipelines and other marine industries are not considered relevant activities for the noise disturbance thresholds (under Conservation Objective 2) and therefore have not been included in the spatial and seasonal assessments (JNCC *et al.* (2020)).

Potential in-combination effect	Maximum number of individuals potentially disturbed (% of reference population)	Potential in-combination effect area (km^2)[10]	Spatial impact area of the SNS SAC[10]	Seasonal effect of the SNS SAC[10]
Worst case disturbance from the Projects	2,681.5 (0.77% of the NS MU)*	4,247.4km²*	15.18%*	4.35%
Piling at other OWFs	11,996.8 (3.46% of the NS MU)	1,175.81km²	26.56%	7.87%
Other activities (assuming 183 days of overlap)				
Construction activities at other OWFs	1,089.7 (0.31% of the NS MU)	N/A	N/A	N/A
One Geophysical surveys	612.4 (0.18% of the NS MU)	1,113.5km²	4.12%	4.12%
Aggregates and dredging	3.74 (0.001% of the NS MU)	N/A	N/A	N/A
Two Seismic surveys	3,197.04 (0.92% of the NS MU)	5,812.8km²	10.86%	10.86%
Pipeline schemes	27.7 (0.008% of the NS MU)	N/A	N/A	N/A
UXO clearance (HO)	1,168.0 (0.33% of the NS MU)	2123.7km²	7.86%	7.86%
UXO clearance (LO)	43.2 (0.014% of the NS MU)	78.5km²	0.29%	0.29%
Total impact with DBS East	**19,418.5 (5.59% of the NS MU)**	**12,428.0km²**	**57.6%**	**33.2%**
Total impact with DBS West	**19,540.2 (5.62% of the NS MU)**	**12,428.0km²**	**57.6%**	**33.2%**

Potential in-combination effect	Maximum number of individuals potentially disturbed (% of reference population)	Potential in-combination effect area (km^2)[10]	Spatial impact area of the SNS SAC[10]	Seasonal effect of the SNS SAC[10]
Total impact with Projects together	**20,820.1 (5.99% of the NS MU)**	**14,551.7km^2**	**65.4%**	**35.4%**
Total number of individuals without DBS	**18,138.6 (5.22% of the NS MU)**	**10,304.3km^2**	**49.7%**	**31.0%**

**The OECC would not pile on the same day as DBS East or DBS West*

420. It should be noted that while the schemes included within the in-combination assessment for disturbance from other activities and industries were included based on the current knowledge of their possible construction or activity windows, it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the harbour porpoise that could be at risk of disturbance during the four year offshore construction period of the Projects.

421. This in-combination assessment will be refined and updated prior to construction in the final SIP, to take account of the latest information on project programmes and any detail on project-level mitigation commitments or marine licence conditions from the in-combination schemes. The final assessment will also take account of the potential for overlaps in the disturbance areas of all activities, and whether they are likely to take place on the same day or within the same season to refine the assessments. The assessment will also take into account the number of days of each activity included. It is expected that taking these points into consideration would reduce the overlaps.

422. Mitigation measures are presented in **Volume 8, Outline Marine Mammal Mitigation Plan (application ref: 8.25)** and will be reviewed for the final MMMP prior to construction. With the implementation of the final SIP **there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise as a result of DBS East and / or DBS West in-combination with other schemes.**

8.3.5.5.2 Impact 2 Barrier Effects

423. For the assessment of the potential for barrier effects due to underwater noise from schemes undergoing construction, the effect to marine mammal species would be as per the assessments provided in **Table 8-57**, for in-combination disturbance effects due to all noisy activities.

424. It is important to note that the OWFs and other noise sources included in the in-combination assessment are spread over the wider area of the North Sea. Taking into account the locations of the OWFs and other noise sources from DBS East and / or DBS West, the maximum underwater effect ranges for disturbance at other schemes would not overlap with the maximum underwater effect ranges for disturbance at the Projects during piling and construction. Therefore, there is no potential for underwater noise from the Projects, other OWFs and noise sources to result in a barrier of movement to marine mammals.

425. The potential for a barrier effect due to underwater noise during operation was assessed as having no effect, and therefore has not been considered within this in-combination assessment.

426. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise.

8.3.5.5.3 Impact 3 Vessel Interaction

427. The in-combination effects from an increase in the number of vessels and vessel movements can pose a potential collision risk for harbour porpoise.

428. As outlined in sections 8.3.5.2.8 and 8.3.5.3.8, the increased collision risk due to project vessels, even using a very precautionary approach, would result in less than one individual (0.0233 harbour porpoise) being at risk of vessel collision per year (**Table 8-35**), for construction phase related vessel collision risk. This amount would be reduced for operation and maintenance phase related vessel collision risk due to the construction phase being the worst case in terms of vessel numbers (see section 8.3.5.2.8).

429. As outlined in **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**, vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where harbour porpoise are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and with a vessel speed limit of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with harbour porpoise.

430. It is expected that other offshore schemes and industries would follow similar measures in order to reduce the potential for collision risk of harbour porpoise with vessels.

431. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low.

432. In addition, based on the assumption that harbour porpoise would be disturbed as a result of underwater noise from piling, other construction activities, operational and maintenance activities and vessels, there should be no potential for increased collision risk with vessels.

433. Therefore, there would be no adverse effect on integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise due to an increase in collision risk with construction vessels.

8.3.5.5.4 Impact 4 Changes to Prey Availability

434. Potential effects on prey species for the Projects were assessed in section 8.3.5.2.9 (construction) and section 8.3.5.3.9 (operation). No adverse effect on integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise was concluded. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. This will be the case for all schemes and therefore although the in-combination effects are additive, the effect would be proportionate to the wider range over which effects would occur.

435. Therefore, there would be no adverse effect on the integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise arising due to changes in prey availability.

8.3.5.6 Summary of Potential Effects on Site Integrity

436. The assessment of the potential effects for the Projects in isolation or together has been summarised in relation to the SNS SAC conservation objectives for harbour porpoise (**Table 8-58**).

437. The SIP and MMMP will provide mitigation or management measures to reduce the potential for any significant disturbance of harbour porpoise as a result of in-combination effects from underwater noise.

438. There would be no adverse effect on integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise, either alone or together, when in-combination with other schemes.

Table 8-58 Summary of the potential effects of the Project, including in-combination effects on the SNS SAC in relation to the conservation objectives for harbour porpoise (X = no potential for AEoI; ✓ = potential for AEoI)

Conservation objectives	The Projects effects					In-combination effects			
	Auditory injury and disturbance from underwater noise	**Barrier effects**	**Vessel interaction**	**Changes to water quality**	**Changes to prey resources**	**Disturbance from underwater noise**	**Barrier Effects**	**Vessel interaction**	**Changes to prey resources**
Harbour porpoise is a viable component of the site	X	X	X	X	X	X	X	X	X
There is no significant disturbance of the species	X	X	X	X	X	X (with Site Integrity Plan)	X	X	X
The condition of supporting habitats and processes and the availability of prey is maintained	X	X	X	X	X	X	X	X	X

8.3.6 Humber Estuary SAC

8.3.6.1 Site Description

439. The Humber is the second largest coastal plain estuary in the UK, and the largest on the east coast of Britain. Grey seal are present as a qualifying feature of the Humber Estuary SAC (Natural England, 2009).

440. The Humber Estuary SAC is located, at closest point, 132km from DBS East Array Area and 143km from DBS West Array Area. Therefore, there is no potential for direct effect on the SAC as a result of the construction, operation, maintenance or decommissioning of the Projects' Array Areas. However, due to the foraging range of grey seal and the movement of grey seal along the east coast of England, there is the potential for effects on foraging grey seal from the Humber Estuary SAC in the vicinity of the Array Areas.

441. Note that the SAC is largely coincident[11] with the Humber Estuary Ramsar site for which grey seal are listed under Ramsar Criterion 3. This criterion states "*A wetland should be considered internationally important if it supports populations of plant and / or animal species important for maintaining the biological diversity of a particular biogeographic region.*"

8.3.6.1.1 Qualifying Features

8.3.6.1.1.1 Grey Seal

442. There is a considerable amount of movement of grey seals among different areas and regional subunits of the North Sea, and there is no evidence to suggest that grey seals on the North Sea coasts of Denmark, Germany, the Netherlands, or France are independent from those in the UK (SCOS, 2022).

443. Compared with other times of the year, grey seal in the UK spends longer hauled out during their annual moult (between December and April) and during their breeding season, in eastern England, pupping occurs mainly between early November and mid-December (SCOS, 2022).

444. DBS East Array Area is located approximately 122km offshore (at the closest point to shore) and DBS West Array Area is located approximately 100km offshore (at the closest point to shore).

[11] There is a small section of coast at Easington which is included in the Ramsar site which is not included within the SAC.

445. The Donna Nook haul-out site is within the Humber Estuary SAC and represents the current best grey seal population estimate of the SAC. In August 2021 there were 3,897 grey seal counted at Donna Nook (SCOS, 2022).

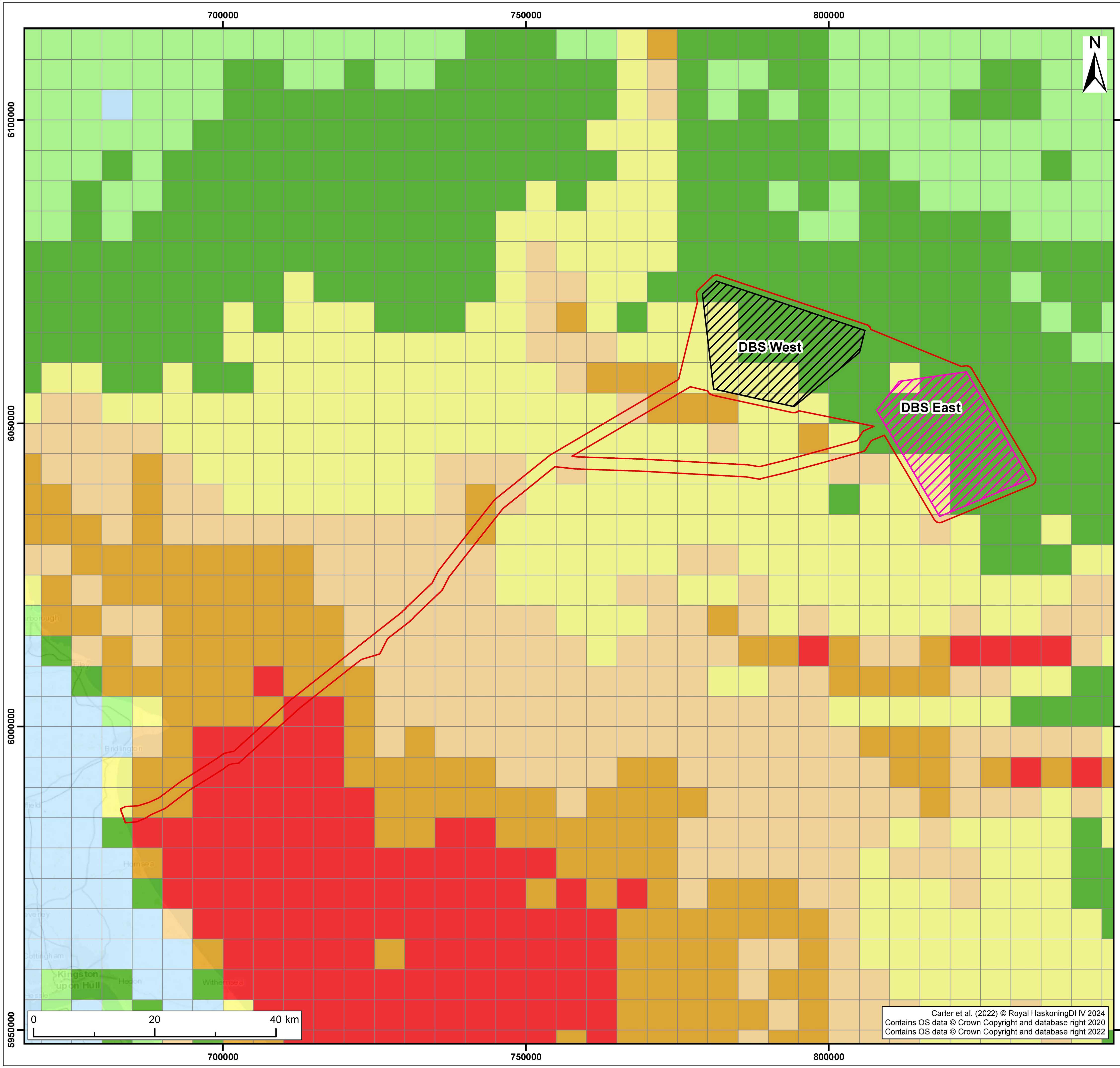
446. A relatively low number of grey seal were recorded during the site-specific aerial surveys, with a total of 11 individuals recorded during the 12 surveys at DBS East AfL Area plus 4km buffer and 31 at DBS West AfL Area plus 4km buffer. However, in addition a total of 25 unidentified seal species were recorded at DBS East AfL Area plus 4km buffer and 34 at DBS West AfL Area plus 4km buffer, a proportion of which are expected to be grey seal.

447. Throughout the surveys the numbers of grey seal, or individuals that could be grey seal (i.e. seal species) were relatively similar year-round, with a slight peak in spring and winter. Due to the low number of grey seal sightings, absolute density and abundance estimates were not possible to derive from the site-specific surveys.

448. Carter *et al.* (2022) produced habitat-based predictions of at-sea distribution for grey seals in the British Isles. The resultant density of seals at-sea maps shows the relative density of seals in each 5km by 5km grid cell. As well as the total grey seals at-sea densities, Carter *et al.* (2022) provide SAC specific densities. These SAC specific densities provide the relative density of grey seal that are associated with each SAC. These SAC specific density estimates have been used to calculate the density of grey seal, associated with the Humber Estuary SAC, present within the Array Areas (**Figure 8-2**; **Table 8-59**). This effectively apportions the potential for effect to only those seals that are affected that are associated with the SAC itself.

449. The highest mean at sea relative density estimates of grey seal for Array Areas, and all Offshore Export Cable areas calculated from Carter *et al.* (2022) are:

- 0.054 individuals per km^2 for DBS East Array Area;
- 0.089 individuals per km^2 for DBS West Array Area;
- 0.728 individuals per km^2 for the OECC; and
- 0.176 individuals per km^2 for the total Offshore Development Area.



Legend:

- Offshore Development Area
- DBS East array area
- DBS West array area

Proportion of the population per 25km² (as a %)

- 0.000000 - 0.001842
- 0.001843 - 0.006213
- 0.006214 - 0.014872
- 0.014873 - 0.029511
- 0.029512 - 0.053813
- 0.053814 - 0.104046
- 0.104047 - 0.627300

Maps show mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid cell square at any one time, and the cellsquare-wise (Carter et al., 2022)

S2	P01	02/04/2024	Suitable for Information	JH	SB	AS
SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR

Title:

Humber Estuary SAC
Grey seal at sea distribution

Figure: 8-2 Drawing No: PC2340-RHD-OF-ZZ-DR-Z-0705

Co-ordinate system: WGS 1984 UTM Zone 31N | Page Size: A3 | Scale: 1:620,000

Project: Dogger Bank South Offshore Wind Farms

Report: Report to Inform Appropriate Assessment

Royal HaskoningDHV
Enhancing Society Together
RWE

450. The assessments are based on mean relative density estimates for the Humber Estuary SAC from (Carter *et al.* 2022) as a worst-case. The corrected SAC grey seal count was used to generate absolute densities from the relative density data of Carter *et al.* (2022). This at-sea population number is 15,495[12], based on the total population of grey seal at the Humber Estuary SAC (provided in **Table 8-59**), and calculating against a correction factor of 0.2515 (Carter *et al.* 2020; to take account of those individuals at sea only).

Table 8-59 Grey seal counts and population estimates

Population area	Grey seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Grey seal SAC population
Humber Estuary SAC population estimate	3,897	SCOS 2022	0.2515	15,495

451. Assessments are undertaken against the SAC population estimate of 15,495 seals, for both the project alone and in-combination.

8.3.6.1.2 Conservation Objectives

452. The Conservation Objectives (Natural England, 2023a) are "*To ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to* achieving *the Favourable Conservation Status 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*

---

[12] Note this is not the total SAC population estimate, as accounts for only those seals that are at-sea and not those that could be hauled-out

- *The supporting processes on which qualifying natural habitats and habitats of qualifying species rely*
- *The populations of qualifying species, and,*
- *The distribution of qualifying species within the site."*

453. For grey seal within the Humber Estuary SAC, the specific targets are to:

- 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 stage and behaviours;
- Maintain connectivity of the habitat within sites and the wider environment to allow movement of migratory species;
- Restrict the introduction and spread of non-native species and pathogens, and their impacts;
- Maintain the extent and spatial distribution of the following supporting habitats; foraging and haul out sites;
- Maintain the cover / abundance of preferred food items required by the species;
- Maintain the natural physio-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;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;
- Maintain water quality to 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 avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. suspended concentrations of sediment, plankton and other material) in areas where this species is, or could be present.

454. Note that with regard to the Ramsar designation, Natural England advice states that for Ramsar sites, a decision has been made by Defra and Natural England not to produce Conservation Advice packages. As the provisions on the Habitats Regulations relating to HRA extend to Ramsar sites, Natural England considers the Conservation Advice packages for the overlapping European Marine Site designations to be, in most cases, sufficient to support the management of the Ramsar interests. Therefore, the conservation objectives listed above cover both the SAC and Ramsar requirements.

8.3.6.2 Potential Effects Summary

455. For the assessments, the potential for any effects is considered in relation to the Humber Estuary SAC Conservation Objectives for grey seal as outlined in **Table 8-60.**

Table 8-60 Potential effects of DBS East and / or DBS West in relation to the Conservation Objectives of the Humber Estuary SAC for Grey Seal

Conservation Objective for grey seal	Potential effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential adverse effect There will be no significant change to the extent and distribution of the habitats of qualifying species in the SAC.
The structure and function (including typical species) of qualifying natural habitats.	No potential adverse effect There will be no significant change to the structure and function (including typical species) of qualifying natural habitats.
The structure and function of the habitats of qualifying species.	No potential adverse effect There will be no significant change to 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.	No potential adverse effect There will be no significant change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
The populations of qualifying species.	Increased collision risk with vessels will be considered further.

Conservation Objective for grey seal	Potential effect
The distribution of qualifying species within the site.	No potential adverse effect There will be no significant change to the distribution of qualifying species within the site. However, significant disturbance and displacement as a result of increased underwater noise levels have the potential to have an effect on the seals foraging at sea and will be considered further.

8.3.6.3 Potential effects during construction

456. Potential effects during construction may arise through disturbance from activities during the installation of offshore infrastructure. Underwater noise during piling, as well as disturbance associated with underwater noise from other construction activities and the presence of vessels offshore, are considered. Potential displacement from important habitat areas and impacts on prey species are also considered.

457. The potential effects during construction assessed for marine mammals are:

- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during piling, and due to ADD activation prior to piling:
  - Permanent auditory injury (PTS) due to impact piling;
  - Disturbance due to impact piling.
- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during other construction activities, including seabed preparations, rock placement and cable installation;
  - Auditory injury due to other construction activities; and
  - Disturbance due to other construction activities.
- Impacts resulting from the deployment of construction vessels:
  - Underwater noise and disturbance from construction vessels:
  - Auditory injury due to construction vessels; and
  - Disturbance due to construction vessels.
  - Barrier effects as a result of underwater noise;
- Vessel interaction (collision risk);

- Changes to prey resource; and
- Disturbance to seal haul-out sites.

8.3.6.3.1 Impact 1: Permanent auditory injury (PTS) due to impact piling

458. Impact piling is a source of high-level underwater noise and causes both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals (see section 8.3.5.2.1 for more detail).

459. Underwater noise modelling was carried out by SubAcoustech to estimate the noise levels likely to arise during piling and determine the maximum potential areas of effect (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** and **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** for further details) and section 8.3.5.2.1 for more detail.

8.3.6.3.1.1 Assessment of potential effects of the Projects alone

460. The underwater noise modelling results for the predicted effect ranges and areas for PTS from a single strike of the maximum hammer energy for the worst case location have been presented **Table 8-61**.

Table 8-61 The Predicted Effect Ranges (and areas) for PTS in Seals, at the Worst case Modelling Location, for the Maximum Hammer Energies and Cumulative Exposure of Both Monopiles and Pin Piles at DBS East or DBS West in isolation

Species	**Location**	**Potential effect ranges (and areas) for PTS**	
		Monopile (6,000kJ)	**Jacket pin pile (3,000kJ)**
Single strike at the maximum hammer energy			
Seal Spp.	DBS East, DBS West, and OECC	60m (<0.01km^2)	<50m (<0.01km^2)
Cumulative exposure from a single pile installation		**One monopile**	**One jacket pin pile**
Seal Spp.	DBS East	1.6km (6.2km^2)	0.75km (1.3km^2)
	DBS West	1.3km (4.3km^2)	0.58km (0.8km^2)
	OECC	2.7km (20 km^2)	1.5km (6.6km^2)

Species	Location	Potential effect ranges (and areas) for PTS	
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
Cumulative exposure from multiple sequential pile installations in 24 hours		**Two sequential monopiles**	**Four sequential jacket pin piles**
Seal Spp.	DBS East	1.6km (6.4km^2)	0.88km (1.7km^2)
	DBS West	1.3km (4.5km^2)	0.63km (1.0km^2)
	OECC	-	1.9km (9.6km^2)

461. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS due to a single strike at the maximum hammer energy, and cumulative exposure, for both monopiles and jacket pin piles, is presented in **Table 8-62.**

Table 8-62 Assessment of the potential for instantaneous PTS due to a single strike of the maximum hammer energy and cumulative exposure for both monopiles and jacket pin piles

Species	Location	Maximum number of individuals (% of reference population	Potential adverse effect on site integrity
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Grey seal	DBS East	0.0005 (0.0005% of Humber Estuary SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.0009 (0.000006% of Humber Estuary SAC count)	
	OECC	0.007 (0.00005% of Humber Estuary SAC count)	
PTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			

Species	Location	Maximum number of individuals (% of reference population	Potential adverse effect on site integrity
Grey seal	DBS East	0.0005 (0.000004% of Humber Estuary SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.0009 (0.000006% of Humber Estuary SAC count)	
	OECC	0.007 (0.00005% of Humber Estuary SAC count)	
PTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum})			
Grey seal	DBS East	0.3 (0.002% of Humber Estuary SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.4 (0.003% of Humber Estuary SAC count)	
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})			
Grey seal	DBS East	0.09 (0.0006% of Humber Estuary SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.15 (0.00098% of Humber Estuary SAC count)	
	OECC	1.24 (0.008% of Humber Estuary SAC count)	

462. As outlined in section 7.3, **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** for piling has been submitted with the application and will be reviewed prior to construction in consultation with the MMO and relevant SNCBs, and will be based on the latest scientific understanding and guidance, as well as detailed project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of any permanent auditory injury (PTS) from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

463. The effective implementation of the MMMP for piling will reduce the risk of PTS to grey seal during piling at the Projects. This mitigation alongside less than 1% of the population being affected, means there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS) from increased underwater noise during construction (piling) of the Projects alone.**

8.3.6.3.1.2 Assessment of potential effects of the Projects together

464. As outlined in section 8.3.3, there is the potential that the Projects could be constructed concurrently. Therefore, the worst case for the Projects being developed at the same time has been assessed, based on simultaneous piling at the two sites and a central location at the same time.

465. The underwater noise modelling results for the predicted effect ranges and areas for PTS from a single and multiple pile installation worst case location have been assessed **Table 8-63**.

Table 8-63 Summary of the Impact Areas for the Concurrent Installation of Monopile and Pin pile Foundations at multiple locations across DBS Array Areas, for Grey Seal Using the Impulsive Southall et al. (2019) Criteria Assuming a Fleeing Animal.

Location	**Potential effect areas for PTS (weighted SEL_{cum})**	
	PTS from two concurrent monopile installations (two sequential at DBS East at the same time as two sequential at DBS West)	**PTS from three concurrent pin pile installations (four sequential at DBS East at the same time as four sequential at DBS West & four sequential at the OECC)**
In-combination	230km^2	240km^2

466. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS, due to a sequential piling event, for both monopiles and jacket pin piles, is presented in **Table 8-64** using the grey seal density from the Humber SAC calculated across the Offshore Development Area.

Table 8-64 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 hour Period

Species	Assessment of effect	Potential adverse effect on site integrity
Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)		
Grey Seal	40.5 (0.26% of Humber Estuary SAC)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
Three concurrent installations at DBS East, DBS West, and OECC, with four sequential jacket pin piles at each location (total of 12 jacket pin piles installed in one day)		
Grey Seal	42.3 (0.27% of Humber Estuary SAC)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.

467. The effective implementation of the MMMP for piling will reduce the risk of PTS to grey seal during piling at the Projects. This mitigation alongside less than 1% of the population being affected, means there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS) from increased underwater noise during construction (piling) for the Projects together**.

8.3.6.3.2 Impact 2: Disturbance or Behavioural effects from Underwater Noise During Piling

468. The range of possible behavioural reactions that may occur as a result of exposure to noise include orientation or attraction to a noise source, increased alertness, modification of characteristics of their own sounds, cessation of feeding or social interaction, alteration of movement / diving behaviour, temporary or permanent habitat abandonment and, in severe cases, panic, or stranding, sometimes resulting in injury or death (Southall *et al.* 2008).

469. There are currently no agreed thresholds or criteria for the behavioural response and disturbance of grey seal, therefore it is not possible to conduct underwater noise modelling to predict impact ranges.

470. Disturbance from construction activities (including piling) may have behavioural consequences on grey seal in the study area, including reduced time spent foraging at sea as animals move away from sources of noise, displacement from vessels, etc. Repeated disruptions can have cumulative negative effects on the bioenergetic budget of marine species, with the potential for long-term effects on survival and reproductive rates (Christiansen *et al.* 2013).

471. Hastie *et al.* (2021) studied the change in foraging behaviour of grey seal when exposed to underwater noise. A high density and low density area of prey was present within an experimental pool, and speakers were located at each prey patch. During the control periods, seals would forage mainly at the high-density patch, but also at the low-density patch for a smaller proportion of time. When the seals were exposed to noise at the low density patch, there was a reduction in foraging of 16-28%, however, when seals were exposed to noise at the high density prey patch, there was no change in foraging in comparison to control periods. This indicates that seals would choose to remain at a noisy environment, if there were good prey resources at the same location.

472. Russell (2016), have shown that grey seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2). This range has therefore been used to determine the number of grey seal that may be disturbed during piling at DBS East Array Area or DBS West Array Area (**Table 8-65**).

473. As per current best practice guidance (Southall *et al.* 2021), a behavioural disturbance dose-response analysis has been carried out for those species for which appropriate dose-response evidence exists within the scientific literature. Where, a species-specific dose-response assessment has been undertaken rather than the fixed behavioural threshold approach that is described above. The dose-response methodology has therefore been undertaken for grey seal. The application of a dose-response approach is explained in section 8.3.5.2.2, with more information on the method used and results of the dose response assessment in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

8.3.6.3.2.1 Assessment of potential effects of the Projects alone

474. A distance of 25km during piling Russell (2016) (or a disturbance area of 1,963.5km^2) has been used to determine the number of grey seals that may be disturbed during monopiling at DBS East, DBS West or OECC (**Table 8-65**). To assess for disturbance of a single jacket pin pile foundation, the recommended EDR of 15km (706.86km^2) for harbour porpoise (Graham *et al.* 2019) has been used as a precautionary impact range for grey seals.

Table 8-65 Assessment of the Potential for Disturbance to Grey Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East or DBS West

Potential disturbance range and area	Location	Assessment of effect	Potential adverse effect on site integrity
One Monopiles			
25km, with a disturbance area of 1,963.5km^2	DBS East	106.0 (0.68% of Humber Estuary SAC)	**No** Less than 5% of the population affected.
	DBS West	174.75 (1.13% of Humber Estuary SAC)	
	OECC	1,429.42 (9.23% of Humber Estuary SAC)	**Yes** More than 5% of the population affected.
One Jacket pin pile foundation			

Potential disturbance range and area	Location	Assessment of effect	Potential adverse effect on site integrity
15km, with a disturbance area of 706.86km^2	DBS East	38.2 (0.25% of Humber Estuary SAC)	**No** Less than 5% of the population affected.
	DBS West	62.9 (0.41% of Humber Estuary SAC)	
	OECC	514.6 (3.32% of Humber Estuary SAC)	

475. As there is the potential for over 5% of the grey seal Humber Estuary SAC population to be potentially disturbed (**Table 7-65**), population modelling was carried out to show that there would be no population consequence due to piling, see section 8.3.6.3.2.1.1 .

476. In addition, a behavioural disturbance dose-response analysis has also been carried out. For seals, a dose-response relationship derived from harbour seal telemetry data collected during several months of piling at the Lincs OWF has been used (Whyte *et al.* 2020). As seen in **Plate 8-4** the greatest SEL_{SS} considered in the Whyte *et al.* (2020) study was 180dB re 1 μPa^{2}s, and no significant responses were observed at SEL_{ss} levels below 145dB re 1 μPa^{2}s. This assessment has therefore considered the probability of response at 5dB increments between 120 dB SEL_{SS} and 200dB SEL_{SS}. At SEL_{SS} greater than 180dB re 1 μPa^{2}s all seals are assumed to be disturbed. At SEL_{SS} of less than 145dB re 1 μPa^{2}s, no significant disturbance is expected. The dose-response curve for harbour seal is appropriate for grey seal, as both species have similar hearing audiograms.

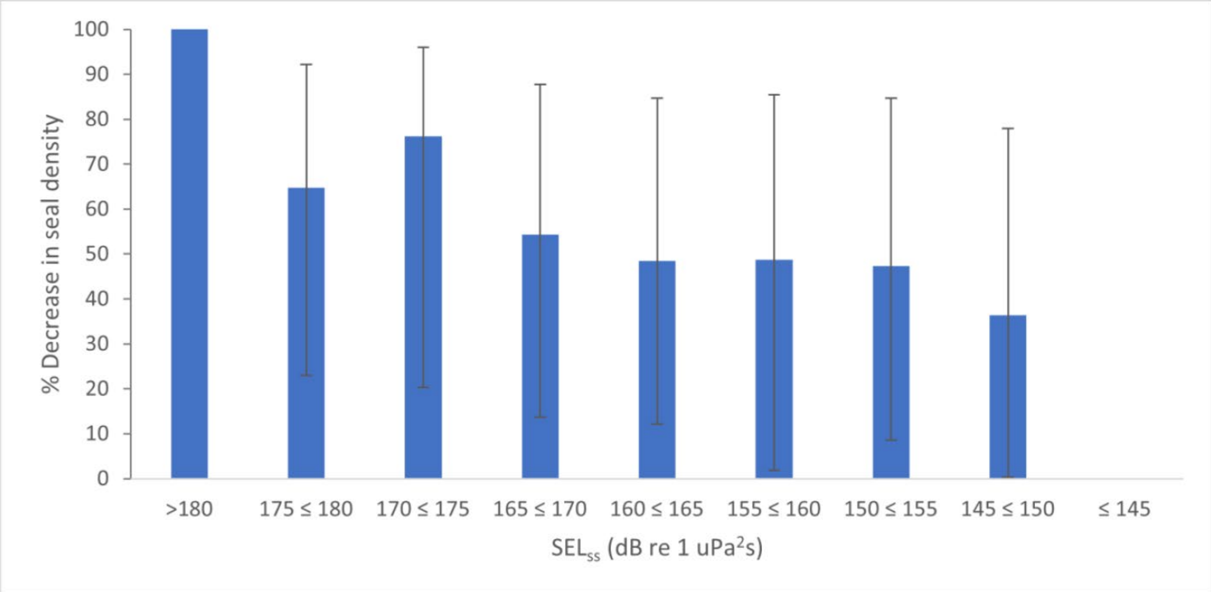


Plate 8-4 Dose-Response Behavioural Disturbance Data for Harbour Seal Derived from the Data Collected and Analysed by Whyte et al. (2020).

477. The estimated numbers (and percentage of the relevant reference populations) of grey seal disturbed as a result of underwater noise during piling are presented in **Table 8-66**.

478. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADDs which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

Table 8-66 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East, DBS West, and the OECC in isolation Based on the Dose-Response Approach

Species	Location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance due to a single, maximum energy monopile strike (SEL$_{SS}$)			
Grey seal	DBS East	48.6 (0.31% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	279.0 (1.8% of the Humber Estuary SAC)	
	OECC	647.2 (4.1% of the Humber Estuary SAC)	

8.3.6.3.2.1.1 Population modelling

479. Population modelling using the Interim Population Consequence of disturbance (iPCoD) has been undertaken to determine the population consequences of disturbance to the grey seal Humber Estuary SAC population due to piling at DBS East and DBS West. As a worst case, the modelling parameters included piling at DBS East over two years, followed by piling at DBS West for two years and with one piling event in the Offshore Export Cable Corridor within the four years. This project scenario, piling at each Project sequentially was the worst case as it resulted in the most disturbance days compared to DBS East and DBS West being constructed together. For more information on the population modelling, an introduction and methodology, and the parameters used, see **Volume 7**, **Appendix 11-4 (application ref: 7.11.11.4)**.

480. If the results showed that there was a consequence of disturbance to the population using the worst case scenario, other project scenarios would have been modelled.

481. While an assessment under the dose response curve approach is considered to be most realistic for seals, population modelling has been undertaken to determine whether the number of animals disturbed will cause a population level effect.

482. If, as a result of noise impacts, a population shows a continued decline of more than 1% per year (versus a modelled unimpacted reference population) over a 6 year period following first disturbance, there is a high likelihood that a significant effect cannot be ruled out (NRW, 2023). This approach has been used to determine whether these results identify a significant effect or not.

483. The population modelling for grey seal is based on:

- A worst case of up to 1,814.4 grey seal disturbed;
  - Based on the EDR (106 at DBS East, and 1,429.4 individuals in the Offshore Export Cable Corridor) (**Table 8-65**).
  - Based on the dose response curve for 279.0 individuals at DBS West
- Up to 16 individuals could at risk of PTS at DBS East, DBS West and the Offshore Export Cable Corridor (combined total from all three locations; **Table 8-62,** where DBS East and DBS West are constructed in isolation, or sequentially); and
- The above numbers of grey seal are being at risk of impact for every piling day with a piling schedule of 4 years.

484. For the Humber Estuary SAC population, by the end of 2032 (2 years after piling ends), the median population size for the impacted population is predicted to be 100% of the unimpacted population. Beyond 2034, the impacted population remains stable as far as 2052 which is the end point of the modelling **(Table 8-67**).

Table 8-67 Results of the iPCoD modelling for DBS East, DBS West and Offshore Export Cable Corridor sequentially scenario, giving the mean population size of grey seal population (Humber SAC population) for years up to 2052 for both impacted and un-impacted population

Time period	Un-impacted pop mean	Impacted pop mean	Median impacted as % of unimpacted
Start	15,495	15,495	100.00%
End 2028	15,613	15,613	100.00%
End 2029	15,689	15,688	99.99%
End 2032	16,033	16,034	100.00%
End 2037	16,538	16,540	100.01%
End 2047	17,668	17,671	100.01%
End 2052	18,225	18,228	100.01%

485. **Plate 8-5** shows the mean unimpacted and the mean impacted population of grey seal within the Humber Estuary SAC population. The graph shows that with piling at DBS East, DBS West and the Offshore Export Cable Corridor, there is no significant impact on the population of grey seal. Therefore, the impact on the population is assessed as having no adverse effect on site integrity.

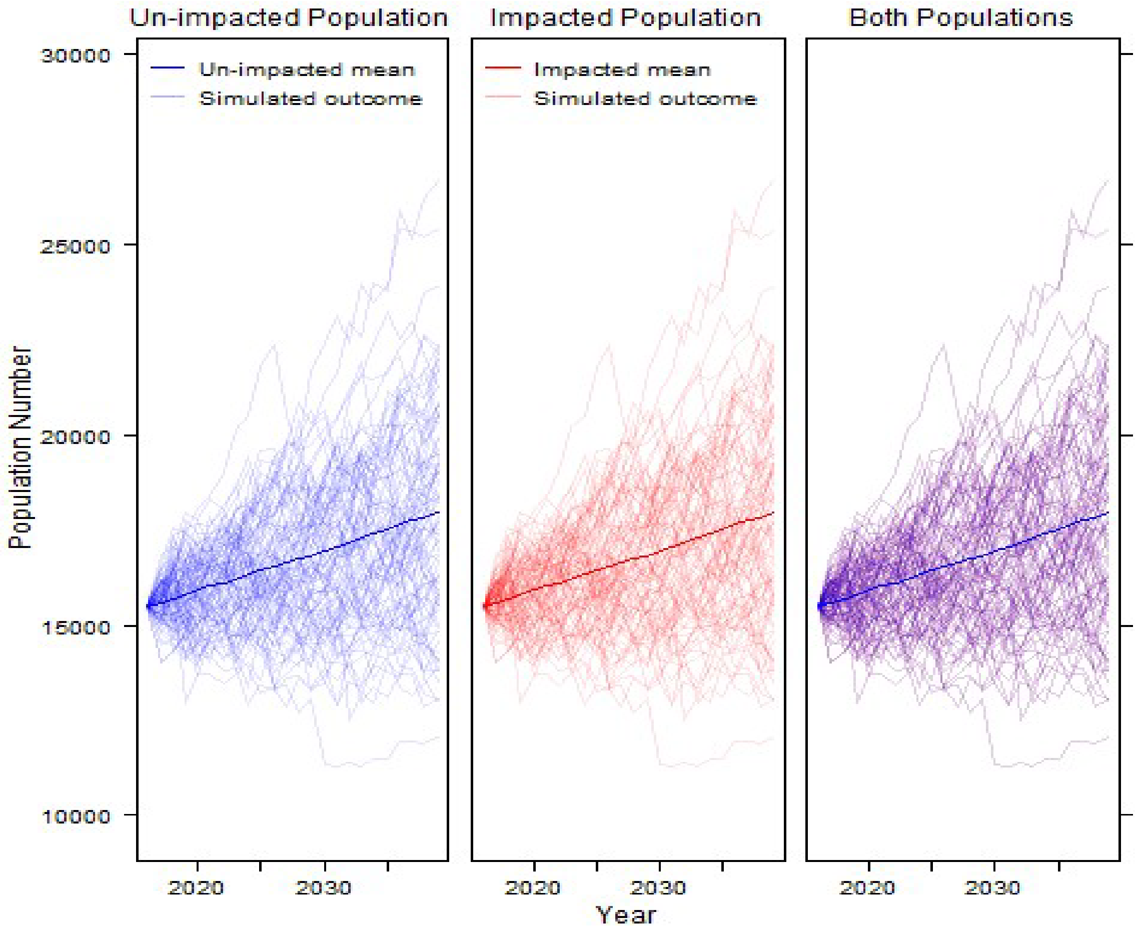


Plate 8-5 Simulated worst case grey seal population sizes (Humber SAC population) for both the unimpacted and the impacted populations

8.3.6.3.2.1.2 Potential disturbance from ADD activation

486. The estimated numbers (and percentage of the relevant reference populations) of grey seal disturbed as a result of underwater noise during piling after ADD duration of 80 minutes is presented in **Table 8-68**.

Table 8-68 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles or Jacket Pin Piles at DBS East or DBS West in isolation

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes as required for monopiles at DBS East, DBS West & Offshore Export Cable Corridor, and jacket pin piles at DBS East, and Offshore Export Cable Corridor			
Grey seal	DBS East	8.8 (0.56% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	14.5 (0.09% of the Humber Estuary SAC)	
	OECC	118.6 (0.76% of the Humber Estuary SAC)	

487. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in isolation.**

8.3.6.3.2.2 Assessment of potential effects of the Projects together

488. The EDR of 25km (Russell, 2016) has been used to determine the number of grey seal that may be disturbed during piling at DBS East and DBS West together based on two monopiles being installed at any one time (or a disturbance area of 3,927km^2) applying the worst case density (average site density for the Offshore Development Area), and for installation of four consecutive pin-piles installed at DBS East, DBS West and the Offshore Export Cable Corridor (with a total disturbance area of 2,120.58km^2) based on the sum of the effect at each location as the worst case (**Table 8-69**).

Table 8-69 Assessment of the Potential for Disturbance to Grey Seal and Harbour Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East and DBS West Together

Potential disturbance range and area	Location	Assessment of effect	Potential adverse effect on site integrity
Monopiles at two concurrent locations (EDR – 25km, with a disturbance area of 3,927km^2)	Offshore Development Area	691.7 (4.5% of Humber Estuary SAC)	**No** Less than 5% of the population affected
Jacket pin piles at three concurrent locations (EDR – 15km, with a disturbance area of 2,120.58km^2)	DBS East, West and OECC	615.7 (3.98% of Humber Estuary SAC)	**No** Less than 5% of the population affected

489. A dose response curve assessment as also be applied to assess the potential disturbance to grey seal in the Humber Estuary SAC as the most realistic approach to assessment. The estimated numbers (and percentage of the relevant reference populations) of grey seal disturbed as a result of underwater noise during piling are presented in **Table 8-70**.

490. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADDs which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

491. The results presented in **Table 8-70** indicate there is the no adverse effect for the installation of two monopiles at DBS East and DBS West together. To provide further evidence to support this, population modelling was undertaken to determine that there would be no effect to the Humber Estuary SAC grey seal population

Table 8-70 Number of Individuals (and % of Reference Population) That Could be Disturbed During Piling at DBS East and DBS West Together Based on the Dose-Response Approach

Species	Project location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance at maximum energy monopile strike (SEL_{SS}) at two locations (DBS East and DBS West together)			
Grey seal	DBS East and DBS West	327.6 (2.11% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	Two piles at DBS West (as worst case)	558.0 (3.6% of the Humber Estuary SAC)	

8.3.6.3.2.2.1 Population modelling

492. The population modelling in section 8.3.6.3.2.1.1, the Projects worst case scenario was used, which is the installation of monopiles at DBS East, followed by DBS West, plus the Offshore Export Cable Corridor installed sequentially over a four year period, as this scenario resulted in the most disturbance days. The parameters are described in **Volume 7**, **Appendix 11-4 (application ref: 7.11.11.4)** and 104 days of piling was modelling for DBS East over a two year period, followed by DBS West (104 monopiles over two years) and randomly one monopile in the Offshore Export Cable Corridor. By covering the worst case project scenario, the results of the population modelling would be the same of less significant than what is presented in 8.3.6.3.2.1.1.

493. Therefore, there is no significant impact on the Humber Estuary SAC population of grey seal. Therefore, the impact on the population is assessed as having no adverse effect on site integrity as stated in section 8.3.6.3.2.1.1 (**Table 8-68** and **Plate 8-5**).

8.3.6.3.2.2.2 Potential disturbance from ADD activation.

494. The estimated numbers (and percentage of the relevant reference populations) of grey seal disturbed as a result of underwater noise during piling after ADD duration of 160 minutes for monopiles **Table 8-71**.

Table 8-71 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles or Jacket Pin Piles at DBS East or DBS West together

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes (160 minutes) as required for two monopiles at DBS East and DBS West			
Grey seal	DBS East	17.6 (0.11% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	29.0 (0.18% of the Humber Estuary SAC)	
	DBS East and DBS West together	23.3 (0.15% of the Humber Estuary SAC)	

495. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in together.**

8.3.6.3.3 Impact 3a: Auditory injury from underwater noise during other construction activities

496. Potential sources of underwater noise during construction activities, other than piling, include seabed preparation, dredging, rock placement, trenching and cable installation.

497. Dredging / cable installation activities have the potential to generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals. Reviews of published sources of underwater noise during dredging activity (Theobald *et al.* 2011; Thomsen *et al.* 2006; Todd *et al.* 2015), indicate that the sound levels that grey seals may be exposed to during dredging activities are typically below permanent auditory injury thresholds (PTS) exposure criteria (as defined in Southall *et al.* 2019). Therefore, the potential risk of any auditory injury in marine mammals as a result of dredging activity is highly unlikely.

498. The noise levels produced by dredging activity / cable installation, could overlap with the hearing sensitives and communication frequencies used by marine mammals (Todd *et al.* 2015), and therefore have the potential to impact grey seals present in the area. For information on the approach to the assessment, see section 8.3.5.2.3.

499. The potential for PTS / TTS effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, not consistent throughout the offshore construction period for the Projects and would be limited to only part of the overall construction period and area at any one time.

500. TTS ranges for seals are presented in **Table 8-72.**

Table 8-72 Predicted impact ranges (and areas) for Auditory Injury from 24 hour cumulative exposure during other construction activities

Criteria and threshold (Southall *et al.* 2019)	**Cable laying**	**Dredging (backhoe and suction (individually))**	**Trenching**	**Rock placement**	**All activities**
SEL_{cum} Weighted (153 dB re 1 μPa²s) Non-impulsive	0.1km (0.03 km²)	<0.1km (<0.03 km²)	<0.1km (<0.03 km²)	<0.1km (<0.03 km²)	0.12 km²

501. The assessment for impacts from underwater noise resulting from other construction activities is shown in **Table 8-73**.

8.3.6.3.3.1 Assessment of potential effects of the Projects alone

502. The number of grey seal that could be impacted as a result of underwater noise during construction activities other than piling is presented in **Table 8-73** has been assessed based on the number of animals that could be present in each of the modelled impact ranges (**Table 8-72**).

Table 8-73 Maximum Number of Individuals (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities, Based on Underwater Noise Modelling for Each Individual Activity and For All Activities at the Same Time at DBS East or DBS West

Species	Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
PTS/TTS for each individual activity				
Grey seal	Cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.002 (0.00001% of Humber Estuary SAC)	**No** Less than 1% of the population affected
		DBS West	0.003 (0.00002% of Humber Estuary SAC)	
		OECC	0.02 (0.00014% of Humber Estuary SAC)	
PTS/TTS for all activities at the same time (4 activities)				
Grey seal	Cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.007 (0.00004% of Humber Estuary SAC)	**No** Less than 1% of the population affected
		DBS West	0.01 (0.00006% of Humber Estuary SAC)	
		OECC	0.08 (0.0005% of Humber Estuary SAC)	

503. The population affected by auditory injury during other construction activities from underwater noise at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury from increased underwater noise during other construction for the Projects in isolation.**

8.3.6.3.3.2 Assessment of potential effects of the Projects together

504. The potential for auditory injury effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, not consistent throughout the offshore construction period for the Projects and would be limited to only part of the overall construction period and area at any one time.

505. The assessment for impacts from underwater noise resulting from other construction activities for DBS East and DBS West is shown in **Table 8-74.**

506. The population affected by auditory injury during other construction activities from underwater noise at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury from increased underwater noise during other construction for the Projects together.**

Table 8-74 Maximum Number of Individuals (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities, Based on Underwater Noise Modelling for All Activities at DBS East and DBS West

Species	Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
PTS/TTS for all activities at the same time (8 activities)				
Grey seal	Cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.01 (0.00008% of Humber Estuary SAC)	**No** Less than 1% of the population affected
		DBS West	0.02 (0.0001% of Humber Estuary SAC)	
		OECC	0.2 (0.001% of Humber Estuary SAC)	

8.3.6.3.4 Impact 3b: Disturbance from underwater noise during other construction activities

507. Underwater noise as a result of dredging activity / cable installation has the potential to disturb marine mammals (Pirotta *et al.* 2014). Therefore, there is the potential for short, perhaps medium-term behavioural reactions and disturbance to grey seal in the area during dredging / cable installation activity. Grey seals may exhibit varying behavioural reactions intensities as a result of exposure to noise (Southall *et al.* 2008).

508. Grey seals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

509. If the response is displacement from the area, it is predicted that grey seals will return once the activity has been completed and therefore any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance effect on grey seal.

510. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources). A review of various studies was used to determine the maximum potential disturbance range for other construction activities and vessels. As discussed in section 8.3.5.2.4 Benhemma-Le Gall *et al.* (2021), reported a 4km (50.3km^2) reduction in harbour porpoise presence for other construction activities, including vessels. As harbour porpoise are the most sensitive marine mammal species, this 4km potential disturbance range has been used for grey seal as a worst case, in the absence of any other data to inform an assessment.

8.3.6.3.4.1 Assessment of potential effects of the Projects alone

511. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range is presented in **Table 8-75** for one activity occurring or four activities happening at the same time.

Table 8-75 Assessment of the potential for disturbance due to other construction activities, including cable laying, suction dredging, cable trenching, and rock placement, for one activity taking place at any one time at DBS East of DBS West

Species	Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Disturbance for each individual activity				
Grey seal	- Cable laying - Trenching - Rock placement - Dredging	DBS East	2.71 (0.018% of Humber Estuary SAC)	**No** Less than 5% of the population affected
		DBS West	4.47 (0.029% of Humber Estuary SAC)	
		OECC	36.59 (0.24% of Humber Estuary SAC)	
Disturbance for 4 activities at the same time at DBS East or DBS West				
Grey seal	- Cable laying - Trenching - Rock placement - Dredging	DBS East	10.9 (0.07% of Humber Estuary SAC)	**No** Less than 5% of the population affected
		DBS West	17.9 (0.11% of Humber Estuary SAC)	
		OECC	146.4 (0.94% of Humber Estuary SAC)	

512. The population disturbed during other construction activities from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise during other construction for the Projects in isolation.**

8.3.6.3.4.2 Assessment of potential effects of the Projects together

513. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range is presented in **Table 8-76** with eight activities occurring at the same time across the Projects.

Table 8-76 Assessment of the potential for disturbance due to other construction activities, including cable laying, suction dredging, cable trenching, and rock placement, for all activities taking place at any one time at DBS East and DBS West

Species	Potential Impact	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Disturbance for 8 activities at the same time at DBS East and DBS West				
Grey seal	- Cable laying - Trenching - Rock placement - Dredging	DBS East	21.71 (0.14% of Humber Estuary SAC)	**No** Less than 5% of the population affected
		DBS West	35.79 (0.23% of Humber Estuary SAC)	
		OECC	292.75 (1.89% of Humber Estuary SAC)	

514. The population disturbed during other construction activities from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise during other construction for the Projects together.**

8.3.6.3.5 Impact 4a: Auditory injury from Underwater Noise due to the Presence of Vessels

515. During construction, there is the potential for up to 32 vessels to on either DBS East or DBS West in isolation, with up to six of those being within the OECC. For the construction of DBS East and DBS West together, there is the potential to be up to 59 vessels at any one time, 12 of which being within the OECC.

516. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the Array Areas and OECC.

517. Noise measurements indicate that the most intense sound emissions from a cargo ship are typically low frequencies, up to and including 1kHz (Robinson *et al.* 2011) travelling at modest speed (between 8 and 16 knots) (Theobald *et al.* 2011). Underwater noise from construction vessels of a similar size also has the potential to disturb marine mammals in the short-term, in areas of increased vessel traffic, but are unlikely to produce any permanent auditory injury (PTS) (Pirotta *et al.* 2014).

518. The vessels will be slow moving (or stationary), and most noise emitted is likely to be of a lower frequency. Noise levels reported by Malme *et al.* (1989) and Richardson *et al.* (1999) for transiting large surface vessels indicate that physiological damage to auditory sensitive marine mammals is unlikely. The potential risk of PTS in marine mammals as a result of vessel activity is highly unlikely, as the sound levels that are produced by vessels is well below the threshold for permanent injury (Southall *et al.* 2019). Trigg *et al.* (2020) found the predicted exposure of grey seals to shipping noise did not exceed thresholds for TTS.

519. Underwater noise modelling was undertaken by SubAcoustech estimate the noise levels due to vessel presence (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) and determine the potential effects on grey seal.

8.3.6.3.5.1 Assessment of potential effects of the Projects alone

520. Impact ranges for PTS and TTS for large and medium vessels for grey seal are less than 100m (<0.03km^2; see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

521. The potential effect of auditory injury (without any mitigation) that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Projects and would be limited to only part of the overall construction period and location at any one time.

522. The assessment of the potential impact for any PTS / TTS as a result of construction vessels, for either one vessel, or up to 32 vessels (32 in the Projects Array Areas, and six in the OECC), shows less than 1% of the reference populations exposed to any temporary impact (**Table 8-77**).

Table 8-77 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East, DBS West or OECC in isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
For one vessel			
Grey seal	DBS East	0.002 (0.00001% of the Humber Estuary SAC)	**No** Less than 1% of the population affected
	DBS West	0.003 (0.00002% of the Humber Estuary SAC)	
	OECC	0.022 (0.0001% of the Humber Estuary SAC)	
For up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the OECC]			
Grey seal	DBS East	0.052 (0.0003% of the Humber Estuary SAC)	**No** Less than 1% of the population affected
	DBS West	0.085 (0.0006% of the Humber Estuary SAC)	
	OECC	0.13 (0.0008% of the Humber Estuary SAC)	

523. The population affected from underwater noise (PTS / TTS) due to the presence of vessels at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation.**

8.3.6.3.5.2 Assessment of potential effects of the Projects together

524. The number of marine mammals that could be impacted as a result of underwater noise from construction vessels has been assessed based on the number of animals that could be present in each of the modelled impact ranges applied to the number of vessels that could be on site at any one time. This assessment is based on the worst case density estimate across the Projects' areas.

525. The potential impact for any auditory injury as a result of construction vessels, for up to 59 vessels in the Offshore Development Area (47 in the Array Areas, and 12 in the OECC), shows less than 1% of the reference population in relation to grey seal as exposed to any temporary impact (**Table 8-78**).

526. The potential for auditory injury effects that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period and would be limited to only part of the overall construction period and location at any one time.

Table 8-78 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of PTS/TTS as a Result of Underwater Noise Associated with Construction Vessels at DBS East, DBS West and OECC Together

Species	Location	Maximum number of individuals (% of reference population) for up to 59 vessels	Potential adverse effect on site integrity
Grey seal	DBS East	0.096 (0.0006% of the Humber Estuary SAC)	**No** Less than 1% of the population affected
	DBS West	0.16 (0.001% of the Humber Estuary SAC)	
	OECC	0.26 (0.002% of the Humber Estuary SAC)	

527. The population affected from underwater noise (auditory injury) due to the presence of vessels at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal from increased underwater noise (auditory injury) due to the presence of vessels for the Projects together.**

8.3.6.3.6 *Impact 4b: Disturbance from Underwater Noise due to the Presence of Vessels*

528. Seals vary in their reaction to vessels depending on vessel type and proximity to haul out sites; however, disturbance (flushing behaviour) has been demonstrated at haul-out sites in the UK up to 200m away if there are pups present (Cates and Acevedo-Gutiérrez, 2017). Land-based disturbance has been shown to cause higher levels of disturbance compared to marine sources, and smaller, quiet vessels like kayaks can cause the highest levels of flushing behaviour (Bonner, 2022). In areas of high vessel traffic, there are habituation effects and disturbance behaviour is generally reduced (Powell Strong and Morris, 2010).

529. Construction vessel activity may generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals. Whilst the main focus of concern remains on the loudest noise sources such as impact piling, dredging, etc., intense vessel activity during construction may also alter the acoustic habitat and disturb marine mammal species (Merchant *et al.* 2014). During the periods when piling is underway, vessel noise is unlikely to add an additional impact to those assessed for piling, as the vessels and vessel noise would be within the maximum impact areas assessed.

530. Jones *et al.* (2017) produced usage maps characterising densities of grey and harbour seals and ships around the British Isles, which were used to produce risk maps of seal co-occurrence with shipping traffic. The analysis indicates that rates of co-occurrence were highest within 50km of the coast, close to seal haul-outs. When considering exposure to shipping traffic in isolation, the study found no evidence relating to declining seal population trajectories with high levels of co-occurrence between seals and vessels. If the response is displacement from the area, it is predicted that seals will return once the activity has been completed and therefore any effects from underwater noise as a result of construction activities, other than piling, will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant disturbance for seals.

531. There is limited data on the potential for a behavioural response or disturbance from vessel noise. Studies by Brandt *et al.* (2018) and Benhemma-Le Gall *et al.* (2021) that found that harbour porpoise could be disturbed up to 2km from construction vessels. As a precautionary approach assessment for grey seal has been based on a disturbance impact range of 4km (50.26km^2); which has been applied to all marine mammal species.

8.3.6.3.6.1 Assessment of potential effects of the Projects alone

532. To assess for vessel disturbance in the Array Areas, with a maximum number of 32 vessels, a 4km buffer has been added around each Array Area. For DBS East Array Area, the impact area is 696.01km^2 and for DBS West Array the impact area is 708.90km^2 (**Table 8-29**; **Plate 8-3**; section 8.3.5.2.6).

533. This accounts for the maximum of 26 vessels in each Array Area at any one time, therefore accounting for the overlap in disturbance areas for 26 vessels present in each Array Area (as shown on **Plate 8-3**).

534. To assess for vessel disturbance in the OECC, there will be a maximum of six vessels at one time. Therefore, a 4km impact range has been added per vessel. For six vessels, the total effect range for the potential of disturbance from vessel activity is 301.56km^2.

535. The potential impact on grey seals of disturbance from vessels in isolation is assessed in **Table 8-79**.

Table 8-79 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
For one vessel			
Grey seal	DBS East	2.714 (0.018% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	4.473 (0.029% of the Humber Estuary SAC)	
	OECC	36.593 (0.24% of the Humber Estuary SAC)	
For up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the OECC]			
Grey seal	DBS East	37.6 (0.242% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	63.1 (0.407% of the Humber Estuary SAC)	
	OECC	219.6 (1.42% of the Humber Estuary SAC)	

536. The potential for the Humber Estuary SAC population to be affected by disturbance from underwater noise due to the presence of vessels at DBS East, DBS West and the OECC is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation.**

537. Vessels transiting to and from the Offshore Development Area can also cause disturbance. Table 11-73 within **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** presents a list of port options that will be used during construction. As a worst-case, the assessment of vessel disturbance during transit from DBS West to Lowestoft is used as that is the greatest distance.

538. Table 11-74 within **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** provides the impact range used for the assessment. The assessment has been carried out on a single vessel with a 4km disturbance range across the distance. The total number of transits for DBS East or DBS West is 3,857 during the five-year construction period, this equates to 772 transits per year, or three vessels per 24 hour period.

539. **Table 8-80** presents the number of individuals that could be temporarily disturbed by the vessel transits, for the area of potential disturbance due to vessels transiting from DBS West to Lowestoft, assuming that any vessel transit results in 24 hours of deterrence from the area as a worst-case. These assessments are based on the worst case density across the Array Areas and the Offshore Development Area. The impact range has been calculated using a 4km buffer around the moving vessel during transit which results in an estimated 1,200km^2 impact area of disturbance.

Table 8-80 Maximum Number of Individuals (and % of Reference Population) that Could Be Disturbed as a Result of Underwater Noise Associated with transiting vessels during construction

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Grey seal	DBS East	64.8 (0.418% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	106.8 (0.689% of the Humber Estuary SAC)	
	Offshore Development Area	211.4 (1.36% of the Humber Estuary SAC)	

540. With less than 5% of the Humber Estuary population temporarily disturbed due to a vessel transiting, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation.**

8.3.6.3.6.2 Assessment of potential effects of the Projects together

541. The maximum number of construction vessels on site at any one time will be up to 59 vessels, with 12 of those vessels being within the OECC. This would equate to up to 47 vessels across the Array Areas at any one time. Therefore, the same approach as outlined for DBS East or DBS West in isolation has been taken; with the assessment of vessel disturbance within the Array Areas being based on each Array Area with 4km buffer.

542. To assess for potential disturbance of the vessels, the number of individuals from DBS East or DBS West in isolation, with 12 vessels within the OECC, has been combined to provide an overall total for the Projects together. This assessment is therefore based on the total area 1,404.910km^2 for the Array Areas, and 603.19km^2 for the OECC (**Table 8-81**).

Table 8-81 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West together

Species	Location	Maximum number of individuals (% of reference population) potentially disturbed from 47 vessels within the Array Areas, and 12 in the Offshore Export Cable Corridor	Potential adverse effect on site integrity
Grey seal	DBS East	75.9 (0.49% of the Humber Estuary SAC)	**No** Less than 5% of the population affected
	DBS West	125.0 (0.81% of the Humber Estuary SAC)	
	OECC	439.1 (2.83% of the Humber Estuary SAC)	

543. The number of vessels that are planned to transit if DBS East and DBS West are constructed together is 7,510 which totals an average of 1,502 vessels per year during a worst case five-year construction period. Therefore, the maximum number of vessels that will be transiting per a 24 hour periods is six. As stated within section 11.6.1.4.3.2 in the **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, it is very unlikely for construction vessels to be transiting together. As the vessel transit assessment for DBS East or DBS West in isolation utilises a disturbance area of the full transit route plus 4km buffer, rather than the number of vessels present within that transit route, the assessment for the Projects together would be the same as DBS East or DBS West in isolation as presented in **Table 8-80**.

544. Therefore, with less than 5% of the Humber Estuary population temporarily disturbed due to a vessel transiting, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects together**.

8.3.6.3.7 Impact 5: Barrier Effects as A Result of Underwater Noise During Construction

8.3.6.3.7.1 Assessment of potential effects of the Projects alone

545. Underwater noise during construction could have the potential to create a barrier effect, preventing movement or migration of grey seals between important feeding and / or breeding areas, or potentially increasing swimming distances if marine mammals avoid the site and go around it. However, the DBS Array Areas are not located on any known migration routes for grey seals.

546. DBS East Array Area is located 122km from the coast at closest point and DBS West Array Area 100km from land at closest point. The nearest seal haul-out site is at Filey Brigg, approximately 28km from landfall at its closest point. The haul-out site is 106km from DBS East and 132km from DBS West.

547. The greatest potential barrier effect for grey seal could be from underwater noise during piling. Piling would not be constant during the piling phases and construction periods. Taking into account the distance of the Array Areas from the coast and from grey seal haul-out sites, there is no potential for underwater noise at the windfarm site to result in barrier effects to seals moving to and from haul-out sites.

548. However grey seals have foraging ranges of up to 448km (Carter *et al*. 2022), with foraging trips lasting up to 30 days (SCOS, 2021). Although grey seal can be affected when travelling to foraging areas, and underwater noise could potentially cause a barrier effect to foraging, however prey consumption on a daily basis is not vital for energy demands, as mature seals do undergo a period of starvation during the breeding seals, where the loose up to 40% of their body weight, however they do spend a lot of the time resting (Sparling, 2003) Therefore, if there are any potential barrier effects from underwater noise, grey seals would be able to compensate by travelling to other foraging areas within their range.

549. However, barrier effects from underwater noise could provide a barrier for foraging to females who are locating as this is considered the more energetically expensive period for females (Mellish *et al*. 2000), and if they can't meet the energy demands, it can cause devastating effects to the female and her pup. Due to the fact that piling will occur over 100km away, it is unlikely lactating females will travel that far, so there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of grey seal.

550. Any disturbance and any barrier effects would be temporary and for a relatively short duration (i.e. during active piling).

551. As it is predicted that grey seals will return once the activity has been completed, and therefore any effects from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of grey seal.

552. Therefore, there would be no significant disturbance of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential barrier effects from increased underwater noise during construction of the Projects in isolation**.

8.3.6.3.7.2 Assessment of potential effects of the Projects together

553. See section 8.3.6.3.7.1.

554. There would be no significant disturbance of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential barrier effects from increased underwater noise during construction of the Projects together**.

8.3.6.3.8 Impact 6: Increased Collision Risk with Vessels During Construction

555. During offshore construction, there will be an increase in vessel traffic within the DBS Array Areas and OECC. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area.

556. Seals in and around the Offshore Development Area and in the wider southern North Sea would typically be habituated to the presence of vessels (given the existing levels of marine traffic, see **Volume 7, Chapter 14 Shipping and Navigation** (**application ref: 7.14)**).

557. Seals are able to detect and avoid vessels. However, vessel strikes are known to occur, possibly due to distraction whilst foraging and socially interacting, or due to the marine mammals' inquisitive nature (Wilson *et al.* 2007). Therefore, increased vessel movements, especially those outside recognised vessel routes, can pose an increased risk of vessel collision to marine mammals. Studies have shown that larger vessels are more likely to cause the most severe or lethal injuries, with vessels over 80m in length causing the most damage to marine mammals (Laist *et al.* 2001). Vessels travelling at high speeds are considered to be more likely to collide with marine mammals, and those travelling at speeds below 10 knots would rarely cause any serious injury (Laist *et al.* 2001).

8.3.6.3.8.1 Assessment of potential effects of the Projects alone

558. There is currently limited information on the collision risk of marine mammals in the southern North Sea. To estimate the potential collision risk of vessels associated with the Offshore Development Area during construction, the potential risk rate per vessel has been calculated for grey seal, which is then used to calculate the total risk to grey seals due to the presence of an additional 32 vessels at any one time during construction (See **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, section 11.6.1.6).

559. The collision risk has been estimated by using data from the CSIP, SMASS and the data from the Cornwall Wildlife Trust (CWT).

560. The total from the records of all grey seal strandings in the UK is 2,987 strandings of grey seal, four of which recorded as probable impact from vessels. This results in a collision risk of 0.045 which has been used for the assessment in **Table 8-83**.

Table 8-82 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collisions with Vessels

Species	Number of strandings	Number of post-mortems where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from vessels	Collision risk rate (%) (number attributed to vessels strike / other physical trauma as proportion of total known cause of death)
Grey seal	2987	577	22	4	0.0451

561. To inform this assessment, the total number of grey seals in the Humber Estuary SAC has been compared against the total vessels present in UK waters, as well as the potential collision risk rate of each species. The total SAC populations for seal species are taken from SCOS (2022). The total presence of vessels in UK waters is taken from the total vessel transits within the 2015 Automatic identification system (AIS) data, which is the latest publicly available.

562. The assessment in **Table 8-83** is based on the number of vessel movements has been based on the estimated 3,857 return vessel trips during the five year construction period for either Project, an average of 772 per year (or 1,502 transits for the Projects together) for either DBS East or DBS West in isolation (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

563. **Table 8-83** predicts that up to two individual grey seal may be at risk of collision (0.009% of the Humber Estuary SAC population). This is a highly precautionary assumption, as it is unlikely that marine mammals in the Offshore Development Area would be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number of vessel movements in the area, and that vessels within the Offshore Development Area would be stationary for much of the time or very slow moving.

564. In addition, vessel movements, where practicable, will be incorporated into recognised vessel routes and hence to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. Vessel operators will use best practice to reduce any risk of collisions with marine mammals, such as reducing the speed of vessel transits wherever possible.

565. Therefore, there would be minimal increase to collision risk of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential vessel collision risk during construction for the Projects in isolation.**

Table 8-83 Predicted Number of Grey seal at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (AEoI Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West in Isolation and together

	DBS East or DBS West in Isolation	DBS East or DBS West together
Collision risk rate[13]	0.0451	
Estimated total number of individuals in UK waters[14]	162,000	
Estimated number of individuals at risk within UK waters	7,300	
Annual number of vessel transits in UK and RoI for 2015[15]	3,852,030	

[13] Where species specific data is not available, the species group data is used
(SCOS, 2022) UK population estimates for seal species
[15] Latest publicly available data

	DBS East or DBS West in Isolation	DBS East or DBS West together
Number of marine mammals at risk of collision per vessel in UK waters	0.002	
Number annual vessel transits associated with construction	772	1,502
Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	Up to 2 per year (1.5)	Up to 3 per year
% reference population	0.009% of the Humber Estuary SAC	0.02% of the Humber Estuary SAC
Potential adverse effect on site integrity	**No** – Less than 1% of population affected	**No** – Less than 1% of population affected

8.3.6.3.8.2 Assessment of potential effects of the Projects together

566. As a precautionary worst case the number of marine mammals that could be at increased risk of collision with construction vessels, if DBS East and DBS West are constructed concurrently has been based on the estimated maximum number of construction vessels for the Offshore Development Area is up to 59 (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

567. To estimate the potential collision risk of vessels associated with the Projects during construction together, the same method has been used described in section 8.3.6.3.8.1.

568. The increased number of vessel movements has been based on the estimated average of 1,502 return vessel trips per year (or 7,510 transits) during the five year construction period (as a worst-case) for DBS East and DBS West together (**Table 8-83**); (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. **Table 8-83** predicts that up to three grey seal may be at risk of collision (0.02% of the Humber Estuary SAC population). This is a highly precautionary assumption, as it is unlikely that marine mammals in the Offshore Development Area would be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number of vessel movements in the area, and that vessels within the Offshore Development Area would be stationary for much of the time or very slow moving.

569. As stated, above vessel movements, where practicable, will be incorporated into recognised vessel routes and hence to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. Vessel operators will use best practice to reduce any risk of collisions with marine mammals, such as reducing the speed of vessel transits wherever possible.

570. Therefore, there would be minimal increase to collision risk of grey seal and **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential vessel collision risk during construction for the Projects together.**

8.3.6.3.9 Impact 7: Changes to Prey Resources

571. The potential effects on prey species during construction can result from:

- Physical seabed disturbance;
- Increased SSC and sediment re-deposition;
- Remobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Changes in fishing activity.

572. As discussed in the harbour porpoise section (section 8.3.5.2.9), **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. Any reductions in prey availability would be small scale, localised and temporary. It is considered highly unlikely that potential reductions in prey availability as a result of construction activities at the Projects would result in detectable changes to grey seal populations.

573. Grey seal feed on a variety of prey species and are considered to be opportunistic feeders, feeding on a wide range of prey species and they have relatively large foraging ranges (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

574. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment, underwater noise and vibration and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there will be **no adverse effect on the integrity of The Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential changes in prey availability during construction for the Projects in isolation or together**.

8.3.6.3.10 Impact 8: Disturbance at seal haul-out sites

575. The Humber Estuary SAC is located, at closest point, 132km from DBS East Array Area, 143km from DBS West Array Area and 50km from the OECC. The main grey seal haul out site is Donna Nook which is 62km from landfall, 65km from the OECC, 153km from DBS East Array Area and 151km from DBS West Array Area at closest distance. The closest seal haul-out site is Filey Brigg which is 28km from landfall, 25km from the OECC, 106km from DBS East and 132km from DBS West. Therefore, there would be no effects from construction activities within the Offshore Development Area, only effects from vessels transiting to and from the Offshore Development Area.

576. Grey seal response to vessels have been reported in several studies. Movement into the water was generally observed to occur at distances of between 20 and 70m, with no detectable disturbance at 150m (Strong and Morris, 2010; Wilson, 2014). However, grey seal has been reported to move into the water when vessels are at a distance of approximately 200m to 300m (Wilson, 2014).

577. Disturbance to seals from vessel noise and presence has been demonstrated at haul-out sites in the UK up to 500m away (Cates and Acevedo-Gutierrez 2017). In a similar study, harbour seals were 25 times more likely to flee into the water when cruise ships passed 100m from haul-out sites than when ships passed within 500m (Jansen et al. 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

578. A study was carried out by Sea Mammal Research Unit (SMRU) (Paterson et al. 2015) using a series of controlled disturbance tests at harbour seal haul-out sites, consisting of regular (every three days) disturbance through direct approaches by vessel and effectively 'chasing' the seals into the water. The seal behaviour was recorded via Global Navigation System (GPS) tags and found that even intense levels of disturbance did not cause seals to abandon their haul-out sites more than would be considered normal (for example seals travelling between sites) and the seals were found to haul-out at nearby sites or to undertake a foraging trip in response to the disturbance (but would later return).

579. Further studies on the effects of vessel disturbance on harbour seals when they are hauled out, suggest that even with repeated disturbance events that are severe enough to cause individuals to flee into the water, the likelihood of harbour seals moving to a different haul-out site would not increase. Furthermore, this appeared to have little effect on their movements and foraging behaviour (Paterson *et al.* 2019).

580. In areas of high vessel traffic, there can be habituation effects and disturbance behaviours are generally reduced over time (Strong *et al.* 2010).

581. Vessel activity, transiting from the Projects to port have the potential to cause disturbance to seal haul-haul out sites. The construction ports to be used for DBS East and DBS West are not yet confirmed. However, a short list has been provided in Table 11-83 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. From the potential port list, Grimsby is approximately 20km from Donna nook which is within the Humber Estuary SAC. This would be the wors case port to use in relation to the Humber Estuary SAC.

582. Vessel movements to and from any of Grimsby port or any other ports will be incorporated within existing vessel routes, where available. If vessels have to transit past Donna Nook, keeping at least 500m away, (taking in research by Cates and Acevedo-Gutierrez 2017). from shore would minimise any disturbance on grey seal but as a precautionary approach and if possible, a greater distance of 1km should be applied.

583. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels.

584. It is expected that if there is any disturbance to seals at haul-out sites from construction activities it is a short-term effect. For example, a 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% pre-disturbance levels four hours after a disturbance event (Paterson *et al.* 2019).

8.3.6.3.10.1 Assessment of potential effects of the Projects alone

585. In total, for the construction of either DBS East or DBS West, up to 3,857 round trips to ports from each Array Area during the construction period, with approximately 722 transits per year during five year construction period for both DBS East and DBS West.

586. As described above, there would only be disturbance if the vessels came within a few hundred metres of a haul out and any effect would be temporary. Taking into account the proximity of shipping channels to and from ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels. Therefore, the effect on grey seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be limited.

587. Therefore, if the vessels committed to keep at least a distance of 500m from the shore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance at seal haul-out sites during construction for the Projects in isolation**.

8.3.6.3.10.2 Assessment of potential effects of the Projects together

588. In total, for the construction of DBS East and DBS West together, up to 7,510 round trips to port from the Offshore Development Area during the construction phase. This represents a slight significant increase in the current number of vessels in the area with 1,502 vessel transits per year.

589. Even with the additional vessel movements, as per the Projects alone case, the effect on grey seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be limited.

590. As describe above if vessels committed to keeping at least 500m from shore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance at seal haul-out sites during construction for the Projects together**.

8.3.6.4 Potential effects during operation and maintenance

591. The potential effects during operation and maintenance that have been assessed for are:

- Auditory injury and disturbance or behavioural impacts resulting from operational WTGs.
- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during maintenance activities, including cable protection and cable reburial;
- Auditory injury and disturbance from the underwater noise associated with the presence of vessels;
- Barrier effects as a result of underwater noise;
- Vessel interaction (collision risk);
- Changes to prey resources; and
- Disturbance to seal haul-outs.

8.3.6.4.1 Impact 1a: Auditory injury due to Operational Wind Turbine Noise

592. The effect of operational wind turbines on marine mammals, including grey seals is described further in section 8.3.5.3.1 and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. Underwater noise modelling was undertaken by Subacoustech to estimate the noise levels likely to arise during the operational phase (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) and determine the potential effects on marine mammals. Key information on the methodology of underwater noise modelling **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**.

8.3.6.4.1.1 Assessment of potential effects of the Projects alone

593. The risk of injury (defined as onset of PTS) as well as the risk of TTS is given as occurring in a range of <100m, a highly precautionary range, and within which the animal would need to stay for a 24 hour period for sufficient noise exposure to result in an effect. Such an occurrence is extremely unlikely and would be atypical behaviour for such a highly mobile species. It should be noted that as the range of risk of onset of TTS is also <100m, the range of onset of PTS would be well within that limit (although the models are not sensitive enough to enable such differentiation at such close range to source) (**Table 8-84**).

Table 8-84 Predicted Impact Ranges (And Areas) for PTS of TTS from 24 hour Cumulative Exposure of Underwater Noise From Operational Turbines

Species	Impact	Operational wind turbine	Area of impact for up to 100 Wind turbines
Grey seal	PTS or TTS	<0.1km ($0.031km^2$)	$3.1km^2$

594. There is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that the marine mammal would have to remain less than 100m from a turbine for 24 hours in a day (**Table 8-84**). However, as a precautionary approach the number of grey seals that could be at risk of auditory injury has been estimated (**Table 8-85**). As outlined previously this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been rounded up to 100m.

595. As described in section 8.3.5.3.1.1 more than one wind turbine will be operating at the same time, and therefore an assessment of the potential for auditory injury, the worst case would be for a total of 100 operational wind turbines.

596. The potential impact for auditory injury as a result of underwater noise from 100 operational wind turbines at DBS East or DBS West, is not significant for grey seal with less than 1% of the reference populations exposed to any long-term effect (**Table 8-85**).

597. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS / TTS) from increased underwater noise from operational wind turbines at the Projects in isolation**.

Table 8-85 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East and DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Potential adverse effect on site integrity
Grey seal	DBS East	0.002 (0.00001% of Humber Estuary SAC)	**No** Less than 1% of the population at risk of auditory injury.
	DBS West	0.003 (0.00002% of Humber Estuary SAC)	

8.3.6.4.1.2 Assessment of potential effects of the Projects together

598. The predicted impact ranges for auditory injury from 24 hour cumulative exposure of underwater noise from operational turbines is <0.1km and the potential impact area for the 200 operational wind turbines at DBS East and DBS West together is up to 6.28km^2.

599. An assessment of the maximum number of individuals that could be at risk of PTS or TTS, due to the underwater noise associated with all operational wind turbines is presented in **Table 8-86** with less than 1% of the reference populations exposed to any long-term impact.

600. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury (TTS) from increased underwater noise from operational wind turbines at the Projects together.**

Table 8-86 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operational Turbines at DBS East and DBS West Together

Species	**Maximum number of individuals (% of reference population) for 200 wind turbines (*highest density in Projects*)**	**Potential adverse effect on site integrity**
Grey seal	4.57 (0.03% of the Humber Estuary SAC)	**No** Less than 1% of the population at risk of auditory injury.

8.3.6.4.2 Impact 1b: Disturbance due to Operational Wind Turbine Noise

601. Currently available data indicates that there is no lasting disturbance or exclusion of seals around OWF sites during operation (Diederichs *et al.* 2008; Lindeboom *et al.* 2011; Marine Scotland, 2012; McConnell *et al.* 2012; Russell and McConnell, 2014; Scheidat *et al.* 2011; Teilmann *et al.* 2006; Tougaard *et al.* 2009a, 2009b, 2006). Data collected suggests that any behavioural responses for seals may only occur up to a few hundred metres away (McConnell *et al.* 2012; Tougaard *et al.* 2009a).

602. Monitoring studies at Nysted and Rødsand have also indicated that operational activities have had no impact on regional seal populations (McConnell *et al.* 2012; Teilmann *et al.* 2006). Seals have been shown to forage within operational OWFs (Lindeboom *et al.* 2011; Russell and McConnell, 2014), indicating no restriction to movements in operational OWF sites.

603. Modelling of noise effects of operational offshore wind turbines suggest that marine mammals are not considered to be at risk of displacement by operational wind farms (Marmo *et al.* 2013). Marine mammals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

604. Aerial surveys of the adjacent seal haul-out sites conducted in the first few months of operation of the Nysted Wind Farm revealed that seals moved between the haul-out sites with the operating wind turbines having no effect on seal movements (Teilman *et al*. 2004). Seals have been recorded to forage within operating windfarms (Russel *et al*. 2014) indicating there is no or minimal disturbance from operating turbines to grey seal.

605. Based on the available literature for examining disturbance of grey seals and operational wind farms, because the noise levels associated with operational wind turbines are low and continuous, a precautionary low significance of effect has been given to all marine mammal species, including grey seals, for DBS East and / or DBS West in isolation or together.

606. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from operational wind turbine noise at the Projects in isolation or together**.

8.3.6.4.3 Impact 2a: Auditory Injury from Underwater Noise Associated with Operation and Maintenance Activities

607. The requirements for any potential operation and maintenance activities, such as additional rock placement or cable re-burial, are currently unknown, however the work required, and associated effects to grey seal, would be less than those during construction. Section 8.3.5.3.3 provides an assessment for the same activities during construction, concluding that there is no potential for a significant effect for the Projects in isolation or together.

608. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to TTS from underwater noise associated with operation and maintenance activities at the Projects in isolation or together**.

8.3.6.4.4 Impact 2b: Disturbance from Underwater Noise Associated with Operation & Maintenance Activities

609. As a precautionary approach, 4km has been used as a potential disturbance range for maintenance activities and vessels, based on the approach to construction activities (see section 8.3.5.3.4.1).

610. The potential disturbance from maintenance activities occurring at the same time has also been assessed based on maximum impact area of 50.27km^2 for each activity, 201.08km^2 for four activities happening simultaneously (see section 8.3.6.3.2).

611. The potential for disturbance that could result from underwater noise during maintenance activities, including cable laying and protection has the potential to disturb less than 1% of the grey seal population at the Humber Estuary SAC (see section 8.3.6.3.4.1). For up to eight activities occurring at the same time in the Offshore Development Area, taking the worst case, less than 2% of the grey seal population would potentially be disturbed (see section 8.3.6.3.4.2).

612. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due less than 5% of the SAC population being disturbed from underwater noise associated with operation and maintenance activities at the Projects in isolation or together**.

8.3.6.4.5 Impact 3a: Auditory Injury from Underwater Noise due to the Presence of Vessels

613. During the operation and maintenance phase there will be an increase in the number of vessels in the Projects' Array Areas. The maximum number of vessels that could be on the Array Areas at any one time has been estimated at up to a total of 20 vessels per Project (Table 11-1 in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

8.3.6.4.5.1 Assessment of potential effects of the Projects alone

614. The results of the underwater noise modelling (in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) as described in section 8.3.5.3.5.1.

615. Therefore, there is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that the marine mammal would have to remain less than 100m for 24 hours in a day. Although auditory injury as a result of vessels is highly unlikely, it has been assessed as precautionary approach.

616. During operation, there may be up to 20 vessels in the Offshore Development Area at any one time, compared to the 32 vessels that would be on site during construction. Therefore, the potential effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than of those during construction (see section 8.3.6.3.5.1). As a precautionary approach the potential impact area of 0.6km^2 for up to 20 vessels in the wind farm site at the same time has been determined.

617. There would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury associated with operation and maintenance vessels at the Projects in isolation** (**Table 8-87**).

Table 8-87 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for up to 20 vessels	Potential adverse effect on site integrity
Grey seal	DBS East	0.032 (0.0002% of Humber Estuary SAC)	**No** Less than 1% of the population at risk of Auditory injury.
	DBS West	0.053 (0.0003% of Humber Estuary SAC)	
	OECC	0.44 (0.003% of Humber Estuary SAC)	

8.3.6.4.5.2 Assessment of potential effects of the Projects together

618. During operation, there may be up to 21 vessels in DBS East Array Area and DBS West Array Area simultaneously at any one time, compared to the 59 vessels that would be on site during construction. Therefore, the potential effects associated with underwater noise from vessels during operation and maintenance would be less than of those during construction (see section 8.3.6.3.5.2).

619. The potential impact for any auditory injury as a result of up to 21 vessels in the Offshore Development Area at the same time using the worst case density across the Offshore Development Area using a potential impact area of 0.63km^2 is insignificant for grey seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 8-88**).

620. There would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to auditory injury associated with operation and maintenance vessels at the Projects together**.

Table 8-88 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for up to 21 vessels	Potential adverse effect on site integrity
Grey seal	0.523 (0.00003% of Humber Estuary SAC)	**No** Less than 1% of the population at risk of auditory injury.

8.3.6.4.6 Impact 3b: Disturbance from Underwater Noise due to the Presence of Vessels

621. If the behavioural response is displacement from the area, it is predicted that grey seal will return once the activity has been completed and therefore any impacts from underwater noise as a result of operation and maintenance vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on grey seal.

8.3.6.4.6.1 Assessment of potential effects of the Projects alone

622. As a worst case the maximum number of grey seal from the Projects has been assessed to indicate the maximum number that could be impacted from DBS East and DBS West, if they are developed in isolation is presented in **Table 8-75** which shows less than 2% of the grey seal population could potentially be disturbed due to the presence of vessels in the Offshore Development Area

623. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects in isolation**.

8.3.6.4.6.2 Assessment of potential effects of the Projects together

624. As a worst case the maximum number of grey seal from the Projects has been assessed to indicate the maximum number that could be impacted from DBS East and DBS West, if they are developed together is the same as that shown in **Table 8-76** with less than 3% of the grey seal population being potentially disturbed.

625. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance from underwater noise associated with operation and maintenance vessels for the Projects together**.

8.3.6.4.7 Impact 4: Barrier Effects

626. As outlined in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, the indicative separation distance between turbines would be a minimum of 0.83km therefore there would be no overlap in the potential impact range of less than 100m (<0.1km) around each turbine. While seal species are known to transit along the coastline, there would be sufficient room for them to swim through the Array Areas at DBS East or DBS West through the operational period.

627. Based on the literature described in section 8.3.6.3.7 it is considered that there would be no barrier effects due to operational wind turbines.

628. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential barrier effects from underwater noise during operation and maintenance for the Projects in isolation or together**.

8.3.6.4.8 Impact 5: Increased Collision Risk with Vessels During Operation and Maintenance

629. It is estimated that the maximum number of vessels that could be required on site at any one-time during operation and maintenance could be up to 21 within the Offshore Development Area, which is considerably less than the 32 vessels that could be on site during construction. However, as a precautionary approach the assessment for construction has been used for the operational and maintenance assessment, as a worst case scenario. **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

630. The assessment of collision risk, as presented for the construction phase (section 8.3.6.3.8.1; **Table 8-83**) and operational phase (section 8.3.6.3.8.2 and **Table 8-83**) is based on the total Offshore Development Area, within which additional vessels may be present, and is not based on the number of vessels present within that area. At either DBS East or DBS West, there may be up to 239 vessel round trips for the Projects alone, or up to 474 transits for the Projects together, which is significantly less than the round trips required for construction. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction (less than 1% of the grey seal Humber Estuary SAC population), as the area of potential effect is the same.

631. In line with the construction assessment, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to increased collision risk from operation and maintenance vessels for the Projects in isolation or together**.

8.3.6.4.9 Impact 6: Changes to Prey Resources

632. Any impact on prey species has the potential to affect grey seal, and as outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, the potential impacts on fish species during operation and maintenance can result from:

- Long Term Habitat Loss;
- Temporary Habitat Loss, Physical Disturbance of The Seabed, Increased Suspended Sediment and Sediment Deposition;
- Underwater Noise;
- EMF; and
- Changes in Fishing Activity.

633. Any impacts on prey species have the potential to affect marine mammals. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** found no difference in the significance of effect on receptors when assessed for DBS East and / or DBS West in isolation or together. Further information of the potential effects from the individual impacts is provided in section 8.3.5.3.9.

634. The potential effects of physical disturbance, permanent and temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment underwater noise, EMF and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there will be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to potential changes in prey availability during construction for the Projects in isolation or together**.

8.3.6.4.10 Impact 7: Disturbance at seal haul-out sites

635. The closest seal haul-out sites are listed in section 8.3.6.3.10. As the closest haul out (Filey Brigg) is 28km from landfall, 25km from the export cable corridor, 106 km from DBS East and 132km from DBS West, there would be no effects from operation and maintenance activities within the Offshore Development Area, only effects from vessels transiting to and from the Offshore Development Area.

636. As described in section 8.3.6.3.10 It has not been confirmed which ports will be used, but a short list has been provided in Table 11-83 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. But if Grimsby port was used, transiting vessels from DBS Offshore Development Area to the port could cause disturbance to the grey seals hauled out at Donna Nook.

637. In total, for the operation and maintenance of either DBS East or DBS West is up to 239 round trips to port from the Projects' Array Area each year for five years and 474 round trips to port from the Offshore Development Area for the operation and maintenance phase. This represents a slight increase in the current number of vessels in the area.

638. Taking into account the worst case scenario of using Grimsby port, it is likely that seals hauled-out along these routes would be habituated to the noise, movements and presence of vessels.

639. However, vessels would use established vessel routes to the port and, where possible, transiting vessels would maintain distances of 500m or more off the coast, particularly in areas near known seal haul-out sites during sensitive periods.

640. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to disturbance at seal haul-out sites during the operation and maintenance phase of the Projects in isolation or together.**

8.3.6.5 Potential effects during decommissioning

641. Potential effects on grey seal associated with decommissioning have not been assessed in detail, as further assessments will be carried out ahead of any decommissioning works to be undertaken, taking account of known information at that time, including relevant guidelines and requirements as described in section 8.3.5.4.

642. The potential effects on grey seal during decommissioning would be the same or less than those assessed for construction. Therefore, there would be **no significant effects on grey seal and no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal at the Projects in isolation or together**.

8.3.6.6 Potential in-combination effects

643. The in-combination assessment considers other schemes and activities where the predicted effects have the potential to combine with the potential effects during construction of the Projects. The construction phase has been assessed as the worst case for potential in-combination effects.

644. The schemes screened into the in-combination assessment for grey seal are those that are located in the relevant seal Mus defined by IAMMWG (2013). Full information on the screening of effects considered for the in-combination assessment is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

645. The marine mammal in-combination assessment will consider schemes which have sufficient information available to undertake the assessment, and will include the potential effects of:

- Underwater noise;
- Barrier Effects;
- Vessel interaction;
- Disturbance to seal haul-out sites; and
- Changes to prey resources (including habitat loss).

646. The screening identified that there is the potential for in-combination effects on grey seals as a result of disturbance from underwater noise during piling and other construction activities. All operational impacts have been screened out of the assessment as described in section 8.3.5.5. Further information is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

8.3.6.6.1 Impact 1 Disturbance from Underwater Noise

647. The potential sources of in-combination underwater noise which could disturb grey seals, and which are screened into the assessment are:

- Disturbance from underwater noise
    - Piling at other OWFs;
    - Other construction activities at OWFs (such as vessels, cable installation works, dredging, seabed preparation and rock placement);
    - Geophysical surveys;
    - Aggregate extraction and dredging;
    - Oil and gas installation / decommissioning schemes;
    - Seismic surveys;
    - Subsea cables and pipelines; and
    - UXO clearance.
- Barrier effects of other OWFs
- Increased collision risk with vessels;
- Disturbance to seal haul-out sites; and
- Changes in prey resources

8.3.6.6.1.1 In combination Impact 1a: Assessment of disturbance from underwater noise

648. A list of UK and European OWF schemes that may the potential for overlapping piling with the Projects is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)** and has been used to inform the assessment for in-combination effects due to piling at other OWFs.

649. For grey seal at the Humber Estuary SAC, other OWFs were included in the assessment against the SAC population where the Carter *et al.* (2022) densities for the individuals associated with the Humber Estuary SAC show presence within the 5km x 5km grid cells that overlap with the other OWF (or where there is a presence of seals within the potential disturbance area of the other OWF, e.g. within 25km for other OWFs that may be piling).

650. Of the UK and European OWFs screened in for having a construction period that could potentially overlap with the construction of the Projects, the below are relevant to grey seal and could be piling at the same time, which is currently estimated to take place in 2027 to 2030 for DBS East and DBS West;

- Dudgeon Extension;
- East Anglia Hub;
- Five Estuaries;
- Hornsea Project Three;
- Hornsea Project Four;
- North Falls;
- Outer Dowsing; and
- Sheringham Shoal Extension.

651. Of these, all are shown to have grey seal associated with the Humber Estuary SAC present within the OWF areas.

652. The commitment to the mitigation measures agreed through the MMMP (in accordance with **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)**) for piling would reduce the risk of physical injury or permanent auditory injury (PTS) in grey seal. In light of this, and taking account of the type, scale and extent of potential effects arising from the Projects assessment, which concluded no adverse effect on integrity for grey seal due to physical injury or PTS from construction (see section 8.3.6.3.1).

653. It is important to note the actual duration for active piling time which could disturb marine mammals is only a very small proportion of the potential construction period, of up to approximately 108 days for DBS East or DBS West and the OECC, based on the estimated maximum duration to install individual piles.

654. As shown in **Table 8-89** below, the DBS East or DBS West Array Areas if constructed in isolation or together represents only a small proportion of grey seal that may be disturbed due to OWF piling based on the worst case assessment for the EDR approach.

655. However, piling in the OECC accounts for a high percentage of the in-combination grey seal that could be disturbed which has the potential to cause an adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal.

Table 8-89 Quantitative assessment for in-combination disturbance for grey seal from piling at other OWFs

Project	Grey seal density (/km^2)	Impact area (25km EDR)	Maximum number of individuals potentially disturbed during single piling
DBS East	0.054	1,963.5	106.0
DBS West	0.089	1,963.5	174.8
DBS OECC*	0.728	1,963.5	1,429.4
Dudgeon Extension	Dose response curve assessment (Equinor New Energy Limited, 2022)		166
East Anglia Hub	0.02 (East Anglia TWO Limited, 2019)	2,124	42.5
Five Estuaries	Dose response curve assessment (Five Estuaries Offshore Wind Farm Ltd, 2023)		168
Hornsea Project Three	Dose response curve assessment (Orsted Power (UK) Ltd, 2018)		53
Hornsea Project Four	Dose response curve assessment, with 39% apportioned to the Humber SAC (Orsted Hornsea Project Four Ltd, 2022)		580.7
North Falls	0.018 (North Falls Offshore Wind Farm Ltd, 2023)	3,927	70.7
Outer Dowsing	0.29 (Outer Dowsing Offshore Wind, 2023)	2,124	615.0
Sheringham Shoal Extension	Dose response curve assessment (Equinor New Energy Limited, 2022)		157

Project	Grey seal density (/km^2)	Impact area (25km EDR)	Maximum number of individuals potentially disturbed during single piling
Total number of grey seal with DBS East			**1,958.9 (12.6% of the Humber SAC)**
Total number of grey seal with DBS West			**2,027.7 (13.1% of the Humber SAC)**
Total number of grey seal with DBS OECC			**3,282.3 (21.2% of the Humber SAC)**
Total number of grey seal with the Projects together			**2,133.7 (13.7% of the Humber SAC)**
Total number of grey seal without the Projects			**1,852.9 (12.0% of the Humber SAC)**

**The OECC would not pile on the same day as DBS East or DBS West*

656. As a significant proportion of the Humber Estuary SAC grey seal population are at risk of disturbance at that stage, population modelling was carried out using the interim Population Consequence of Disturbance (iPCoD) model. The methodology is described in **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**.

657. For the cumulative scenario assessed (see **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)** for details of the schemes considered, and their parameters) within the Humber Estuary SAC population, the iPCoD model predicts no change in the grey seal population size over time (**Table 8-90**; **Plate 8-6**).

658. The median population size was predicted to be 100% of the un-impacted population size at the end of 2028 (1 year after the piling has commenced). By the end of 2052, which is the end point of the modelling, at which point the median impacted to un-impacted ratio remains 100%).

659. For the Humber Estuary SAC grey seal population, the potential of the in-combination for disturbance from underwater noise from piling is assessed as not significant due to there being less than a 1% population level impact over both the first six years and 25 year modelled periods (**Table 8-90**). Based on the population modelling **there is no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal for in-combination with piling at the Projects and other OWFs.**

Table 8-90Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the Humber Estuary SAC grey seal population (for years up to 2052 for both impacted and un-impacted populations in addition to the median ratio between their population sizes)

Time period	Un-impacted pop mean	Impacted pop mean	Median impacted
Start	15494	15494	100.00%
End 2028	15575	15575	100.00%
End 2029	15692	15691	100.00%
End 2032	15946	15946	100.01%
End 2037	16458	16460	100.02%
End 2047	17564	17565	100.02%
End 2052	18169	18170	100.01%

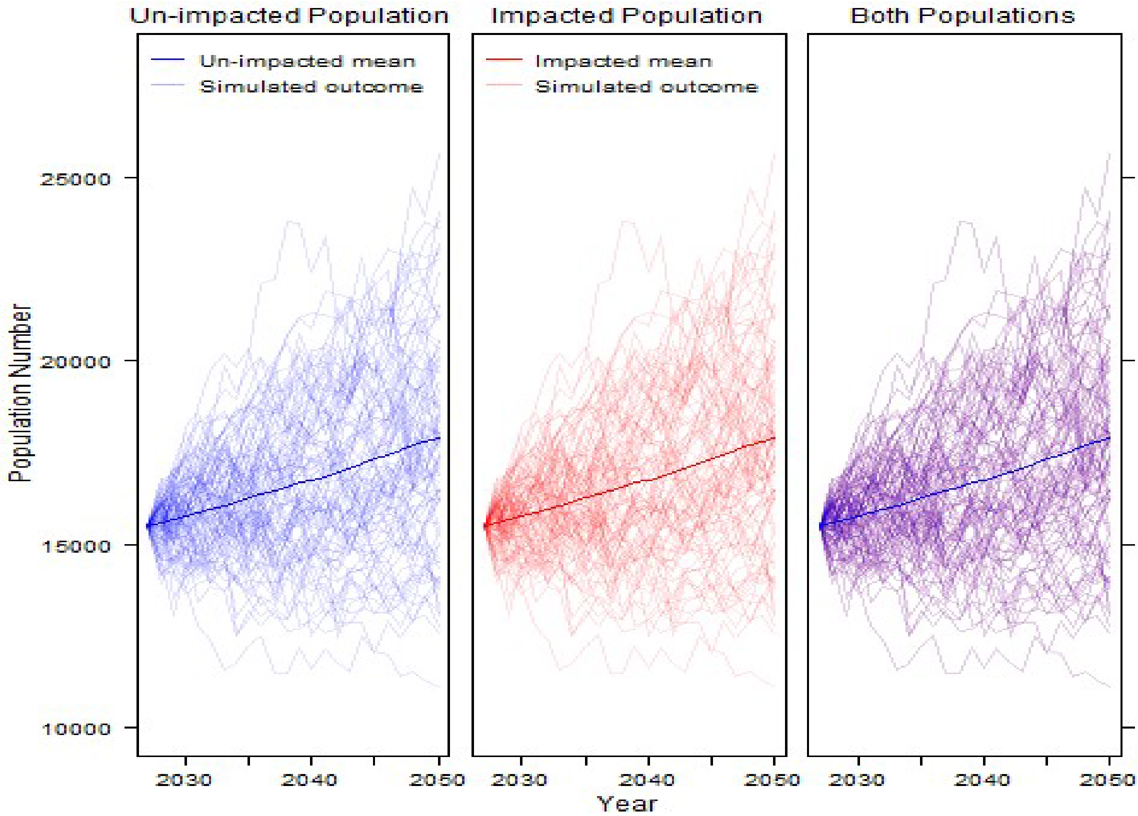


Plate 8-6 Simulated worst case Humber Estuary SAC grey seal population sizes for both the un-impacted and the impacted populations.

8.3.6.6.1.2 In combination impact 1b: Assessment of underwater noise from construction activities other than piling at other OWFs.

660. All OWFs with construction dates that have the potential to overlap with the construction dates for DBS East and / or DBS West have the potential for other construction activities (such as seabed preparation, dredging, trenching, cable installation, rock placement, drilling and vessels) to occur at the same time as other construction activities at the Projects.

661. The OWFs screened in have all been assessed for the worst case scenario of piling at the same time as the Projects. The underwater noise from of other construction activities would be less than that of piling (assessed above) these in-combination effects. Therefore, **there is no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal for in-combination with piling at the Projects and other OWFs**.

8.3.6.6.1.3 In-combination Impact 1c: Assessment of disturbance from other industries and activities

662. During the construction period for DBS East and / or DBS West, there is the potential for disturbance to marine mammals associated with other potential noise sources, including:

- Geophysical surveys;
- Aggregate extraction and dredging;
- Oil and gas installation schemes;
- Seismic surveys;
- Subsea cable and pipelines;
- Other marine renewable schemes (such as wave and tidal schemes);
- Disposal sites; and
- UXO clearance.

663. For the installation of oil and gas infrastructure, marine renewable schemes, and disposal sites, all potential schemes have been screened out. Further information on the in-combination screening (and these results) are provided in **Volume 7, Appendix 11-5 CEA Screening (application ref: 7.11.11.5).**

8.3.6.6.1.3.1 Disturbance from Geophysical surveys

664. It is currently not possible to estimate the number of potential OWF geophysical surveys that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West.

665. OWF geophysical surveys using SBPs and USBL systems have the potential to disturb marine mammals and have therefore been screened into the in-combination assessment, as a precautionary approach. The potential disturbance range used in the cumulative assessment is based on the SNCB guidance for assessment for harbour porpoise.

666. Assessments for the RoC HRA for the SNS SAC (BEIS, 2020), modelled the potential for disturbance due to the use of a SBP, and results indicated that there is the potential for a possible behavioural response in harbour porpoise at up to 3.77km (44.65km^2) from the source. The current guidance for assessing the significance of noise disturbance for harbour porpoise SACs (JNCC *et al.* 2020) recommends the use of an EDR of 5km (78.54km^2) for geophysical surveys.

667. As a worst case, it has been assumed that all grey seal within 5km of the survey source, a total area of 78.54km^2 could be disturbed.

668. For geophysical surveys with SBPs, it is realistic and appropriate to base the assessments on the potential effect area around the vessel, as the potential for disturbance would be around the vessel at any one time. Seals would not be at risk throughout the entire area surveyed in a day, as animals would return once the vessel had passed, and the disturbance had ceased.

669. It is currently not possible to estimate the location or number of potential geophysical surveys that could be undertaken at the same time as construction and potential piling activity at the Projects. It is therefore assumed, as a worst case scenario, it is assumed that there could potentially be two geophysical surveys in the North Sea at any one time, during construction of the Projects, with a total disturbance area of 78.54km².

670. As the location of the potential geophysical surveys is currently unknown, the following assessment for grey seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for the Humber Estuary SAC of 0.053km². Analysis of the activities reported to the MNR, indicated in the year 2021 in the North Sea, there was a total of 30 SBP surveys carried out for a total of 257 days. The amount undertaken in 2021 suggests an average of less than one geophysical survey at any one time within a year. This therefore assumes that there could be up to one geophysical survey within the area in which grey seal associated with the Humber Estuary SAC may be present (**Table 8-91**).

671. For up to one geophysical survey there is the potential for 4.2 grey seals (0.03% of the Humber SAC population) to be disturbed. If these are undertaken at the same time as construction of DBS East or West in isolation or together, with no other in-combination activities, less than 2% of the Humber Estuary SAC population may be disturbed. Therefore, there would be no significant disturbance and no adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects along with two geophysical surveys.

Table 8-91 Quantitative assessment for in-combination disturbance of grey seal due to up to two geophysical surveys at OWFs

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Humber SAC

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
One geophysical survey	0.053	78.54	4.2 (0.03% of the Humber SAC population)
Total number of grey seal (DBS East and West together)			**<1.03% of the Humber SAC population)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.6.6.1.3.2 Disturbance from aggregate extraction and dredging

672. Taking into account the small potential effect ranges, distances of the aggregate extraction and dredging schemes from the Projects, the potential for contribution to in-combination effects is very small. Therefore, risk of PTS for grey seals from aggregate extraction and dredging has been screened out from further consideration in the in-combination assessment.

673. As a precautionary approach, a total of six aggregate extraction and dredging schemes are included in the in-combination assessment for the potential in-combination disturbance.

674. As outlined in the BEIS (2020) RoC HRA for the SNS SAC, studies have indicated that harbour porpoise may be displaced by dredging operations within 600m of the activities (Diederichs *et al.* 2010). As a worst case assessment, a disturbance range of 600m for up to six operational aggregate schemes at the same time as the Projects construction has been used to assess any potential disturbance to grey seal. A disturbance range of 600m would result in a potential disturbance area of 1.13km^2 for each project, or up to 6.8km^2 for all six aggregate schemes.

675. For the potential for 0.3 grey seals (0.001% of the Humber SAC population) to be disturbed from aggregate and dredging (**Table 8-92**). For up to six operational aggregate schemes undertaken at the same time as construction of DBS East or West in isolation or together, with no other in-combination activities, less than 1% of the Humber Estuary SAC population may be disturbed. Therefore, there would be no significant disturbance and there is no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects as well as six operational aggregate schemes.

Table 8-92 Quantitative assessment for cumulative disturbance of grey seal due to up to six aggregate extraction and dredging activities near the Projects

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Humber SAC population
Up to six aggregate extraction and dredging schemes	0.053	5.7	0.001% of the Humber SAC population
Total number of grey seal (DBS East and West together)			**<1% of the Humber SAC population)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.6.6.1.3.3 Disturbance from seismic surveys

676. It is currently not possible to estimate the number of potential seismic surveys that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West. Therefore, it has been assumed that at any one time, up to two seismic surveys could be taking place at the same time within the Projects.

677. This assessment for the potential disturbance due to seismic surveys is based on the following:

   - There is little available information on the potential for disturbance from seismic surveys for grey seal, however, observations of behavioural changes in other seal species have shown avoidance reactions up to 3.6km from the source for a seismic survey (Harris *et al*. 2001). A more recent assessment of potential for disturbance to seal species, as a result of seismic surveys, shows potential disturbance ranges from 13.3km to 17.0km from the acoustic source (BEIS, 2020). These ranges are based on modelled impact ranges, using the National Marine Fisheries Service (NMFS) Level B harassment threshold of 160dB, for a noise source of 3,070 cubic inches, 4,240 cubic inches, or 8,000 cubic inches; and

- A potential disturbance range of 17.0km (or disturbance area of 907.9km^2 for one survey, and 1,815.8km^2 for up to two seismic surveys) will therefore be applied to grey seal due to a lack of species-specific information.

678. As the location of the potential seismic surveys is currently unknown, the following assessments for grey seal use the average density estimate across the Carter *et al.* (2022) relative density dataset for the Humber Estuary SAC of 0.053/km^2. This therefore assumes that there could be up to two seismic surveys within the area at which grey seal associated with the Humber Estuary SAC may be present.

679. For the potential for 96.2 grey seals (0.62% of the Humber SAC population) to be disturbed from seismic surveys (**Table 8-93**). For up to two seismic surveys undertaken at the same time as construction of DBS East or West in isolation or together, with no other in-combination activities, less than 2% of the Humber Estuary SAC population may be disturbed. Therefore, there would be no significant disturbance and there is no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects as well as two seismic surveys (**Table 8-93**).

Table 8-93 Quantitative assessment for cumulative disturbance of grey seal due to up to two seismic surveys near the Projects

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Humber SAC population
Up to two seismic surveys	0.053	1,815.8	0.62% of the Humber SAC population
Total number of grey seal (DBS East and West together)			**<1.62% of the Humber SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.6.6.1.3.4 Disturbance from subsea cables and pipelines

680. Only one subsea cable scheme (Sea Link) has been screened into the in-combination assessment. This scheme is currently at scoping stage and therefore there is limited information available on potential effects and disturbance ranges for which to inform an in-combination assessment with DBS East and / or DBS West.

681. The disturbance ranges that could be generated during the cabling works and vessels would be up to 4km (with a disturbance area of 50.3km^2), for grey seal. This has been used to inform the assessments for pipeline schemes, as activities would be similar, in the absence of any additional information for the scheme screened in for assessment.

682. The density of grey seal for the Sea Link scheme has been estimated based on the Carter *et al.* (2022) relative density data for the Humber Estuary SAC, with an estimated density (for only those grey seals that are associated with the Humber Estuary SAC) of 0.013/km^2.

683. For the potential for 0.7 grey seals (0.004% of the Humber SAC population) to be disturbed from subsea cables and pipeline schemes (**Table 8-94**). For one subsea cable scheme undertaken at the same time as construction of DBS East or West in isolation or together, with no other in-combination activities, less than 1% of the Humber Estuary SAC population may be disturbed. Therefore, there would be no significant disturbance and there is no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects as well as subsea pipeline scheme (**Table 8-94**).

Table 8-94 Quantitative assessment for cumulative disturbance of grey seal due to subsea cable and pipeline activity near the Projects

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Humber SAC population
Cable and pipeline schemes	0.013	50.3	0.004% of the Humber SAC population

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Total number of grey seal (DBS East and West together)			**<1% of the Humber SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.6.6.1.3.5 Disturbance from UXO Clearance

684. It is currently not possible to estimate the number of potential UXO clearance events that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West, and therefore, on a worst case basis, the potential for one high-order clearance and one low-order clearance has been assessed as having the potential to take place at the same time.

685. The potential effect area during a single UXO clearance event, based on the modelled worst case effect range at the Projects for TTS / fleeing response (weighted SEL) of 22.0km (1,520.5km²) for high-order clearance and 5.7km (1.02km²) for low-order clearance.

686. However, as outlined in the BEIS (2020) RoC HRA, due to the nature of the sound arising from the detonation of UXO, i.e. each blast lasting for a very short duration, marine mammals, are not predicted to be significantly displaced from an area, any changes in behaviour, if they occur, would be an instantaneous response and short-term. Guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010a).

687. Mitigation measures required for UXO clearance include the use of low-order clearance techniques, which could include a small donor charge, rather than full high-order detonation which is only used as a last resort. It is therefore highly unlikely that more than one UXO high-order detonation would occur at exactly the same time or on the same day as another UXO high-order detonation, even if they had overlapping UXO clearance operation durations. The in-combination assessment is therefore based on potential for disturbance from one UXO high-order detonation without mitigation (worst case), as well as one low-order clearance event.

688. As the location of the potential UXO clearances are currently unknown, the following assessment for grey seal uses the average density estimate across the Humber Estuary SAC of 0.053/km^2.

689. For the potential for 80.6 grey seals (0.52% of the Humber SAC population) to be disturbed from a high order UXO clearance and 0.05 grey seal (0.0003% of the Humber SAC population) (**Table 8-95**). For up to two UXO clearances undertaken at the same time as construction of DBS East or West in isolation or together, with no other in-combination activities, less than 2% of the Humber Estuary SAC population may be disturbed. Therefore, there would be no significant disturbance and there is no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects as well as UXO Clearance (**Table 8-95**).

Table 8-95 Quantitative assessment for cumulative disturbance of grey seal due to UXO clearance near the Projects

Potential in-combination effect	**Marine mammal density (/km^2)**	**Potential in-combination effect area (km^2)**	**Maximum number of individuals potentially disturbed (% of reference population)**
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Humber SAC population
One high-order UXO clearance	0.053	1,520.5	0.52% of the Humber SAC population
One low-order UXO clearance	0.053	1.02	0.0003% of the Humber SAC population
Total number of grey seal (DBS East and West together)			**<1.53% of the Humber SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.6.6.1.4 Summary of in-combination effect 1: assessment of disturbance from all noisy activities associated with offshore industries

690. Each of the above described noise sources are quantitively assessed together in **Table 8-96**.

691. It should be noted that while the schemes included within the in-combination assessment for disturbance from other activities and industries were done so based on the current knowledge of their possible construction or activity windows, and it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the grey seals that could be at risk of disturbance during the four year offshore construction period of the Projects.

692. Based on the current worst case total the in-combination assessment (**Table 8-96**) less than 5% of the reference population is affected. As such this would suggest there is no potential for significant effects from disturbance during construction and therefore, there is **no potential for adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects and disturbance from all noisy activities associated with offshore industries**.

693. It should be noted that this conclusion is considered to be highly precautionary as:

- The assessment assumes the in-combination piling schemes are all piling at exactly the same time as the Projects and each using monopiles. Experience from the build-out of schemes in the Southern North Sea suggests that this is unrealistic. Piling durations are typically overestimations, further limiting temporal overlap.
- The speculative assessments for geophysical surveys; seismic surveys and UXO clearance assume all of these activities would occur simultaneously and no mitigation has been applied.
- There is no spatial overlap of effects with the SAC.
- Not all individuals would be displaced over the entire potential disturbance range used within the assessments.
- Behavioural effects from UXO clearance, if they occur, would be an instantaneous response and short-term. Guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010a).

Table 8-96 Quantitative assessment for all noisy activities with the potential for in-combination disturbance effects for grey seals

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at other OWFs including the worst case disturbance from the Project*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Humber SAC
One geophysical survey	0.053	78.54	4.2 (0.02% of the Humber SAC population)
Up to six aggregate extraction and dredging schemes	0.053	5.7	0.3 (0.001% of the Humber SAC population)
Two seismic surveys	0.053	1,815.8	96.2 (0.62% of the Humber SAC population)
Subsea cables and pipelines	0.013	50.3	0.7 (0.004% of the Humber SAC population)
One high-order UXO clearance	0.053	1,520.5	80.6 (0.52% of the Humber SAC population)
One low-order UXO clearance	0.053	1.02	0.05 (0.0003% of the Humber SAC population)
Total number of grey seal (DBS East or West together)			**2.1% of the Humber SAC population**
Total number of grey seal without the Projects			**1.1% of the Humber SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.6.6.2 Impact 2 Barrier Effects

694. It is important to note that the OWFs and other noise sources included in the in-combination assessment are spread over the wider area of the North Sea. Taking into account the locations of the OWFs and other noise sources from DBS East and / or DBS West, the maximum underwater effect ranges for disturbance at other schemes would not overlap with the maximum underwater effect ranges for disturbance at the Projects during piling and construction. Therefore, there is no potential for underwater noise from the Projects, other OWFs and noise sources to result in a barrier of movement to grey seal.

695. There would be **no adverse effect due to in-combination barrier effects on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal**.

8.3.6.6.3 Impact 3 Vessel Interaction

696. The in-combination effects from an increase in the number of vessels and vessel movements can pose a potential collision risk for grey seal.

697. As outlined in sections 8.3.6.3.8 and 8.3.6.4.8, the increased collision risk due to project vessels, even using a very precautionary approach, would result in less than one individual (0.032 grey seal) being at risk of vessel collision per year (**Table 8-83**) for construction phase related vessel collision risk. This amount would be reduced for operation and maintenance phase related vessel collision risk due to the construction phase being the worst case in terms of vessel numbers (see section 8.3.6.4.8).

698. As outlined in **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where grey seal are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and with a vessel speed limit of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with grey seal. It is expected that other offshore schemes and industries would follow similar measures in order to reduce the potential for collision risk of grey seal with vessels.

699. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low.

700. In addition, based on the assumption that grey seal would be disturbed as a result of underwater noise from piling, other construction activities, operational and maintenance activities and vessels, there should be no potential for increased collision risk with vessels.

701. Therefore, there would be **no adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due in-combination increases in collision risk with construction vessels**.

8.3.6.6.4 Impact 4 Disturbance to seal haul-out sites

702. As stated in section 8.3.6.3.10 the closest seal haul out site is 106km from the DBS East Array Area and 25km from the Offshore Export Cable Corridor, there is therefore no potential for any direct disturbance as a result of construction or operation and maintenance activities from either DBS East or DBS West (including landfall and the export cable route). The only effects would be from vessels transiting to and from the Offshore Development Area.

703. It is assumed that all schemes would follow similar best practice measures with regards to avoiding disturbance at haul-out sites. In addition, where seal haul-out sites are near to a vessel corridor, the seals present in that area would be used to vessels transiting past the area.

704. Therefore, there would be **no adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal due to in-combination disturbance to seal haul-out sites**.

8.3.6.6.5 Impact 5 Changes to Prey Availability

705. Potential effects on prey species for the Projects were assessed in section 8.3.5.2.9 (construction) and section 8.3.5.3.9 (operation). No adverse effect on integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise was concluded. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. This will be the case for all schemes and therefore although the in-combination effects are additive, the effect would be proportionate to the wider range over which effects would occur.

706. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Therefore, there would be **no adverse effect on the integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal arising due to changes in prey availability**.

8.3.6.7 Summary of Potential Effects on Site Integrity

707. The assessment of the potential effects for the Projects in isolation or together has been summarised in relation to the Humber Estuary SAC conservation objectives for grey seal (**Table 8-97**).

708. The MMMP will provide mitigation or management measures to reduce the potential for any significant disturbance of grey seal as a result of in-combination effects from underwater noise.

709. There would be **no adverse effect on integrity of the Humber Estuary SAC in relation to the conservation objectives for grey seal either alone or in-combination with other schemes**.

Table 8-97 Summary of the potential effects of the Project, including in-combination effects on the Humber Estuary SAC in relation to the conservation objectives for grey seal (X = no potential for AEoI; ✓ = potential for AEoI)

Conservation objectives	The Projects effects					In-combination effects				
	Auditory injury and disturbance from underwater noise	Barrier effects	Disturbance at seal haul-out sites	Vessel interaction	Changes to prey resources	Disturbance from underwater noise	Barrier effects	Vessel interaction	Disturbance to seal haul-out sites	Changes to prey resources
Grey seal is a viable component of the site	X	X	X	X	X	X	X	X	X	X
There is no significant disturbance of the species	X	X	X	X	X	X	X	X	X	X
The condition of supporting habitats and processes and the availability of prey is maintained	X	X	X	X	X	X	X	X	X	X

8.3.7 The Wash and North Norfolk Coast SAC

8.3.7.1 Site Description

710. The Wash, located on the east coast of England, is the largest embayment in the UK, and the extensive intertidal flats both within The Wash, and extending along the north Norfolk coast, provide ideal conditions for harbour seal breeding and haul-out sites. Harbour seal are a primary reason for the designation of The Wash and North Norfolk Coast SAC.

711. The Wash and North Norfolk Coast SAC is located, at closest point, 180km from the closest point at DBS East Array Area and 168km from the closest point at DBS West Array Area. Therefore, there is no potential for direct effects on the SAC as a result of the construction, operation, maintenance or decommissioning of DBS Array Areas. However, due to the foraging range of harbour seals, there is the potential for effects on foraging harbour seal from The Wash and North Norfolk Coast SAC in the vicinity of the Projects.

8.3.7.1.1 Qualifying Features

8.3.7.1.1 Harbour seal

712. Principal harbour seal haul-out sites in The Wash and North Norfolk Coast SAC include Blakeney Point and The Wash (SCOS, 2022).

713. In the 2021 August seal haul-out count for The Wash sites and Blakeney Point, an average of 2,667 harbour seal were counted within The Wash, and an average of 181 harbour seals at the Blakeney Points site, with a total average count of 2,848 for the haul-out sites associated with The Wash and North Norfolk Coast SAC (SCOS, 2022).

714. No harbour seal sightings were confirmed during the site-specific aerial surveys. However, there was a total of 25 unidentified seal species were recorded in DBS East AfL Area and 34 individuals within DBS West AfL Area recorded through the 24 survey dates, a proportion of which could be harbour seal (although the majority are expected to be grey seal).

715. Due to the absence of harbour seal sightings, absolute density and abundance estimates were not possible to derive from the site-specific surveys.

716. The harbour seal density estimates for the Array Areas have been calculated from the latest seal at sea maps produced by SMRU (Carter et al. 2022). This is based on the 5km x 5km grids that overlap each area (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) and using the density data for The Wash and North Norfolk Coast SAC. This effectively apportions the potential for effect to only those seals that are associated with the SAC itself.

717. The total harbour seal at sea population in the British Isles is approximately 42,900 individuals, based on the corrected values and most recent haul-out counts for the UK (SCOS, 2022). The total at-sea harbour seal population for The Wash has been estimated as 3,956, based on the total population of harbour seal of this SAC (provided in **Figure 8-3** and **Table 8-98** below), and calculating against a correction factor of 0.72 (Lonergan et al. 2013) to take account of those individuals at sea only. This is the population estimate used with the Carter *et al.* (2022) data to calculate density estimates for the Array Areas (**Figure 8-3**).

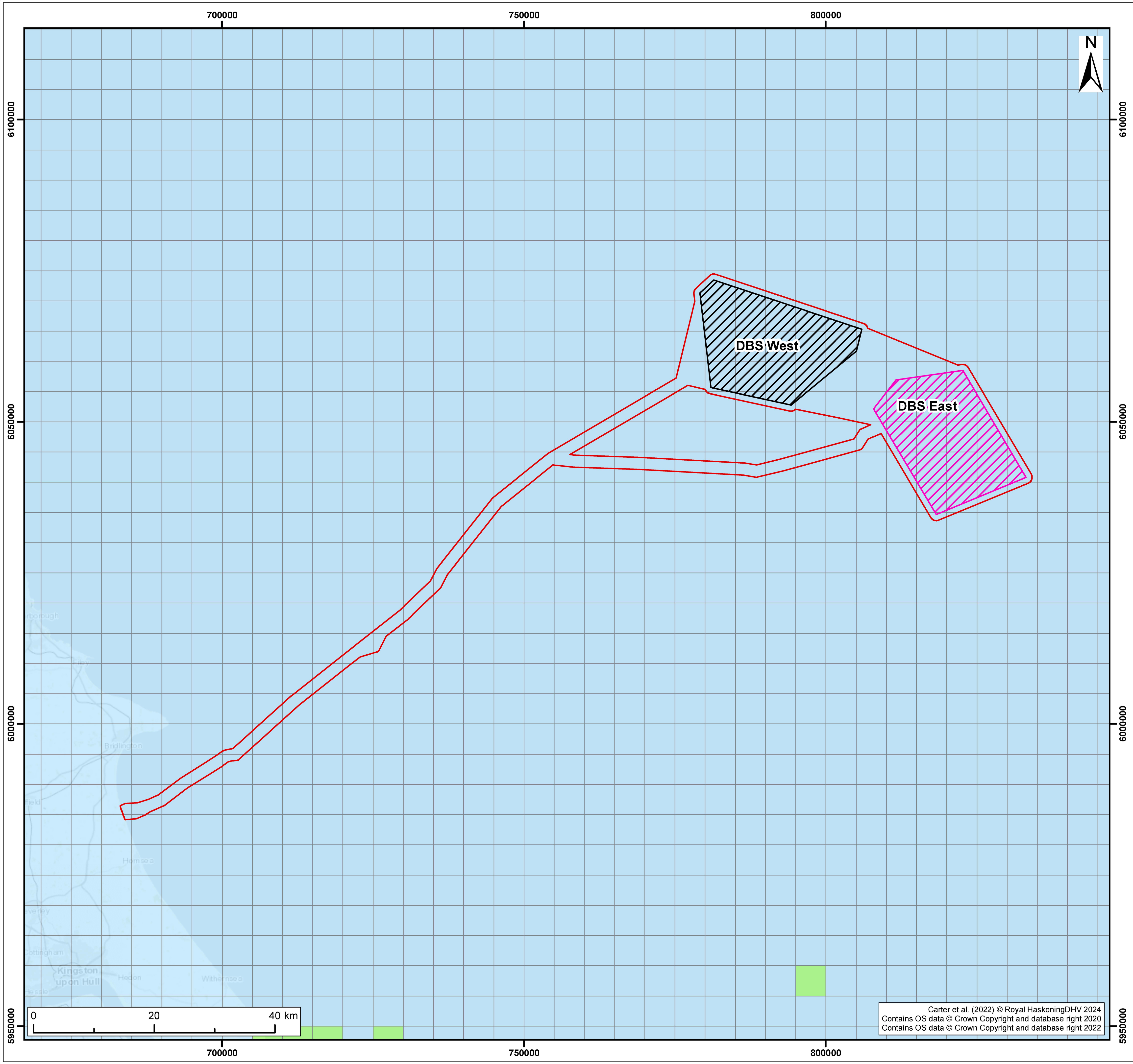
718. The mean at sea density estimates for these areas have been used in the assessment:

- 0.0018 individuals per km^2 for the DBS East Array Area;
- 0.0015 individuals per km^2 for the DBS West Array Area;
- 0.012 individuals per km^2 for the OECC; and
- 0.001 individuals per km^2 for the total Offshore Development Area.

Table 8-98 Harbour seal counts and population estimates

Population area	Harbour seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Harbour seal SAC population
Total SAC population	2,848	SCOS, 2022	0.72	3,956

719. There are indications of a current decline in the numbers of harbour seal in The Wash. The assessments are based on the current harbour seal counts at the time of writing. However, any assessments will be based on the latest harbour seal counts at that time to take account of any changes.



Legend:

- Offshore Development Area
- DBS East array area
- DBS West array area

Proportion of the population per 25km² (as a %)

- 0.000000 - 0.041401
- 0.041402 - 0.156184

Maps show mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid cell square at any one time, and the cellsquare-wise (Carter et al., 2022)

SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR
S2	P01	02/04/2024	Suitable for Information	JH	SB	AS

Title:

The Wash and Norfolk Coast SAC
Harbour seal at sea distribution

Figure: 8-3 Drawing No: PC2340-RHD-OF-ZZ-DR-Z-0704

Co-ordinate system: WGS 1984 UTM Zone 31N | Page Size: A3 | Scale: 1:620,000

Project: Dogger Bank South Offshore Wind Farms

Report: Report to Inform Appropriate Assessment

Royal HaskoningDHV
Enhancing Society Together

RWE

8.3.7.1.2 Conservation Objectives

720. The Conservation Objectives (Natural England, 2023b) are:

"To ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status 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 habitats of qualifying species rely,*
- *The populations of qualifying species, and,*
- *The distribution of qualifying species within the site."*

721. For harbour seal within The Wash and North Norfolk Coast SAC, the specific targets are to:

- 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 stage and behaviours;
- Maintain connectivity of the habitat within sites and the wider environment to allow movement of migratory species;
- Restrict the introduction and spread of non-native species and pathogens, and their impacts;
- Maintain the extent and spatial distribution of the following supporting habitats; foraging and haul-out sites;
- Maintain the abundance of preferred food items required by the species;
- Maintain the natural physio-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;
- Restrict aqueous contaminants to levels equating to High Status according to Annex VIII and Good Status according to Annex X of the Water Framework Directive, avoiding deterioration from existing levels;

- Maintain water quality to 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 avoiding deterioration from existing levels; and
- Maintain natural levels of turbidity (e.g. suspended concentrations of sediment, plankton and other material) in areas where this species is, or could be present.

722. Due to the decline in the harbour seal population within The Wash and North Norfolk Coast SAC, Natural England are in the process of updating the Conservation Objectives of the SAC.

8.3.7.2 Potential Effects Summary

723. The assessments for The Wash and North Norfolk Coast SAC, the potential for effects is considered in relation to the SAC Conservation Objectives for harbour seal (**Table 8-99**).

Table 8-99 Potential Effects of the Projects in Relation to the Conservation Objectives of The Wash and North Norfolk Coast SAC for Harbour Seal

Conservation Objective for harbour seal	Potential Effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential LSE. There will be no significant change to the extent and distribution of the habitats of qualifying species in the SAC.
The structure and function (including typical species) of qualifying natural habitats.	No potential LSE. There will be no significant change to the structure and function (including typical species) of qualifying natural habitats.
The structure and function of the habitats of qualifying species.	No potential LSE. There will be no significant change to 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.	No potential LSE. There will be no significant change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.

Conservation Objective for harbour seal	Potential Effect
The populations of qualifying species.	Increased collision risk with vessels may cause a potential LSE which will be considered further.
The distribution of qualifying species within the site.	No potential LSE. There will be no significant change to the distribution of qualifying species within the site. However, significant disturbance and displacement as a result of increased underwater noise levels have the potential to have an effect on the seals foraging at sea and will be considered further.

8.3.7.3 Potential effects during construction

724. Potential effects during construction are the same as stated in section 8.3.6.3.

8.3.7.3.1 Impact 1: Permanent auditory injury (PTS) due to impact piling

725. Impact piling is a source of high-level underwater noise and can cause both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on harbour seals, the same for grey seal as stated in section 8.3.6.3.1.

726. The maximum predicted impact range for PTS is 1.6km, for cumulative SEL (including soft-start and ramp-up) for a monopile with maximum hammer energy of 6,000kJ. The underwater noise modelling results for the predicted effect ranges and areas for PTS from a single strike of the maximum hammer energy for the worst case location have been assessed (**Table 8-61**).

727. The Wash and North Norfolk Coast SAC is located, at closest point, 180km from the closest point at DBS East Array Area and 168km from the closest point at DBS West Array Area. Therefore, there is no potential for direct overlap with the SAC. However, it is assumed that harbour seal in and around Projects could be from The Wash and North Norfolk SAC.

8.3.7.3.1.1 Assessment of potential effects of the Projects alone

728. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS due to a single strike at the maximum hammer energy, and cumulative exposure of a single pile installation or sequential pile installations in 24 hours. These assessments are for both monopiles and jacket pin piles, being presented in **Table 8-100**.

729. It is important to note that assessment for PTS from cumulative exposure is highly precautionary. There is a lot of variation in the potential effect ranges for SEL_{cum} at each location and between locations (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). In addition, the maximum hammer energy is only likely to be required at a few of the piling installation locations and for shorter periods of time.

730. Mitigation measures are presented in **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** and will be reviewed in the final MMMP prior to construction. The effective implementation of the MMMP for piling will reduce the risk of permanent auditory injury (PTS) to harbour seal during piling at the Projects. This mitigation alongside less than 1% of the population being affected, means would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS) from increased underwater noise during construction (piling) for the Projects in isolation.**

Table 8-100 Assessment of the potential for instantaneous PTS due to a single strike of the maximum hammer energy for a monopile and jacket pin pile, and Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 hour Period for the Projects in isolation

Species	Location	Assessment of effect		Potential adverse effect on site integrity
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)	
PTS due to a single strike at maximum hammer energy (SPL_{peak})				
Harbour seal	DBS East	0.00002 (0.0000005% of the Wash and North Norfolk Coast SAC)	0.00002 (0.0000005% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population would be at risk from PTS MMMP would reduce this risk further
	DBS West	0.00002 (0.0000004% of the Wash and North Norfolk Coast SAC)	0.00001 (0.0000004% of the Wash and North Norfolk Coast SAC)	

Species	Location	Assessment of effect		Potential adverse effect on site integrity
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)	
	OECC	0.0001 (0.000003% of the Wash and North Norfolk Coast SAC)	0.0001 (0.000003% of the Wash and North Norfolk Coast SAC)	
Piles in a 24 hour period (SEL_{cum})		**Two sequential monopiles**	**Four sequential jacket pin pile**	
Harbour seal	DBS East	0.012 (0.0003% of the Wash and North Norfolk Coast SAC)	0.003 (0.00008% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population would be at risk from PTS MMMP would reduce this risk further
	DBS West	0.01 (0.0002% of the Wash and North Norfolk Coast SAC)	0.003 (0.00006% of the Wash and North Norfolk Coast SAC)	
	OECC	N/A	0.12 (0.002% of the Wash and North Norfolk Coast SAC)	

8.3.7.3.1.2 Assessment of potential effects of the Projects together

731. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS, due to a sequential piling event, for both monopiles and jacket pin piles, is presented in **Table 8-64** using the harbour seal density from the Wash and North Norfolk Coast SAC calculated across the DBS East Array Area.

732. As a worst case the maximum number of marine mammals from each Project have been assessed to indicate the maximum number of marine mammals that could be impacted from DBS East and West together, if they are developed concurrently (**Table 8-101**).

Table 8-101 Assessment of the potential for instantaneous PTS due to a single strike of the maximum hammer energy for a monopile and jacket pin pile, and Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 hour Period for the Projects together

Species	Assessment of effect	Potential adverse effect on site integrity
Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)		
Harbour Seal	0.41 (0.01% of Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population would be at risk from PTS MMMP would reduce risk of PTS
Three concurrent installations at DBS East, DBS West, and OECC, with four sequential jacket pin piles at each location (total of 12 jacket pin piles installed in one day)		
Harbour Seal	0.43 (0.01% of Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population would be at risk from PTS MMMP would reduce risk of PTS

733. As outlined in section 8.3.1, a MMMP for piling, in accordance with **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)**, will be finalised post-consent in consultation with the MMO and relevant SNCBs. It will be based on the latest scientific understanding and guidance, as well as detailed project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of any permanent auditory injury (PTS) from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

734. The effective implementation of the MMMP for piling will reduce the risk of permanent auditory injury (PTS) to harbour seal during piling at the Projects. This mitigation alongside less than 1% of the population being affected, means would be **no adverse effect on the integrity of The Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to auditory injury (PTS) from increased underwater noise during construction (piling) for the Projects together**.

8.3.7.3.2 Impact 2: Disturbance or Behavioural effects from Underwater Noise During Piling

735. The range of possible behavioural reactions that may occur as a result of exposure to noise is described in section 8.3.6.3.2.

736. Harbour seal exhibit alternate periods of foraging and resting at haul out sites (during which limited, or no feeding occurs). Prolonged fasting also occurs in these species during annual breeding and moult, when there are marked seasonal changes in body condition (Bäcklin *et al*. 2011; Rosen and Renouf, 1997). Although adult seals may be relatively robust to short term (weeks rather than days) changes in prey resources, young and small individuals have a more sensitive energy balance. This is exhibited through effects of mass dependent survival (Harding *et al.* 2005).

737. (Russell, 2016) showed that harbour seal is present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2). This range has been used to determine the number of harbour seal that may be disturbed during piling at the Projects.

738. As per current best practice guidance (Southall *et al*. 2021), a behavioural disturbance dose-response analysis has been carried out for those species for which appropriate dose-response evidence exists within the scientific literature (see section 8.3.6.3.2).

739. More information on the method used and results of the dose response assessment can be found in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

8.3.7.3.2.1 Assessment of potential effects of the Projects alone

740. Regarding harbour seal, Russell (2016) has shown it to be present in significantly reduced numbers up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) for monopiles and 15km (706.86km^2) for one jacket pin pile foundation. This range has been used to determine the number of harbour seals that may be disturbed during piling at DBS East, DBS West or OECC (**Table 8-102**).

Table 8-102 Assessment of the Potential for Disturbance to Harbour Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East or DBS West in Isolation

Species	Potential disturbance range and area	Location	Assessment of effect	Potential adverse effect on site integrity
Monopiles				
Harbour seal	25km, with a disturbance area of 1,963.5km^2	DBS East	3.5 (0.089% of Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
		DBS West	2.9 (0.074% of Wash and North Norfolk Coast SAC)	
		OECC	23.6 (0.59% of Wash and North Norfolk Coast SAC)	
Jacket pin piles				
Harbour seal	15km, with a disturbance area of 706.86km^2	DBS East	1.3 (0.032% of Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
		DBS West	1.1 (0.026% of Wash and North Norfolk Coast SAC)	
		OECC	8.5 (0.21% of Wash and North Norfolk Coast SAC)	

741. A does response methodology (described in in section 8.3.6.3.2) has been undertaken for harbour seal. The estimated numbers (and percentage of the relevant reference populations) of harbour seal disturbed as a result of underwater noise during piling is presented in **Table 8-103**.

742. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADDs which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

Table 8-103 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East, DBS West, and the OECC in isolation Based on the Dose-Response Approach

Species	Location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance due to a single, maximum energy monopile strike (SEL_{SS})			
Harbour seal	DBS East	0.7 (0.01% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population effected
	DBS West	0.6 (0.02% of the Wash and North Norfolk Coast SAC)	
	OECC	4.0 (0.10% of the Wash and North Norfolk Coast SAC)	

8.3.7.3.2.1.1 Potential disturbance from ADD activation

743. The estimated numbers (and percentage of the relevant reference populations) of harbour seal disturbed as a result of underwater noise during piling after ADD duration of 80 minutes is presented in **Table 8-104**.

Table 8-104 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles or Jacket Pin Piles at DBS East or DBS West in isolation

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes as required for monopiles at DBS East, DBS West & Offshore Export Cable Corridor, and jacket pin piles at DBS East, and Offshore Export Cable Corridor			
Harbour seal	DBS East	0.29 (0.007% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	DBS West	0.24 (0.006% of the Wash and North Norfolk Coast SAC)	
	OECC	1.95 (0.05% of the Wash and North Norfolk Coast SAC)	

744. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in isolation**.

8.3.7.3.2.2 Assessment of potential effects of the Projects together

745. Regarding harbour seal and grey seal, a study has shown that harbour seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) (Russell, 2016). This range has been used to determine the number harbour seal that may be disturbed during piling at DBS East and DBS West together based on two monopiles being installed at any one time (or a disturbance area of 3,927km^2), and for installation of four consecutive jacket pin-piles installed at DBS East, DBS West and the OECC for three jacket pin pile foundations with a disturbance area of 2,120.58km^2 (**Table 8-105**).

Table 8-105 Assessment of the Potential for Disturbance to Harbour Seal Based on a Disturbance Range of 25km for Monopiles and 15km Jacket Pin Piles at Either DBS East and DBS West Together

Species	Potential disturbance range and area	Location	Assessment of effect	Potential adverse effect on site integrity
Harbour seal	Monopiles at two concurrent locations (EDR – 25km, with a disturbance area of 3,927km^2)	DBS East & West	47.1 (1.19% of Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	Jacket pin piles at three concurrent locations (EDR – 15km, with a disturbance area of 2,120.58km^2)	DBS East, West and OECC	25.4 (0.64% of Wash and North Norfolk Coast SAC)	

746. The estimated numbers (and percentage of the relevant reference populations) of harbour seal disturbed as a result of underwater noise during piling using the dose response approach are presented in **Table 8-106**.

747. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADDs which may reduce localised marine mammal densities prior to piling. This assessment can therefore be considered conservative.

Table 8-106 Number of Individuals (and % of Reference Population) That Could be Disturbed During Piling at DBS East and DBS West Together Based on the Dose-Response Approach

Species	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance at maximum energy monopile strike (SEL_{SS}) at two locations (DBS East and DBS West together)		
Harbour seal	4.7 (0.11% of the Wash and North Norfolk Coast SAC	**No** Less than 5% of the population effected

8.3.7.3.2.2.1 Population modelling

748. Although there is a very small impact of potential disturbance to harbour seal (less than 1%), in light of the declining population of the Wash and North Norfolk Coast SAC, population modelling has been carried out to show what the long term effects will be. As outlined in section 8.3.6.3.2.2.1 population modelling has been undertaken to determine whether the number of animals disturbed cause a population level effect for both DBS East and DBS West together sequentially as worst case for a declining harbour seal population.

749. The population modelling for harbour seal is based on:

- A worst case of up to 30 harbour seal disturbed;
  - Based on the dose response curve assessments (3.5 at DBS East, 2.9 at DBS West and 23.6 individuals in the OECC; **Table 8-102**).
- Up to one individual could at risk of PTS at DBS East, DBS West and the OECC (combined total from all three locations; **Table 8-100** and
- The above number of harbour seal being at risk of impact for every piling day with a piling schedule of 4 years.

750. Due to reports stating that the harbour seal population is in decline in the Wash and North Norfolk Coast SAC, the population modelling was undertaken with the parameters for a declining population as described in **Volume 7**, **Appendix 11-4 (application ref: 7.11.11.4)** (based on Sinclair *et al*. 2020).

751. For the Wash and North Norfolk Coast SAC population, by the end of 2032 (2 years after piling ends), the median population size for the impacted population is predicted to be 100% of the unimpacted population. Beyond 2034, the impacted population maintains relatively stable as the un-impacted population remains (100%) as far as 2052 which is the end point of the modelling (**Table 8-107**).

Table 8-107 Results of the iPCoD modelling for DBS East, DBS West and Offshore Export Cable Corridor sequentially scenario, giving the mean population size of harbour seal population (Wash SAC population) for years up to 2052 for both impacted and un-impacted population

Time period	Un-impacted pop mean	Impacted pop mean	Median impacted as % of unimpacted
Start	3,956	3,956	100.00%
End 2028	3,544	3,544	100.00%
End 2029	3,179	3,179	100.00%
End 2032	2,287	2,287	100.00%
End 2037	1,318	1,318	100.00%
End 2047	438	438	100.00%
End 2052	252	252	100.00%

752. **Plate 8-7** shows the mean unimpacted and the mean impacted population of harbour seal within the Wash and North Norfolk Coast SAC population. The graph shows that with piling at DBS East, DBS West and the OECC, there is no significant impact on the population of harbour seal. Therefore, the impact on the population is assessed as having no significant effect.

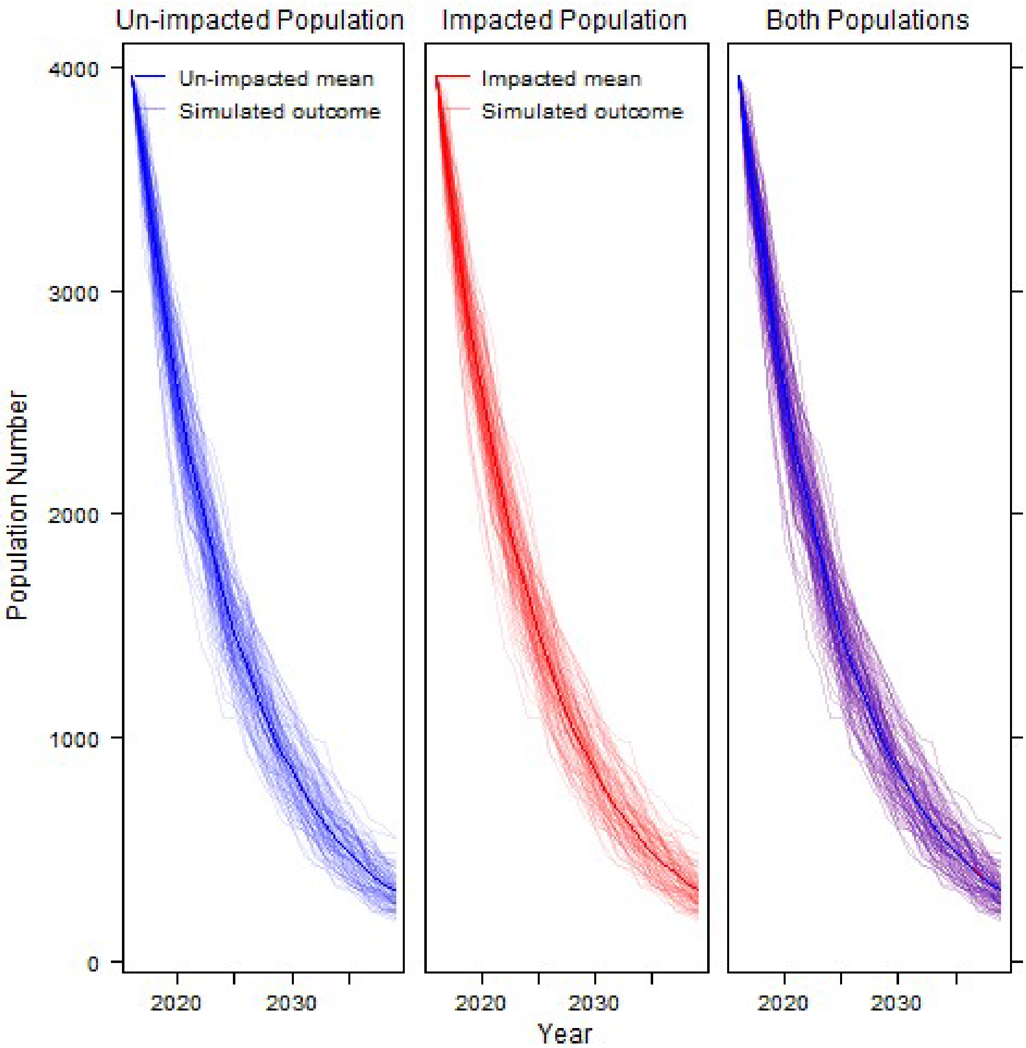


Plate 8-7 Simulated worst case harbour seal population sizes (The Wash SAC population) for both the unimpacted and the impacted populations.

753. Undertaking the population modelling, the Projects worst case scenario was used, which is the installation of monopiles at DBS East and DBS West, plus the OECC installed sequentially, therefore resulting in more disturbance days. The parameters are described in **Volume 7**, **Appendix 11-4 (application ref: 7.11.11.4)** and 104 days of piling was modelling for DBS East over a two year period, followed by DBS West (104 monopiles over two years) and randomly one monopiles in the OECC.

754. There is no significant impact on the Wash and North Norfolk Coast SAC population of harbour seal. Therefore, the impact on the population is assessed as having no adverse effect on site integrity.

8.3.7.3.2.2.2 Potential disturbance from ADD activation

755. The estimated numbers (and percentage of the relevant reference populations) of grey seal disturbed as a result of underwater noise during piling after ADD duration of 160 minutes for monopiles **Table 8-108**.

Table 8-108 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles or Jacket Pin Piles at DBS East or DBS West together

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes (160 minutes) as required for two monopiles at DBS East and DBS West			
Harbour seal	DBS East	0.58 (0.014% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	DBS West	0.48 (0.012% of the Wash and North Norfolk Coast SAC)	
	DBS East and DBS West together	0.53 (0.013% of the Wash and North Norfolk Coast SAC)	

756. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in together**.

8.3.7.3.3 Impact 3a: Auditory injury from underwater noise during other construction activities

757. Potential sources of underwater noise from construction activities is discussed in section 8.3.5.2.3 with more detail in seals in section 8.3.6.3.3.

758. The results of the underwater noise modelling indicate that any harbour seal would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours, to be exposed to noise levels that could induce PTS or TTS. As a precautionary approach the potential impact area for all activities occurring at the same time has also been determined (**Table 8-72**, section 8.3.6.3.3).

8.3.7.3.3.1 Assessment of potential effects of the Projects alone

759. The number of harbour seal that could be impacted as a result of underwater noise during construction activities other than piling has been assessed based on the number of animals that could be present in each of the modelled impact ranges (**Table 8-21**).

760. Given that less than 1% of the population (**Table 8-109**) would be at risk from auditory injury, there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury from increased underwater noise during other construction activities for the Projects alone**.

Table 8-109 Maximum Number of Individuals (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for Each Individual Activity and for all Activities at the Same Time at DBS East or DBS West in isolation

Species	Location	Maximum number of individuals (% of reference population) for PTS/TTS for each individual activity	Maximum number of individuals (% of reference population) for PTS/TTS for all activities at the same time	Potential adverse effect on site integrity
Harbour seal	DBS East	0.00005 (<0.0001% of the Wash and North Norfolk SAC)	0.001 (<0.0001% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population would be at
	DBS West	0.00005 (<0.0001% of the Wash and North Norfolk Coast SAC)		

Species	Location	Maximum number of individuals (% of reference population) for PTS/TTS for each individual activity	Maximum number of individuals (% of reference population) for PTS/TTS for all activities at the same time	Potential adverse effect on site integrity
	OECC	0.0004 (<0.0001% of the Wash and North Norfolk Coast SAC)		risk from auditory injury.

8.3.7.3.3.2 Assessment of potential effects of the Projects together

761. As a worst-case, the maximum number of marine mammals from each Project has been assessed to indicate the maximum number of marine mammals that could be impacted from the Projects together, if they are developed concurrently (**Table 8-110**).

762. Given that less than 1% of the population would be at risk from auditory injury, there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to auditory injury from increased underwater noise during other construction activities for the Projects together.**

Table 8-110 Maximum Number of Individuals (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities Based on Underwater Noise Modelling for All Activities at the Same Time at the Projects

Species	Location	Maximum number of individuals (% of reference population) for PTS/TTS for all activities at the same time	Potential adverse effect on site integrity
Harbour seal	DBS East	0.0004 (0.00001% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population would be at risk from auditory injury.
	DBS West	0.0004 (0.000009% of the Wash and North Norfolk Coast SAC)	
	OECC	0.003 (0.00007% of the Wash and North Norfolk Coast SAC)	

8.3.7.3.4 Impact 3b: Disturbance from underwater noise during other construction activities

763. If the response is displacement from the area, it is predicted that harbour seal will return once the activity has been completed. Therefore, any impacts from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. There is unlikely to be potential for any significant disturbance impact on marine mammals. Further information into the assessment around disturbance is discussed in section 8.3.6.3.4.

8.3.7.3.4.1 Assessment of potential effects of the Projects alone

764. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range (with an effect area of 50.27km^2). This is a precautionary approach as it is unlikely that all harbour seal would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place in the Offshore Development Area (**Table 8-111**).

765. Given that less than 5% of the population would be at risk from disturbance, there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to disturbance from increased underwater noise during other construction activities for the Projects alone**.

Table 8-111 Assessment of the Potential for Disturbance Due to Other Construction Activities, for One and Multiple Activities Taking Place at Any One Time Either at DSB East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for disturbance for each individual activity (50.27km²)	Maximum number of individuals (% of reference population) for disturbance for multiple construction activity (201.06km²)	Potential adverse effect on site integrity
Harbour seal	DBS East	0.09 (0.002% of the Wash and North Norfolk Coast SAC)	0.4 (0.009% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population would be at risk from disturbance.
	DBS West	0.08 (0.002% of the Wash and North Norfolk Coast SAC)	0.3 (0.008% of the Wash and North Norfolk Coast SAC)	
	OECC	0.603 (0.015% of the Wash and North Norfolk Coast SAC)	2.4 (0.06% of the Wash and North Norfolk Coast SAC)	

8.3.7.3.4.2 Assessment of potential effects of the Projects together

766. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities based on the 4km potential disturbance range at DBS East and DBS West Together for up to eight vessels (with an effect area of 402.12km²) is presented in **Table 8-112**. This is a precautionary approach as it is unlikely that all marine mammal species would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place in the Offshore Development Area (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** for further information). The assessment has been undertaken on the worst case density within the Offshore Development Area for each species.

767. Given that less than 5% of the population would be at risk from disturbance, there would be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to disturbance from increased underwater noise during other construction activities for the Projects together**.

Table 8-112 Assessment of The Potential for Disturbance Due to Other Construction Activities Taking Place at Any One Time at DBS East and DBS West Together

Species	Location	Maximum number of individuals (% of reference population) for disturbance for all activities at the same time	Potential adverse effect on site integrity
Harbour seal	DBS East	0.72 (0.018% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population would be at risk from disturbance.
	DBS West	0.6 (0.015% of the Wash and North Norfolk Coast SAC)	
	OECC	4.8 (0.12% of the Wash and North Norfolk Coast SAC)	

8.3.7.3.5 Impact 4a: Auditory injury from Underwater Noise due to the Presence of Vessels

768. See section 8.3.6.3.5.

8.3.7.3.5.1 Assessment of potential effects of the Projects alone

769. Impact ranges for PTS / TTS for large and medium vessels for all species are less than 100m (<0.03km^2; see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). Results and assessments are based on risk of auditory injury.

770. The potential effect of auditory injury (without any mitigation) that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Project and would be limited to only part of the overall construction period and area at any one time.

771. The assessment of the potential impact for any auditory injury as a result of construction vessels, for either one vessel, or up to 32 vessels (26 in the Array Areas, and six in the OECC), shows less than 5% of the reference populations exposed to any temporary impact (**Table 8-113**).

Table 8-113 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East, DBS West or OECC in isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
For one vessel			
Harbour seal	DBS East	<0.0001 (<0.000001% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population affected
	DBS West	<0.0001 (<0.000001% of the Wash and North Norfolk Coast SAC)	
	OECC	<0.0001 (<0.00001% of the Wash and North Norfolk Coast SAC)	
For up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the OECC]			
Harbour seal	DBS East	0.002 (0.00004% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population affected
	DBS West	0.001 (0.00004% of the Wash and North Norfolk Coast SAC)	
	OECC	0.002 (0.00005% of the Wash and North Norfolk Coast SAC)	

772. The population affected from underwater noise (auditory injury) due to the presence of vessels at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation**.

8.3.7.3.5.2 Assessment of potential effects of the Projects together

773. The number of marine mammals that could be impacted as a result of underwater noise from construction vessels has been assessed based on the number of animals that could be present in each of the modelled impact ranges applied to the number of vessels that could be on site at any one time (n=59). This assessment is based on the worst case density estimate across the project areas.

774. The potential impact for any PTS / TTS as a result of construction vessels, for up to 59 vessels in the Offshore Development Area (47 in the Array Areas, and 12 in the OECC), shows less than 1% of the reference population in relation to harbour seal as exposed to any temporary impact (**Table 8-114**).

775. The potential for PTS / TTS effects that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Projects of five to seven years and would be limited to only part of the overall construction period.

Table 8-114 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East, DBS West and OECC Together

Species	Location	Maximum number of individuals (% of reference population) potentially disturbed from 47 vessels within the Array Areas, and 12 in the Offshore Export Cable Corridor	Potential adverse effect on site integrity
Harbour seal	DBS East	0.003 (0.00008% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population affected
	DBS West	0.003 (0.00007% of the Wash and North Norfolk Coast SAC)	
	OECC	0.0043 (0.0001% of the Wash and North Norfolk Coast SAC)	

776. The population affected from underwater noise (auditory injury) due to the presence of vessels at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal from increased underwater noise (auditory injury) due to the presence of vessels for the Projects together**.

8.3.7.3.6 Impact 4b: Disturbance from Underwater Noise due to the Presence of Vessels

777. Seals vary in their relation to vessels, for more information see section 8.3.6.3.6.

8.3.7.3.6.1 Assessment of potential effects of the Projects

778. To assess for vessel disturbance in the Array Areas, a 4km buffer has been added around each Array Area. For DBS East Array Area, the impact area is 696.01km^2 and for DBS West Array the impact area is 708.90km^2 (**Table 8-29**; **Plate 8-3**). For the OECC, there will be a maximum of six vessels at one time. Therefore, a 4km impact range has been added per vessel. For six vessels, the total effect range for the potential of disturbance from vessel activity is 301.56km^2.

779. The potential impact on harbour seals of disturbance from vessels in isolation is assessed in **Table 8-115**.

Table 8-115 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
For one vessel			
Harbour seal	DBS East	0.09 (0.002% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	DBS West	0.08 (0.002% of the Wash and North Norfolk Coast SAC)	
	OECC	0.6 (0.015% of the Wash and North Norfolk Coast SAC)	
For up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the OECC]			
Harbour seal	DBS East	1.3 (0.03% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	DBS West	1.1 (0.03% of the Wash and North Norfolk Coast SAC)	
	OECC	3.6 (0.09% of the Wash and North Norfolk Coast SAC)	

780. The population affected by disturbance from underwater noise due to the presence of vessels at the Projects is less than 5%. The impact range will be constantly moving with the vessel, and not remain within the full area as assessed. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation**.

781. Vessels transiting to and from the Offshore Development Area can also cause disturbance. Table 11-73 within **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** presents a list of port options that will be used during construction. As a worst-case, the assessment of vessel disturbance during transit from DBS West to Lowestoft is used as that is the greatest distance. Taking the same approach ass section 8.3.6.3.6.1; the impact range has been calculated using a 4km buffer around the moving vessel during transit which results in an estimated 1,200km^2 impact area of disturbance.

782. **Table 8-116** presents the number of individuals that could be temporarily disturbed by the vessel transits. These assessments are based on the worst case density across the Offshore Development Area.

Table 8-116 Maximum Number of Individuals (and % of Reference Population) that Could Be Disturbed as a Result of Underwater Noise Associated with transiting vessels during construction

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Harbour seal	DBS East	2.2 (0.054% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	DBS West	1.8 (0.045% of the Wash and North Norfolk Coast SAC)	
	OECC	14.4 (0.36% of the Wash and North Norfolk Coast SAC)	

783. The population affected by disturbance from underwater noise due to the presence of transiting vessels at the Projects is less than 5%. The impact range will be constantly moving with the vessel, and not remain within the full area as assessed. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation**.

8.3.7.3.6.2 Assessment of potential effects of the Projects

784. The maximum number of construction vessels on site at any one time will be up to 59 vessels, with 12 of those vessels being within the OECC. This would equate to up to 47 vessels across the Array Areas at any one time. Therefore, the same approach as outlined in section 8.3.6.3.6.2 with an impact area of 1,404.9km^2 for both DBS East and DBS West Array Areas

785. To assess for potential disturbance of the vessels in the OECC, and the impact range has been calculated for an impact area of 603.19km^2 to represent 12 vessels within the OECC (**Table 8-117**).

Table 8-117 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West together

Species	Location	Maximum number of individuals (% of reference population) potentially disturbed from 47 vessels within the Array Areas, and 12 in the Offshore Export Cable Corridor	Potential adverse effect on site integrity
Harbour seal	DBS East	2.5 (0.06% of the Wash and North Norfolk Coast SAC)	**No** Less than 5% of the population affected
	DBS West	2.1 (0.05% of the Wash and North Norfolk Coast SAC)	
	OECC	3.6 (0.09% of the Wash and North Norfolk Coast SAC)	

786. To assess for potential disturbance from transiting vessels the same approach has been taken as described in section 8.3.6.3.6.1 (**Table 8-80**) with the effect of significance presented in **Table 8-117**.

787. Therefore, with less than 5% of the Wash and North Norfolk Coast SAC population temporarily disturbed due to a vessel transiting, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects together**.

8.3.7.3.7 Impact 5: Barrier Effects as A Result of Underwater Noise During Construction

8.3.7.3.7.1 Assessment of potential effects of the Projects alone

788. Underwater noise during construction could have the potential to create a barrier effects, preventing movement or migration of harbour seal between important feeding and / or breeding areas, or potentially increasing swimming distances if harbour seal avoid the site and go around it.

789. The Wash and North Norfolk Coast SAC is located, at closest point, 180km from DBS East Array Area, 178km from DBS West Array Area at the closest point and 118km from the OECC.

790. Telemetry studies and the relatively low seal at sea usage (Carter *et al.* 2022) in and around the Offshore Development Area do not indicate any regular seal foraging routes through the sites. Russell (2016), showed that harbour seal will still undertake foraging activities during OWF construction activities; so there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of harbour seal.

791. A tagging study was undertaken for harbour seals within the outer Thames estuary, through the Thames Harbour Seal Conservation Project (Barker *et al.* 2014). This study included the tagging of harbour seals in 2012. The results of this tagging study were used to define foraging areas of harbour seal within the outer Thames area. The activity of the seals while tagged was used to identify key foraging areas, with five such areas being found, which were all located within 4.5km of the nearest haul-out site. These foraging locations were plotted against the OWFs in the area (at the time of the study), which shows that the round 3 East Anglia sites were the furthest they travelled, which is just over 100km from haul-out sites. The Projects are not located near to any of the five identified key foraging areas (Barker *et al.* 2014).

792. The greatest potential barrier effect for harbour seal could be from underwater noise during piling. Piling would not be constant during the piling phases and construction periods. There will be gaps between the installations of individual piles, and if installed in groups there could be periods when piling is not taking place as piles are brought out to the site. There will also be potential delays for weather or other technical issues. Therefore, any disturbance and any barrier effects from piling would be temporary and for a relatively short duration.

793. There is unlikely to be the potential for any barrier effects from underwater noise for other construction activities and vessels, as it is predicted that harbour seal will return once the activity has been completed. Therefore, any effects from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. There is unlikely to be the potential for any barrier effects that could significantly restrict the movements of marine mammals.

794. Harbour seal have foraging ranges of up to 273km (Carter *et al.* 2022). Therefore, if there are any potential barrier effects from underwater noise, marine mammals would be able to compensate by travelling to other foraging areas within their range.

795. If any barrier effects occur due to underwater noise from piling, it is predicted that harbour seal will return once the activity has bene completed, and therefore any effects from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. Therefore, there is unlikely to be the potential for any barrier effects that could significantly restrict the movements of harbour seal.

796. Therefore, there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to potential barrier effects from increased underwater noise during construction for the Projects in isolation**.

8.3.7.3.7.2 Assessment of potential effects of the Projects together

797. See section 8.3.7.3.7.1. Disturbance and any barrier effects would be temporary and for a relatively short duration (i.e., during active piling). It is unlikely that all harbour seal potentially affected would be from The Wash and North Norfolk SACSAC, which is located at the closest point; 228km from DBS East Array Area and 194km from DBS West Array Area.

798. Disturbance and any barrier effects during piling would be temporary and for a relatively short duration (i.e. during active piling). Therefore, there would be no significant disturbance of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to potential barrier effects from increased underwater noise during construction for the Projects together**.

8.3.7.3.8 Impact 6: Increased Collision Risk with Vessels During Construction

8.3.7.3.8.1 Assessment of potential effects of the Projects alone

799. During the offshore construction phase of the Projects there will be an increase in vessel traffic within and on transit to the Offshore Development Area. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area. **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)** provides details on vessel good practice and code of conduct that will be implemented to avoid marine mammal collisions.

800. The collision risk has been estimated using data from CSIP and SMASS data as described in section 8.3.6.3.8.1 and **Table 8-118**.

Table 8-118 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collisions with Vessels

Species	Number of strandings	Number of post-mortems where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from vessels	Collision risk rate (%) (number attributed to vessels strike / other physical trauma as proportion of total known cause of death)
Harbour seal	624	185	5	0	0.0270

801. The potential number of harbour seal that could potentially be at risk of collision with vessels is less than one individual (**Table 8-119**).

802. All vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals (see **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**).

803. Therefore, there would be no increased collision risk of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to increased collision risk from construction vessels for the Projects in isolation.**

Table 8-119 Predicted Number of Harbour Seal at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (AEoI Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West in Isolation and Together

	DBS East or DBS West in Isolation	DBS East or DBS West together
Collision risk rate[16]	0.0270	
Estimated total number of individuals in UK waters[17]	42,900	
Estimated number of individuals at risk within UK waters	1,159	
Annual number of vessel transits in UK and RoI for 2015[15]	38,520.30	
Number of marine mammals at risk of collision per vessel in UK waters	0.0003	
Number annual vessel transits associated with construction	772	1,502

[16] Where species specific data is not available, the species group data is used (SCOS, 2022) UK population estimates for seal species
[17] Latest publicly available data

	DBS East or DBS West in Isolation	DBS East or DBS West together
Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	Less than one animal (0.2)	Less than one animal (0.5)
% reference population	0.006% of the Wash and North Norfolk Coast SAC	0.011% of the Wash and North Norfolk Coast SAC
Potential adverse effect on site integrity	No – Less than 1% of population affected	No – Less than 1% of population affected

8.3.7.3.8.2 Assessment of potential effects of the Projects together

804. As a precautionary assessment, the number of harbour seal that could be at increased risk of collision with construction vessels, if DBS East and DBS West are constructed concurrently, has been based on the estimated maximum number of construction vessel transits for both Array Areas of up to 1,502 (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

805. To estimate the potential collision risk of vessels associated with DBS East and DBS West Array Areas during construction together, the same approach has been taken as for the Projects alone (see section 8.3.7.3.8.1).

806. The potential number of harbour seal that could potentially be at risk of collision with vessels is less than one individual (**Table 8-119**).

807. This is a highly precautionary, as it is unlikely that all harbour seal would be at increased collision risk with vessels during construction, considering the existing number of vessel movements in the area, and that vessels within the windfarm would be stationary for much of the time or very slow moving. Taking into account the disturbance from vessels, the actual risk is likely to be very low or negligible for all species.

     There would be no increased collision risk of harbour seal and **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to increased collision risk from construction vessels for the Projects together**.

8.3.7.3.9 Impact 7: Changes to Prey Resources

808. The potential effects on prey species during construction can result from:

- Physical seabed disturbance;
- Increased SSC and sediment re-deposition;
- Remobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Changes in fishing activity.

809. As discussed in the harbour porpoise section (section 8.3.5.2.9) and in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes impacts of negligible to minor adverse significance in EIA terms. Any reductions in prey availability would be small scale, localised and temporary. It is considered highly unlikely that potential reductions in prey availability as a result of construction activities at the Projects would result in detectable changes to harbour seal populations.

810. Harbour seal feed on a variety of prey species and are considered to be opportunistic feeders, feeding on a wide range of prey species and they have relatively large foraging ranges (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

811. The potential impacts of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment, underwater noise and vibration and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there will be **no adverse effect on the integrity of The Wash and North Norfolk SAC in relation to the conservation objectives for harbour seal due to potential changes in prey availability during construction for the Projects in isolation or together**.

8.3.7.3.10 Impact 8: Disturbance at seal haul-out sites

812. The Wash and North Norfolk Coast SAC is located, at closest point, 180km from the closest point at DBS East Array Area and 168km from the closest point at DBS West Array Area. The closest harbour seal haul out site is the Wash which sits 119km from landfall and the OECC. Blakeney Point is closer to the Array Areas, sitting 167km from DBS East Array Area and 179km from DBS West Array Area at the closest distance.

813. A study on harbour seals, using remote video monitoring showed hauled out 10km from the Nysted OWF, at Rødsand seal sanctuary showed that there was no disturbance to the hauled out seals during the construction period (thought to be due to boat regulations), but that during periods of piling the number of seals on land decreased significantly (between 31 and 61%) (Edrén *et al*. 2004). However, the seal haul-out sites are greater than 100km away from piling activity so any piling activity at the Projects should not cause any disturbance to seals hauled out.

814. As studies on the distance of disturbance, on land or in the water, for hauled-out harbour seals have found that the closer the disturbance, the more likely seals are to move into the water. The estimated distance at which most seal movements into the water occurred, varies between study site and type of disturbance but has been estimated at typically less than 100m (Wilson, 2014).

815. A study was carried out by SMRU (Paterson *et al.* 2015) using a series of controlled disturbance tests at harbour seal haul-out sites, consisting of regular (every three days) disturbance through direct approaches by vessels and effectively 'chasing' the seals into the water. The seal behaviour was recorded via GPS tags and found that even intense levels of disturbance did not cause seals to abandon their haul-out sites more than would be considered normal (for example seals travelling between sites) and the seals were found to haul-out at nearby sites or to undertake a foraging trip in response to the disturbance (but would later return).

816. Further studies on the effects of vessel disturbance on harbour seals when they are hauled out, suggest that even with repeated disturbance events that are severe enough to cause individuals to flee into the water, the likelihood of harbour seals moving to a different haul-out site would not increase. Furthermore, this appeared to have little effect on their movements and foraging behaviour (Paterson *et al.* 2019).

817. A study by Jansen *et al.* (2010) of the reactions of harbour seal from cruise ships found that, if a cruise ship was less than 100m from a harbour seal haul-out site, individuals were 25 times more likely to flee into the water than if the cruise ship was at a distance of 500m from the haul-out site. At distances of less than 100m, 89% of individuals would flee into the water, at 300m this would fall to 44% of individuals, and at 500m, only 6% of individuals would flee into the water. Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

818. Vessel activity, transitioning from the Projects to port have the potential to cause disturbance to seal haul-haul out sites. The construction ports to be used for DBS East and DBS West are not yet confirmed. However, a short list has been provided in Table 11-83 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. If Lowestoft or Great Yarmouth ports are used, there is a potential risk of disturbance to the harbour seals hauled out around the Wash and North Norfolk Coast SAC such as Blakeney Point. Although Blakeney Point is approximately 95km from the closest port, vessels may need to transit past. Although, movements to and from any port will be incorporated within existing vessel routes.

819. Vessel movements to and from any of these ports will be incorporated within existing vessel routes, where available. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels.

820. It is expected that if there is any disturbance to seals at haul-out sites from construction activities it is a short-term effect. For example, a 2019 study on harbour seals in Scotland found that 30 minutes after a disturbance event, seals return to 52% pre-disturbance levels at haul-out sites and 94% pre-disturbance levels four hours after a disturbance event (Paterson *et al.* 2019).

8.3.7.3.10.1 Assessment of potential effects of the Projects alone

821. In total, for the construction of either DBS East or DBS West, up to 896 transits from the Offshore Development Area to port per year during five-year construction period for both DBS East and DBS West in isolation.

822. However, taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels. Therefore, the significance of effect of harbour seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be low. Vessel operators can also use best practice and remain at least 500m away from any seal haul-out sites to reduce any risk of potential disturbance.

823. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for Harbour seal due to disturbance at seal haul-out sites during construction for the Projects alone**.

8.3.7.3.10.2 Assessment of potential effects of the Projects together

824. In total, for the construction of DBS East and DBS West together, up to 1,752 vessel transits from the Offshore Development Area to the ports per year.

825. However, as mentioned above, vessel operators can remain at least 500m away from haul out sites to reduce any risk of potential disturbance.

826. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance at seal haul-out sites during construction for the Projects together**.

8.3.7.4 Potential effects during Operation and maintenance

827. The potential effects during operation and maintenance that have been assessed for are:

828. Auditory injury and disturbance or behavioural impacts resulting from operational WTGs;

- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during maintenance activities, including cable protection and cable reburial;
- Auditory injury and disturbance from the underwater noise associated with the presence of vessels;
- Barrier effects as a result of underwater noise;
- Vessel interaction (collision risk);
- Changes to prey resources; and
- Disturbance to seal haul-outs.

8.3.7.4.1 Impact 1a: Auditory injury due to Operational Wind Turbine Noise

829. The effect of operational wind turbines on marine mammals, including harbour seals is described further in section 8.3.5.3.1 and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. Underwater noise modelling was undertaken by Subacoustech Environmental Ltd to estimate the noise levels likely to arise during the operational phase (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) and determine the potential effects on marine mammals. Key information on the methodology of underwater noise modelling and the full results of the assessments for marine mammals is provided in **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**.

8.3.7.4.1.1 Assessment of potential effects of the Projects alone

830. The number of harbour seal that could be impacted as a result of underwater noise from operational wind turbines has been assessed based on the number of animals that could be present in the modelled impact area (**Table 8-120**).

831. It is important to note that PTS is unlikely to occur in harbour seal, as the modelling indicates that the harbour seal would have to remain less than 100m from a turbine for 24 hours for any potential risk of PTS.

Table 8-120 Predicted Impact Ranges (And Areas) for PTS or TTS from 24 hour Cumulative Exposure of Underwater Noise From Operational Turbines

Species	Impact	Operational wind turbine	Area of impact for up to 100 Wind turbines
Harbour seal	PTS or TTS	<0.1km (0.031km^2)	3.1km^2

832. There is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that the harbour seal would have to remain less than 100m from a turbine for 24 hours in a day (**Table 8-120**). However, as a precautionary approach the number of harbour seals that could be at risk of auditory injury has been estimated (**Table 8-121**). As outlined previously this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been rounded up to 100m.

833. It is likely that more than one wind turbine will be operating at the same time, and therefore an assessment of the potential for auditory injury, due to all operational wind turbines, is required as described in section 8.3.6.4.1.1.

834. The potential impact for any auditory injury as a result of underwater noise from 100 operational wind turbines at DBS East or DBS West, is not significant for harbour seal with less than 1% of the reference population exposed to any long-term impact (**Table 8-85**).

835. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to auditory injury from increased underwater noise from operational wind turbines at the Projects in isolation**.

Table 8-121 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East and DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Potential adverse effect on site integrity
Harbour seal	DBS East	0.006 (0.0001% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population at risk of auditory injury.
	DBS West	0.005 (0.0001% of the Wash and North Norfolk Coast SAC)	

8.3.7.4.1.2 Assessment of potential effects of the Projects together

836. The number of harbour seals that could be impacted as a result of underwater noise from operational wind turbines at DBS East and DBS West together has been assessed using the same method described in section 8.3.6.4.1.2 with the potential impact area for the 200 operational wind turbines at DBS East and DBS West together is up to 6.28km^2.

837. An assessment of the maximum number of individuals that could be at risk of TTS, due to the underwater noise associated with all operational wind turbines is presented in **Table 8-122**.

838. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to auditory injury from increased underwater noise from operational wind turbines at the Projects together**.

Table 8-122 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory injury as a Result of Underwater Noise Associated with Operational Turbines at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for 200 wind turbines (*highest density in the Projects*)	Potential adverse effect on site integrity
Harbour seal	0.01 (0.0003% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population at risk of auditory injury.

8.3.7.4.2 Impact 1b: Disturbance due to Operational Wind Turbine Noise

839. Disturbance due to operational wind turbines in relation to harbour seals is the same as that discussed in section 8.3.6.4.2. Monitoring studies at Nysted and Rødsand have indicated that operational activities have had no impact on regional seal populations (Teilmann *et al*. 2006; McConnell *et al*. 2012). Tagged harbour seals have been recorded within two operational OWF sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around WTGs (Russell *et al*. 2014). Data collected suggests that any behavioural responses for seal may only occur up to a few hundred metres away (Touggard *et al*. 2009b; McConnell *et al*. 2012).

840. Therefore, previous studies have showed that there would potentially be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from operational wind turbine noise at the in isolation or together**.

8.3.7.4.3 Impact 2a: Auditory injury from Underwater Noise Associated with Operation and Maintenance Activities

841. See section 8.3.7.3.3.1 and 8.3.7.3.3.2 for further information. The effects during operations and maintenance due to the shorter duration and the fewer number of activities taking place at one time are less than during the construction phase and therefore there would be less auditory injury.

842. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to auditory injury from underwater noise associated with operation and maintenance activities at the Projects in isolation and together**.

8.3.7.4.4 Impact 2b: Disturbance from Underwater Noise Associated with Operation & Maintenance Activities

843. See section 8.3.7.3.2.1 and 8.3.7.3.2.2 for further information. The effects during operations and maintenance due to the shorter duration and the fewer number of activities taking place at one time are less than during the construction phase and therefore there would be lower levels of overall disturbance.

844. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from underwater noise associated with operation and maintenance activities at the Projects in isolation or together**.

8.3.7.4.5 Impact 3a: Auditory injury from Underwater Noise due to the Presence of Vessels

845. See section 8.3.6.4.5 for further information on this impact.

8.3.7.4.5.1 Assessment of potential effects of the Projects alone

846. The results of the underwater noise modelling for auditory injury are described in section 8.3.6.4.5.1. The assessment has been carried out for 20 vessels, with a potential impact area of $0.6km^2$.

847. Therefore, as there is less 1% of the population affected, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from underwater noise (auditory injury) associated with operation and maintenance vessels at the Projects in isolation** (**Table 8-123**).

Table 8-123 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for up to 20 vessels	Potential adverse effect on site integrity
Harbour seal	DBS East	0.001 (0.00003% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population at risk of Auditory injury.
	DBS West	0.001 (0.00002% of the Wash and North Norfolk Coast SAC)	
	OECC	0.007 (0.0002% of the Wash and North Norfolk Coast SAC)	

8.3.7.4.5.2 Assessment of potential effects of the Projects together

848. The maximum number of vessels in the Offshore Development Area is 21, which provides an impact area of 0.63km^2 (See section 8.3.6.3.3 for more information).

849. **Table 8-124** presents that less than 1% of the Wash and North Norfolk Coast SAC harbour seal population will be affected.

850. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from underwater noise (auditory injury) associated with operation and maintenance vessels at the Projects together**.

Table 8-124 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for up to 21 vessels	Potential adverse effect on site integrity
Harbour seal	0.008 (0.0002% of the Wash and North Norfolk Coast SAC)	**No** Less than 1% of the population at risk of Auditory injury

8.3.7.4.6 Impact 3b: Disturbance from Underwater Noise due to the Presence of Vessels

851. If the behavioural response is displacement from the area, it is predicted that harbour seal will return once the activity has been completed and therefore any impacts from underwater noise as a result of operation and maintenance vessels will be both localised and temporary. Therefore, there is unlikely to be the potential for any significant impact on harbour seal.

8.3.7.4.6.1 Assessment of potential effects of the Projects alone

852. As vessel activity is lower in operation and maintenance compared to the construction phase. The number of harbour seals that could potentially be disturbed will be lower, therefore using the assessment presented in **Table 8-115** (section 8.3.7.3.6.1) as a worst case shows that less than 1% of the population could be affected.

853. **Table 8-116** (section 8.3.7.3.6.1) presents the number of individuals that could be temporarily disturbed by the vessel transits which is less than 1% of the Wash and North Norfolk Coast SAC. Therefore, with less than one individual being affected, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects in isolation**.

8.3.7.4.6.2 Assessment of potential effects of the Projects together

854. To assess for potential disturbance form vessel activity if DBS East and DBS West were constructed together, the maximum number of vessels in the Offshore Development Area would be 21, which is less than 59 in construction.

855. Therefore, as a worst case the maximum number of harbour seal from the assessment in **Table 8-117 (**section 8.3.7.3.6.2) show that less than 1% of the population will potentially be affected.

856. **Table 8-116** (section 8.3.7.3.6.1) presents the number of individuals that could be temporarily disturbed by the vessel transits which is less than 1% of the Wash and North Norfolk Coast SAC. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects together**.

8.3.7.4.7 Impact 4: Barrier Effects

857. Based on the qualitative assessment carried out in section 8.3.7.3.7, it is considered that there would be no barrier effects due to operational wind turbines.

858. Therefore, there would be no significant effects on harbour seal and **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to potential barrier effects from underwater noise during operation and maintenance for the Projects in isolation or together**.

8.3.7.4.8 Impact 5: Increased Collision Risk with Vessels During Operation and Maintenance

859. It is estimated that the maximum number of vessels that could be required on site at any one-time during operation and maintenance could be up to 21 at the Offshore Development Area, as described in section 8.3.6.4.8.

860. The assessment of collision risk, as presented for the construction phase (section 8.3.7.3.8; **Table 8-120**), is based on the total Offshore Development Area, within which additional vessels may be present, and is not based on the number of vessels present within that area. At either DBS East or DBS West, there may be up to 239 vessel round trips for the Projects alone, or up to 474 transits for the Projects together, which is significantly less than the round trips required for construction.

861. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

862. In line with the construction assessment, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to increased collision risk from operation and maintenance vessels for the Projects in isolation or together**.

8.3.7.4.9 Impact 6: Changes to Prey Resources

863. Any impact on prey species has the potential to affect harbour seal. As outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, the potential impacts on fish species during operation and maintenance can result from:

- Permanent Habitat Loss;
- Temporary Habitat Loss, Physical Disturbance of the Seabed, Increased Suspended Sediment and Sediment Deposition;
- Underwater Noise;
- EMF; and
- Changes in Fishing Activity.

864. Any effects on prey species have the potential to affect marine mammals. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** found no difference in the significance of effect on receptors when assessed for DBS East and / or DBS West in isolation or together. Further information of the potential effects from the individuals' impacts is provided in section 8.3.5.3.9.

865. The potential effects of physical disturbance, permanent and temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment underwater noise, EMF and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there would therefore be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to changes in prey availability (from permanent habitat loss resulting from the introduction of hard substrates) during the operation and maintenance phase of the Projects in isolation or together**.

8.3.7.4.10 Impact 7: Disturbance at seal haul-out sites

866. As assessed in section 8.3.7.3.10, the Wash and North Norfolk Coast SAC is located 180km from the closest point at DBS East Array Area and 168km from the closest point at DBS West Array Area. The closest harbour seal haul-out site is the Wash which sits 119km from landfall and the Offshore Export Cable Corridor. Blakeney Point is closer to the Array Areas, sitting 167km from DBS East Array Area and 179km from DBS West Array Area at the closest distance.

867. The studies by Edren *et al.* (2010) and Russell, (2016), found there to be disturbance at seal haul-out sites (4km and 25km, respectively) during operation and maintenance activities. Due to the distances of the haul out sites from the Projects, it is very unlikely that any operation and maintenance activities will cause a disturbance. The potential for any increase in disturbance to seal haul-out sites as a result of operation activities will be from vessel movements during operation and maintenance.

868. In total, for the operation and maintenance of either DBS East or DBS West is up to 239 round trips to port from the Offshore Development Area each year for five years. This represents a slight increase in the current number of vessels in the area.

869. Taking into account the proximity of shipping channels to and from existing ports, it is likely that seals hauled-out along these routes and in the area of the ports would be habituated to the noise, movements and presence of vessels.

870. As described in section 8.3.7.3.10, it has not been confirmed which ports will be used, but a short list has been provided in Table 11-83 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**. If Lowestoft or Great Yarmouth ports are used, transiting vessels would maintain distances of at least 500m or more off the coast, particularly in areas near known seal haul-out sites during sensitive periods.

871. The assessment within **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** considered the significance of effect to be assessed as minor adverse (not significant) for harbour seals in EIA terms for the Projects in isolation or together.

872. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due to disturbance at seal haul-out sites during the operation and maintenance phase of the Projects in isolation or together**.

8.3.7.5 Potential effects during decommissioning

873. Potential effects on harbour seal associated with decommissioning have not been assessed in detail, as further assessments will be carried out ahead of any decommissioning works to be undertaken, as described in section 8.3.6.5.

874. Therefore, the potential effects on harbour seal during decommissioning would be the same or less than those assessed for construction. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal in relation to the decommissioning phase of the Projects in isolation or together**.

8.3.7.6 Potential in-combination effects

875. The in-combination assessment considers other schemes and activities where the predicted effects have the potential to combine with the potential effects during construction of the Projects. The construction phase has been assessed as the worst case for potential in-combination effects.

876. The schemes screened into the in-combination assessment for harbour seal are those that are located in the relevant seal MUs, based on IAMMWG (2013). The harbour seal population in the Wash and North Norfolk Coast SAC, has been defined as part of the southwest MU area, therefore this resulted in the screening area. Full information on the screening of effects considered for the in-combination assessment is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

877. The marine mammal in-combination assessment will consider schemes which have sufficient information available to undertake the assessment, and will include the potential effects of:

- Underwater noise;
- Barrier effects
- Vessel interaction;

- Disturbance to seal haul-out sites; and
- Changes to prey resources (including habitat loss).

878. The in-combination screening identified that there is the potential for cumulative effects on harbour seals as a result of disturbance from underwater noise during piling and other construction activities. All operational impacts have been screened out of the assessment (see section 8.3.5.5). Further information is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

8.3.7.6.1 Impact 1 Disturbance from Underwater Noise

8.3.7.6.1.1 In combination impact 1a: Assessment of disturbance from underwater noise from piling at other OWF

879. A list of UK and European OWF schemes that may the potential for overlapping piling with the Projects is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)** and has been used to inform the assessment for in-combination effects due to piling at other OWFs.

880. For harbour seal at the Wash and North Norfolk Coast SAC, other OWFs were included in the assessment against the SAC population where the Carter *et al*. (2022) densities for the individuals associated with the Wash and North Norfolk Coast SAC show presence within the 5km x 5km grid cells that overlap with the other OWF (or where there is a presence of seals within the potential disturbance area of the other OWF, e.g. within 25km for other OWFs that may be piling).

881. Of the UK and European OWFs screened in for having a construction period that could potentially overlap with the construction of the Project(s), the below are relevant to grey seal and could be piling at the same time, which is currently estimated to take place in 2027 to 2031 for DBS East and DBS West;

- Dudgeon Extension
- East Anglia Hub
- Five Estuaries;
- Hornsea Project Three
- Hornsea Project Four;
- North Falls;
- Outer Dowsing; and
- Sheringham Shoal Extension.

882. Of these, all are shown to have harbour seal associated with the Wash and North Norfolk Coast SAC present within the project areas and is within the SE England MU.

883. The commitment to the mitigation measures agreed through the MMMP (in accordance with **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)**) for piling would reduce the risk of physical injury or permanent auditory injury (PTS) in harbour seal. In light of this, and taking account of the type, scale and extent of potential effects arising from the Projects assessment, which concluded no adverse effect on integrity for harbour seal due to physical injury or PTS from construction (see section 8.3.7.3.1).

884. It is important to note the actual duration for active piling time which could disturb marine mammals is only a very small proportion of the potential construction period, of up to approximately 108 days DBS East or DBS West and the OECC, based on the estimated maximum duration to install individual piles.

885. As shown in **Table 8-125** below, DBS East or DBS West if constructed in isolation represents only a small proportion of harbour seal that may be disturbed due to OWF piling:

- 3.5 individuals at DBS East or 0.088% of the Wash and North Norfolk Coast SAC population;
- 3.0 individuals at DBS West or 0.076% of the Wash and North Norfolk Coast SAC population; and
- 23.6 individuals at the OECC or 0.597% of the Wash and North Norfolk Coast SAC population.

886. As shown in **Table 8-125** below, DBS East or DBS West if constructed in isolation could disturb less than 4% of the Wash and North Norfolk Coast SAC population, if piling was undertaken at the same time as all other schemes. If DBS East and West were constructed together, up to 4% of the SAC population may be disturbed.

887. Piling at the OECC in combination with other piling events, over 4% of the Wash and North Norfolk Coast SAC population could potentially be disturbed (**Table 8-125**).

Table 8-125 Quantitative assessment for the potential disturbance of harbour seal from piling activities that could be happening at the same time as the Projects

<table>
<tr><th>Project</th><th>Harbour seal density (/km²)</th><th>Impact area (25km EDR)</th><th>Maximum number of individuals potentially disturbed during single piling</th></tr>
<tr><td>DBS East</td><td>0.0018</td><td>1963.5</td><td>3.5</td></tr>
<tr><td>DBS West</td><td>0.0015</td><td>1963.5</td><td>3.0</td></tr>
<tr><td>DBS OECC*</td><td>0.012</td><td>1963.5</td><td>23.6</td></tr>
<tr><td>Dudgeon Extension</td><td colspan="2">Dose responds assessment.
(Equinor New Energy Limited, 2022)</td><td>31</td></tr>
<tr><td rowspan="2">East Anglia Hub</td><td>0.0007</td><td>2,124</td><td rowspan="2">1.5</td></tr>
<tr><td colspan="2">(East Anglia TWO Limited, 2019)</td></tr>
<tr><td>Five Estuaries</td><td colspan="2">Dose responds assessment.
(Five Estuaries Offshore Wind Farm Ltd (2023)</td><td>3.0</td></tr>
<tr><td>Hornsea Project Three</td><td colspan="2">Dose responds assessment.
(Orsted Power (UK) Ltd, 2018)</td><td>8.3</td></tr>
<tr><td>Hornsea Project Four</td><td colspan="2">Dose responds assessment.
(Orsted Hornsea Project Four Ltd, 2022)</td><td>5.0</td></tr>
<tr><td rowspan="2">North Falls</td><td>0.0001</td><td>3,927</td><td rowspan="2">0.39</td></tr>
<tr><td colspan="2">(North Falls Offshore Wind Farm Ltd (2023))</td></tr>
<tr><td rowspan="2">Outer Dowsing</td><td>0.031</td><td>974.9</td><td rowspan="2">35</td></tr>
<tr><td colspan="2">(Outer Dowsing Offshore Wind, 2023)</td></tr>
</table>

Project	Harbour seal density (/km^2)	Impact area (25km EDR)	Maximum number of individuals potentially disturbed during single piling
Sheringham Shoal Extension	Dose responds assessment. (Equinor New Energy Limited, 2022)		62
Total number of harbour seal with DBS East			**149.7 (3.78% of the Wash and North Norfolk Coast SAC)**
Total number of harbour seal with DBS West			**149.2 (3.77% of the Wash and North Norfolk Coast SAC)**
Total number of harbour seal with DBS OECC			**169.8 (4.3% of the Wash and North Norfolk Coast SAC)**
Total number of harbour seal with Projects together			**152.7 (3.9% of the Wash and North Norfolk Coast SAC)**
Total number of harbour seal without Projects			**146.2 (3.7% of the Wash and North Norfolk Coast SAC)**

**The OECC would not pile on the same day as DBS East or DBS West*

888. In order to determine if piling from the Projects along with other OWFs would have any impact on the Wash and North Norfolk Coast SAC harbour seal population, population modelling was carried out using the iPCoD model. The methodology is described in **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**.

889. As the harbour seal population in the Wash and North Norfolk Coast SAC is in decline, the parameters used for harbour seal for the modelling was representative of a declining population, (Sinclair, *et al*. 2020).

890. For the cumulative scenario assessed (see **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**) for details of the schemes considered) within the Wash and North Norfolk Coast SAC population, the iPCoD model predicts no change in the harbour seal population size over time (**Table 8-126, Plate 8-8**).

891. The median population size was predicted to be 100% of the un-impacted population size at the end of 2028 (1 year after the piling has commenced). By the end of 2052, which is the end point of the modelling, at which point the median impacted to un-impacted ratio remains 100%).

892. For the Wash and North Norfolk Coast SAC harbour seal population, the potential magnitude of the in-combination for disturbance from underwater noise from piling is assessed as not significant due to there being less than a 1% population level impact over both the first six years and 25 year modelled periods (**Table 8-126**, **Plate 8-8**). Based on the population modelling **there is no potential for adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for grey seal for in-combination with piling at the Projects and other OWFs**.

Table 8-126 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the Wash and North Norfolk Coast SAC harbour seal population (for years up to 2052 for both impacted and un-impacted populations in addition to the median ratio between their population sizes

Year	Un-impacted pop mean	Impacted pop mean	Median
Start	3956	3956	100.00%
End 2028	3551	3551	100.00%
End 2029	3185	3185	100.00%
End 2032	2288	2288	100.00%
End 2037	1318	1318	100.00%
End 2047	436	436	100.00%
End 2052	250	250	100.00%

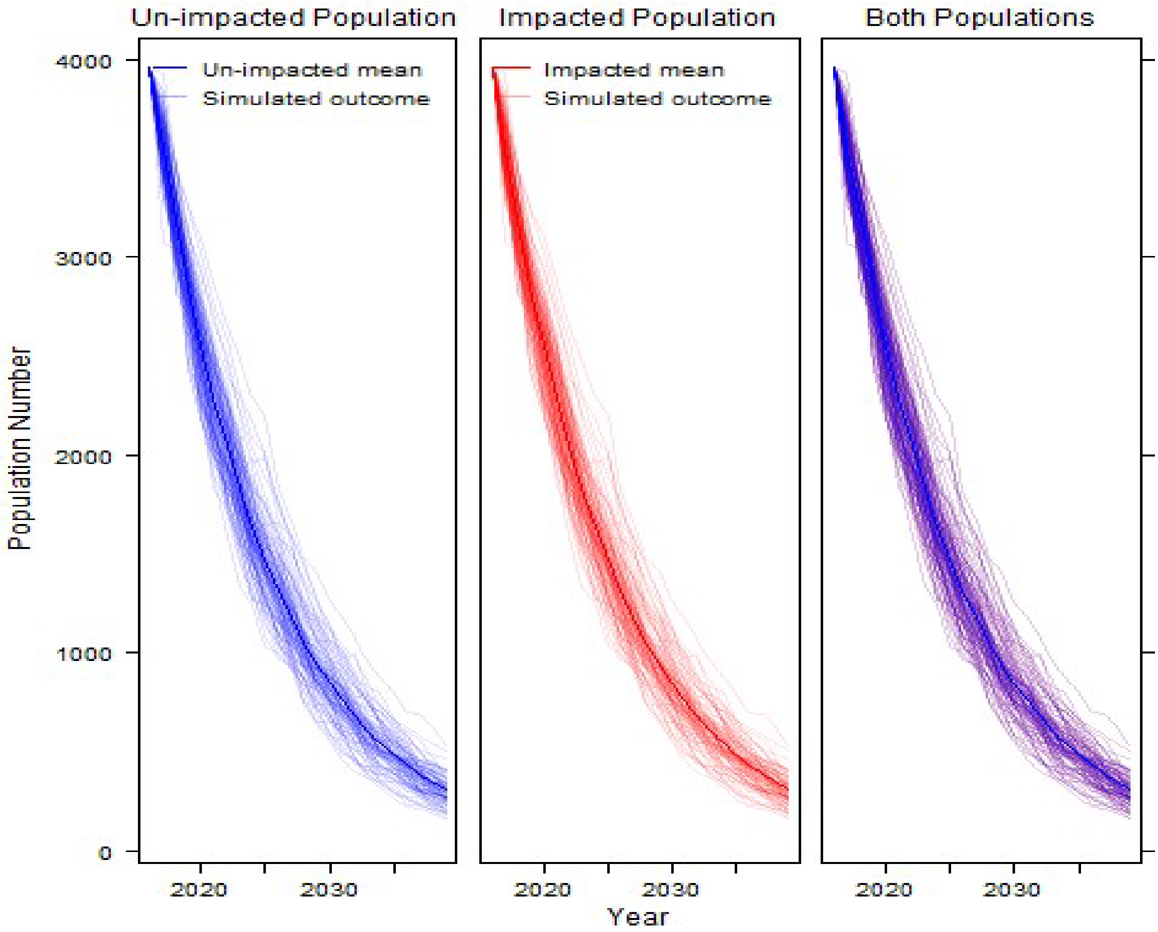


Plate 8-8 Simulated worst case of the Wash and North Norfolk Coast SAC harbour seal (declining) population sizes for both the un-impacted and the impacted populations

8.3.7.6.1.2 In combination impact 1b: Assessment of underwater noise from construction activities other than piling at other OWFs.

893. All OWFs with construction dates that have the potential to overlap with the construction dates for DBS East and / or DBS West have the potential for other construction activities (such as seabed preparation, dredging, trenching, cable installation, rock placement and vessels) to occur at the same time as other construction activities at the Projects.

894. The OWFs screened in have all been assessed for the worst case scenario of piling at the same time as the Projects. Therefore other construction activities at OWFs that could have an in-combination effect the Projects are not considered further at this time.

8.3.7.6.1.3 *In-combination Impact 1c: Assessment of disturbance from other industries and activities*

895. During the construction period for DBS East and / or DBS West, there is the potential for disturbance to marine mammals associated with other potential noise sources, including:

- Geophysical surveys;
- Aggregate extraction and dredging;
- Oil and gas installation schemes;
- Seismic surveys;
- Subsea cable and pipelines;
- Other marine renewable schemes (such as wave and tidal schemes);
- Disposal sites; and
- UXO clearance.

896. For the installation of oil and gas infrastructure, marine renewable schemes, and disposal sites, all potential schemes have been screened out. Further information on the CEA screening (and these results) are provided in the see **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

8.3.7.6.1.3.1 Disturbance from Geophysical Surveys

897. It is currently not possible to estimate the number of potential geophysical surveys that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West. For more information on the assessment of geophysical surveys see section 8.3.6.6.1.3.1.

898. As the location of the potential geophysical surveys is currently unknown, the following assessment for harbour seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for The Wash and North Norfolk Coast SAC of 0.027/km^2. This assumes that there could be up to one geophysical survey within the area in which harbour seal associated with The Wash and North Norfolk Coast SAC may be present (**Table 8-127**).

899. For up to one geophysical surveys undertaken at the same time as construction of DBS East or West in isolation or constructed together, with no other in-combination activities, less than 2% of the Wash and North Norfolk Coast SAC population may be disturbed (**Table 8-133**). Therefore, there would be no adverse effect on integrity of Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal in-combination with DBS East and / or DBS West as well as with one geophysical survey.

Table 8-127 Quantitative assessment for in-combination disturbance of harbour seal due to up to two geophysical surveys at OWFs

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Wash SAC population
One geophysical survey	0.027	78.54	2.1 0.05% of the Wash SAC population
Total number of harbour seal (DBS East and West together)			**< 1.05% of the Wash SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.7.6.1.3.2 Disturbance from Aggregate Extraction and Dredging

900. Taking into account the small potential effect ranges, distances of the aggregate extraction and dredging schemes from the Projects, the potential for contribution to in-combination effects is very small. For more information see section 8.3.6.6.1.3.2 Disturbance from aggregate extraction and dredging.

901. As the location of the potential geophysical surveys is currently unknown, the following assessment for harbour seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for The Wash and North Norfolk Coast SAC of 0.027/km^2. This therefore assumes that there could be up to six aggregate extraction and dredging schemes within the area in which harbour seal associated with The Wash and North Norfolk Coast SAC may be present.

902. For the potential for in-combination disturbance from aggregate and dredging schemes undertaken at the same time as construction of the Projects, with no other in-combination activities, less than 1% of the Wash and North Norfolk Coast SAC population could be impacted if DBS East or DBS West was constructed in isolation or if the Projects were constructed together (**Table 8-128**).

903. Therefore, there would be no significant disturbance and therefore no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal in-combination with DBS East and / or DBS West as well as with aggregate extraction and dredging activities.

Table 8-128 Quantitative assessment for cumulative disturbance of harbour seal due to up to six aggregate extraction and dredging activities near the Projects

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Wash SAC population
Up to six aggregate extraction and dredging schemes	0.027	5.7	0.2 (0.005% of the Wash SAC population)
Total number of harbour seal (DBS East and West together)			**< 1% of the Wash SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.7.6.1.3.3 Disturbance from Seismic Surveys

904. For more information see section 8.3.6.6.1.3.3 Disturbance from seismic surveys.

905. As the location of the potential seismic surveys is currently unknown, the following assessment for harbour seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for The Wash and North Norfolk Coast SAC of 0.027/km². This therefore assumes that there could be up to two geophysical surveys within the area in which harbour seal associated with The Wash and North Norfolk Coast SAC may be present.

906. For the potential for in-combination disturbance from seismic surveys undertaken at the same time as construction of the Projects , with no other in-combination activities, less than 2% of the Wash and North Norfolk Coast SAC population could be impacted if DBS East or DBS West was constructed in isolation or if the Projects were constructed together (**Table 8-129**).

907. Therefore, there would be no significant disturbance and therefore no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal in-combination with DBS East and / or DBS West as well as with two seismic surveys.

Table 8-129 Quantitative assessment for cumulative disturbance of harbour seal due to up to two seismic surveys near the Projects

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Wash SAC population
Up to two seismic surveys	0.027	1,815.8	49.0 (1.239% of the Wash SAC population)
Total number of harbour seal (DBS East and West together)			**< 2.2% of the Wash SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.7.6.1.3.4 Disturbance from Pipeline Activities

908. For more information see section 8.3.6.6.1.3.4 Disturbance from pipeline activities.

909. As the location of the potential cable and subsea pipeline schemes is currently unknown, the following assessment for harbour seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for The Wash and North Norfolk Coast SAC of 0.027/km². This therefore assumes that there could be up to one pipeline and cable project within the area in which harbour seal associated with The Wash and North Norfolk Coast SAC may be present.

910. For the potential for in-combination disturbance from subsea pipeline activities undertaken at the same time as construction of the Projects , with no other in-combination activities, less than 1% of the Wash and North Norfolk Coast SAC population could be impacted if DBS East or DBS West was constructed in isolation or if the Projects were constructed together (**Table 8-130**).

911. Therefore, there would be no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal in-combination with DBS East and / or DBS West as well as with pipeline activities.

Table 8-130 Quantitative assessment for cumulative disturbance of harbour seal due to subsea cable and pipeline activity near the Projects

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Wash SAC population
Cable and pipeline schemes	0.027	50.3	1.4 (0.035% of the Wash SAC population)
Total number of harbour seal (DBS East and West together)			**<1% of the Wash SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.7.6.1.3.5 Disturbance from UXO Clearance

912. It is currently not possible to estimate the number of potential UXO clearance events that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West, and therefore, on a worst case basis, the potential for one high-order clearance and one low-order clearance has been assessed as having the potential to take place at the same time. For more information see section 8.3.6.6.1.3.5 Disturbance from UXO Clearance.

913. As the location of the potential UXO clearance is currently unknown, the following assessment for harbour seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for The Wash and North Norfolk Coast SAC of 0.027/km^2. This therefore assumes that there could be up to one high-order and one low-order UXO clearance within the area in which harbour seal associated with The Wash and North Norfolk Coast SAC may be present.

914. For the potential for in-combination disturbance from UXO clearance activities undertaken at the same time as construction of the Projects , with no other in-combination activities, less than 2% of the Wash and North Norfolk Coast SAC population could be impacted if DBS East or DBS West was constructed in isolation or if the Projects were constructed together (**Table 8-131**).

915. Therefore, there would be no significant disturbance and therefore no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal in-combination with DBS East and / or DBS West as well as with one high-order and one low-order UXO clearance.

Table 8-131 Quantitative assessment for cumulative disturbance of harbour seal due to UXO clearance near the Projects

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Wash SAC population
One high-order UXO clearance	0.027	1,520.5	41.1 (1.036% of the Wash SAC population)
One low-order UXO clearance	0.027	1.02	0.03 (0.0007% of the Wash SAC population)
Total number of harbour seal (DBS East and West together)			**< 2% of the Wash SAC population)**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.7.6.1.4 Summary of In-combination Effect 1: Assessment of Disturbance from all Noisy Activities Associated with Offshore Industries

916. Each of the above described other noise sources are quantitively assessed together in **Table 8-132**.

917. It should be noted that while the schemes included within the in-combination assessment for disturbance from other activities and industries were done so based on the current knowledge of their possible construction or activity windows, and it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the harbour seals that could be at risk of disturbance during the four year offshore construction period of the Projects.

918. As shown in **Table 8-132** below, for all in-combination schemes and activities, whether DBS East and West were constructed separately or together, less than 4% of the SAC population would be disturbed, and therefore there is **no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal**.

919. As shown in the above assessments, the majority of harbour seal at risk of disturbance are from OWF piling, with those schemes that are within close proximity of the Wash and North Norfolk Coast SAC contributing a large proportion of the in-combination disturbance.

Table 8-132 Quantitative assessment for all noisy activities with the potential for in-combination disturbance effects for harbour seals and the Wash and North Norfolk Coast SAC

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at other OWFs including the worst case disturbance from the Project*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the Wash SAC population
One Geophysical survey	0.027	78.54	0.05% of the Wash SAC population
Up to six aggregate extraction and dredging schemes	0.027	5.7	0.005% of the Wash SAC population

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Two Seismic surveys	0.027	1,815.8	1.24% of the Wash SAC population
Subsea cables and pipelines	0.027	50.3	0.035% of the Wash SAC population
One high-order UXO clearance	0.027	1,520.5	1.04% of the Wash SAC population
One low-order UXO clearance	0.027	1.02	0.0007% of the Wash SAC population
Total number of harbour seal (DBS East and West together)			**< 3.3% of the Wash SAC population**
Total number of harbour seals without the Projects			**2.37% of the Wash SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.7.6.2 Impact 2 Barrier Effects

920. It is important to note that the OWFs and other noise sources included in the in-combination assessment are spread over the wider area of the North Sea. Taking into account the locations of the OWFs and other noise sources from DBS East and / or DBS West, the maximum underwater effect ranges for disturbance at other schemes would not overlap with the maximum underwater effect ranges for disturbance at the Projects during piling and construction. Therefore, there is no potential for underwater noise from the Projects, other OWFs and noise sources to result in a barrier of movement to harbour seal.

921. There would be **no adverse effect due to barrier effects on the integrity of the Wash and Norfolk coast SAC in relation to the conservation objectives for harbour seal**.

8.3.7.6.3 Impact 3 Vessel Interaction

922. The in-combination effects from an increase in the number of vessels and vessel movements can pose a potential collision risk for harbour seal.

923. As outlined in sections 8.3.7.3.8 and 8.3.7.4.8, the increased collision risk due to project vessels, even using a very precautionary approach, would result in less than one individual (0.027 harbour seal) being at risk of vessel collision per year for construction phase related vessel collision risk. This amount would be reduced for operation and maintenance phase related vessel collision risk due to the construction phase being the worst case in terms of vessel numbers (see section 8.3.7.3.8).

924. As detailed in **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**, vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where harbour seal are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and with a vessel speed limit of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with harbour seal. It is expected that other offshore schemes and industries would follow similar measures in order to reduce the potential for collision risk of harbour seal with vessels.

925. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low.

926. In addition, based on the assumption that harbour seal would be disturbed as a result of underwater noise from piling, other construction activities, operational and maintenance activities and vessels, there should be no potential for increased collision risk with vessels.

927. Therefore, there would be **no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due an increase in collision risk with construction vessels**.

8.3.7.6.4 Impact 4 Disturbance to seal haul-out sites

928. The closest harbour seal haul out site is the Wash and North Norfolk Coast SAC is approximately 119km from landfall and the Offshore export cable corridor.

929. It is not expected for DBS East or DBS West to have any significant impact on the seal haul-out sites, the main concern would be disturbance from transiting vessels.

930. Transiting vessels can reduce their transit speeds wherever practicable, and the avoidance of transiting within 1km or at least 500m of any seal haul-out site to minimising any disturbance to seal haul-out sites.

931. It is assumed that all other schemes would follow the same best practice measures with regards to avoiding disturbance at haul-out sites. In addition, where seal haul-out sites are near to a vessel corridor, the seals present in that area would be used to vessels transiting past the area.

932. Therefore, there would be **no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal due an increase in disturbance to seal haul-out sites**.

8.3.7.6.5 Changes to Prey Availability

933. Potential effects on prey species for the Projects were assessed in section 8.3.5.2.9 (construction) and section 8.3.5.3.9 (operation). No adverse effect on integrity of the SNS SAC in relation to the conservation objectives for harbour porpoise was concluded. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. This will be the case for all schemes and therefore although the in-combination effects are additive, the effect would be proportionate to the wider range over which effects would occur.

934. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Therefore, there would be **no adverse effect on the integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal arising due to changes in prey availability**.

8.3.7.7 Summary of Potential Effects on Site Integrity

935. The assessment of the potential effects for the Projects in isolation or together has been summarised in relation to the Wash and North Norfolk Coast SAC conservation objectives for harbour seal (**Table 8-133**).

936. **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** provides mitigation or management measures to reduce the potential for any significant auditory injury and potentially disturbance of harbour seal as a result of in-combination effects from underwater noise and will be reviewed in the final MMMP prior to construction.

937. There would be **no adverse effect on integrity of the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal, either alone or together, when in-combination with other schemes**.

Table 8-133 Summary of the potential effects of the Project, including in-combination effects on the Wash and North Norfolk Coast SAC in relation to the conservation objectives for harbour seal (X = no potential for AEoI; ✓ = potential for AEoI)

Conservation objectives	The Projects effects						In-combination effects				
	Auditory injury and disturbance from underwater noise	Barrier effects	Disturbance at seal haul-out sites	Vessel interaction	Changes to water quality	Changes to prey resources	Disturbance from underwater noise	Barrier effects	Vessel interaction	Disturbance to seal haul-out sites	Changes to prey resources
Harbour seal is a viable component of the site	X	X	X	X	X	X	X	X	X	X	X
There is no significant disturbance of the species	X	X	X	X	X	X	X	X	X	X	X
The condition of supporting habitats and processes and the availability of prey is maintained	X	X	X	X	X	X	X	X	X	X	X

X = No potential for any adverse effect on integrity of the site in relation to the conservation objectives

8.3.8 Berwickshire & North Northumberland Coast SAC

8.3.8.1 Site Description

938. The Berwickshire and North Northumberland Coast (BNNC) SAC is one of the most biologically diverse marine areas in Europe, with its range of intertidal and subtidal habitats along with the internationally significant population of grey seals. The SAC lies in between England and Scotland.

939. The Berwickshire and North Northumberland Coast SAC is 228km from DBS East Array Area at closest point and 194km from DBS West Array Area at closest point. Therefore, there is no potential for direct effect on the SAC as a result of the construction, operation, maintenance or decommissioning of DBS Array Areas. However, due to the foraging range of grey seal and the movement of grey seal along the east coast of England, there is the potential for effects on foraging grey seal from the Berwickshire and North Northumberland Coast SAC in the vicinity of the Array Areas.

8.3.8.1.1 Qualifying Features

8.3.8.1.1.1 Grey seal

940. Grey seals are described further in section 8.3.6.1.1.1.

941. The highest mean at sea relative density estimates of grey seal for DBS Array Areas, and the OECC, calculated from Carter *et al.* (2022) are:

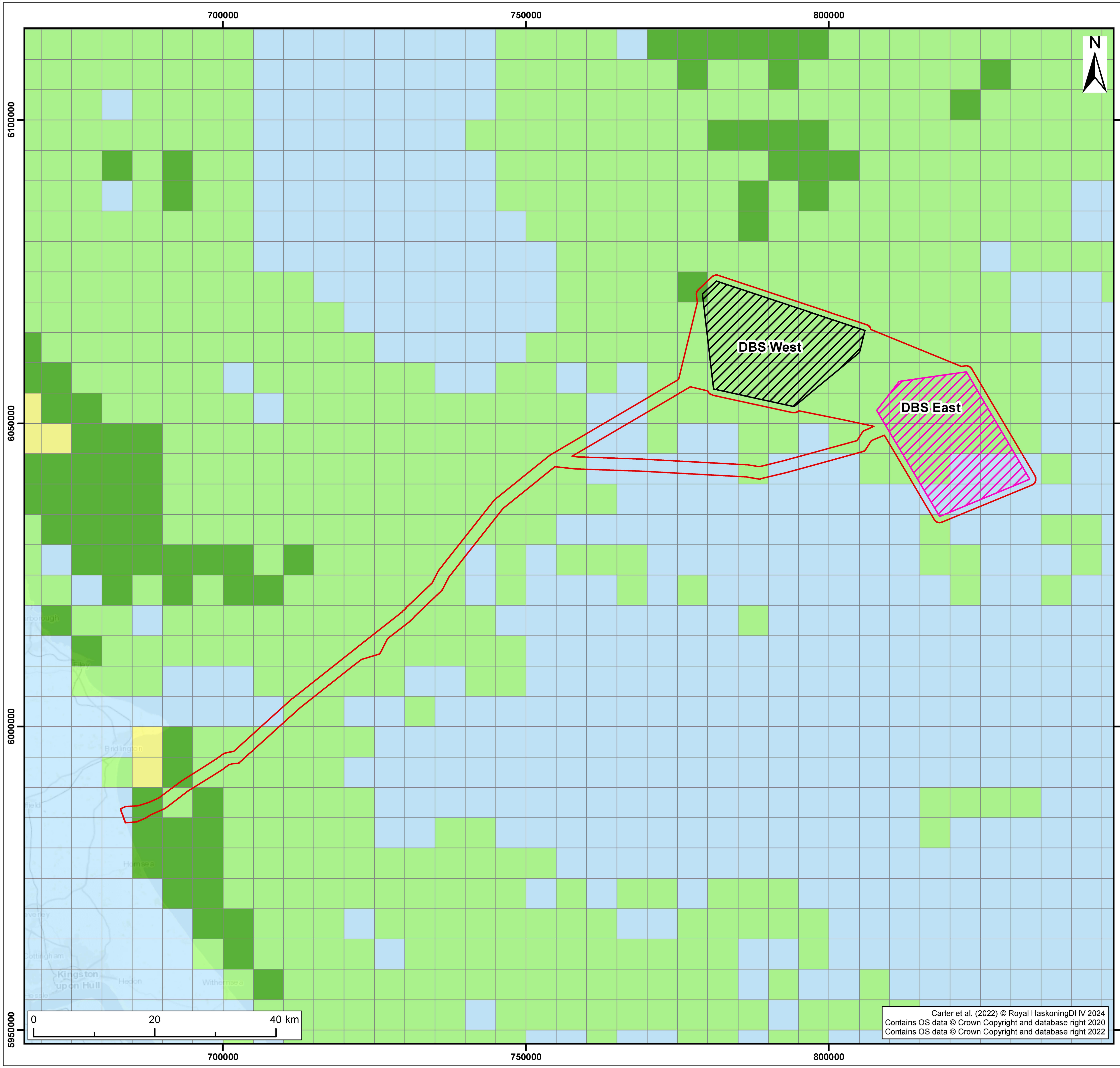
- 0.032 individuals per km^2 for DBS East Array Area;
- 0.054 individuals per km^2 for DBS West Array Area;
- 0.041 individuals per km^2 for the OECC; and
- 0.041 individuals per km^2 for the total Offshore Development Area.

942. The assessments are based on mean relative density estimates for the BNNC SAC from (Carter *et al.* 2022) as a worst-case. The corrected SAC grey seal count was used to generate absolute densities from the relative density data of Carter *et al.* (2022) (**Figure 8-4**). This at-sea population number is 14,563[18], based on the total population of grey seal at the Berwickshire and North Northumberland Coast SAC (of 16,903, as provided in **Table 8-134**), and calculating against a correction factor of 0.2515 to take account of those individuals at sea only.

[18] Note this is not the total SAC population estimate, as accounts for only those seals that are at-sea and not those that could be hauled-out

Table 8-134 Grey Seal Counts and Population Estimates

Population area	Grey seal haul-out count	Source of haul-out count data	Correction factor for seals not available to count	Grey seal SAC population
BNNC SAC	6,427	SCOS (2022)	0.2515	16,903



Legend:

- Offshore Development Area
- DBS East array area
- DBS West array area

Proportion of the population per 25km² (as a %)

- 0.000000 - 0.004638
- 0.004639 - 0.015781
- 0.015782 - 0.033800
- 0.033801 - 0.058976

Maps show mean percentage of at-sea population estimated to be present in each 5 km x 5 km grid cell square at any one time, and the cellsquare-wise (Carter et al., 2022)

SUI	REV	DATE	DESCRIPTION	DRW	CHK	APR
S2	P01	31/01/2024	Suitable for Information	JH	SB	AS

Title:

Berwickshire and Northumberland North Coast SAC
Grey seal at sea distribution

Figure: 8-4 | Drawing No: PC2340-RHD-OF-ZZ-DR-Z-0706

Co-ordinate system: WGS 1984 UTM Zone 31N | Page Size: A3 | Scale: 1:620,000

Project: Dogger Bank South Offshore Wind Farms

Report: Report to Inform Appropriate Assessment

Royal HaskoningDHV
Enhancing Society Together
RWE

8.3.8.1.2 Conservation Objectives

943. The Conservation Objectives (Natural England, 2023c) are "*to ensure that the integrity of the site is maintained or restored as appropriate, and ensure that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring;*

- *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, and,*
- *The distribution of qualifying species within the site.*"

8.3.8.2 Potential Effects Summary

944. For the assessments, the potential for any effects is considered in relation to the Berwickshire and North Northumberland Coast SAC Conservation Objectives for grey seal as outlined in **Table 8-135**.

Table 8-135 Potential Effects of DBS East and / or DBS West in Relation to the Conservation Objectives of the BNNC SAC for Grey Seal

Conservation Objective for grey seal	Potential effect
The extent and distribution of qualifying natural habitats and habitats of qualifying species.	No potential adverse effect There will be no significant change to the extent and distribution of the habitats of qualifying species in the SAC.
The structure and function (including typical species) of qualifying natural habitats.	No potential adverse effect There will be no significant change to the structure and function (including typical species) of qualifying natural habitats.
The structure and function of the habitats of qualifying species.	No potential adverse effect There will be no significant change to the structure and function) of the habitats of the qualifying species.

Conservation Objective for grey seal	Potential effect
The supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.	No potential adverse effect There will be no significant change to the supporting processes on which qualifying natural habitats and the habitats of qualifying species rely.
The populations of qualifying species.	Increased collision risk with vessels will be considered further.
The distribution of qualifying species within the site.	No potential adverse effect There will be no significant change to the distribution of qualifying species within the site. However, significant disturbance and displacement as a result of increased underwater noise levels have the potential to have an effect on the seals foraging at sea and will be considered further.

8.3.8.3 Potential Effects During Construction

945. Potential effects during construction may arise through disturbance from activities during the installation of offshore infrastructure. Underwater noise during piling, as well as disturbance associated with underwater noise from other construction activities and the presence of vessels offshore, are considered. Potential displacement from important habitat areas and impacts on prey species are also considered.

946. The potential effects during construction assessed for grey seal are:

- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during piling, and due to ADD activation prior to piling:
  - Permanent auditory injury (PTS) due to impact piling; and
  - Disturbance due to impact piling.
- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during other construction activities, including seabed preparations, rock placement and cable installation;
- Auditory injury and disturbance or behavioural impacts resulting from the deployment of construction vessels;

- Vessel interaction (collision risk);
- Barrier effects as a result of underwater noise;
- Changes to prey resource; and
- Disturbance to seal haul-out sites.

8.3.8.3.1 Impact 1: Permanent Auditory Injury (PTS) due to Impact Piling

947. Impact piling is a source of high-level underwater noise and causes both physiological (e.g. lethal, physical injury and auditory injury) and behavioural (e.g. disturbance and masking of communication) impacts on marine mammals. For more information see section 8.3.6.3.1.

948. Underwater noise modelling was carried out by SubAcoustech to estimate the noise levels likely to arise during piling and determine the maximum potential areas of effect (see **Volume 7**, **Chapter 11 Marine Mammals (application ref: 7.11)** and **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** for further details).

8.3.8.3.1.1 Assessment of Potential Effects of the Projects Alone

949. See section 8.3.6.3.1.1 for the predicted effect ranges and areas for PTS for DBS East or DBS West in **Table 8-61**.

950. An assessment of the maximum number of individuals that could be at risk of instantaneous PTS, due to a single strike at the maximum hammer energy, for both monopiles and jacket pin piles, is presented in **Table 8-136**.

Table 8-136 Assessment of the Potential For Instantaneous PTS due to a Single Strike of the Maximum Hammer Energy and Cumulative Exposure for Both Monopiles and Jacket Pin Piles

Marine mammal species	Location	Maximum number of individuals (% of reference population	Potential adverse effect on site integrity
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Grey seal	DBS East	0.0003 (0.000002% of BNNC SAC count)	**No** MMMP would reduce risk of PTS. Less than 1% of the population at risk.
	DBS West	0.0005 (0.000003% of BNNC SAC count)	
	OECC	0.0004 (0.000002% of BNNC SAC count)	
PTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			

Marine mammal species	Location	Maximum number of individuals (% of reference population	Potential adverse effect on site integrity
Grey seal	DBS East	0.0003 (0.000002% of BNNC SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.0005 (0.000003% of BNNC SAC count)	
	OECC	0.0004 (0.000002% of BNNC SAC count)	
PTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum})			
Grey seal	DBS East	0.2 (0.001% of BNNC SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.2 (0.001% of BNNC SAC count)	
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})			
Grey seal	DBS East	0.05 (0.0003% of BNNC SAC count)	**No** MMMP would reduce risk of PTS Less than 1% of the population at risk.
	DBS West	0.09 (0.0005% of BNNC SAC count)	
	OECC	0.07 (0.0004% of BNNC SAC count)	

951. The effective implementation of the MMMP for piling will reduce the risk of PTS to grey seal during piling at the Projects. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS) from increased underwater noise during construction (piling) of the Projects alone**.

8.3.8.3.1.2 Assessment of Potential Effects of the Projects Together

952. As outlined in section 2 of **Volume 6, Report to Inform the Appropriate Assessment Habitats Regulations Assessment Part 1 of 4 (application ref: 6.1)**, there is the potential that the Projects could be constructed concurrently. Therefore, the worst case for the Projects being developed at the same time has been assessed, based on simultaneous piling at the two sites at the same time.

953. The underwater noise modelling results for the predicted effect ranges and areas for PTS from multiple pile installation locations at the same time, for either monopiles or pin piles, are shown in **Table 8-63**.

954. An assessment of the maximum number of individuals that could be at risk of cumulative PTS exposure, due to multiple sequential piling events, for both monopiles and jacket pin piles, is presented in **Table 8-137**.

Table 8-137 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 hour Period

Species	Assessment of effect	Potential adverse effect on site integrity
Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)		
Grey Seal	12.4 (0.07% of the BNNC SAC) [based on the worst case density at DBS West]	**No** MMMP would reduce risk of PTS. Less than 1% of the population at risk.
Three concurrent installations at DBS East, DBS West, and OECC, with four sequential jacket pin piles at each location (total of 12 jacket pin piles installed in one day)		
Grey Seal	13.0 (0.08% of the BNNC SAC) [based on the worst case density at DBS West]	**No** MMMP would reduce risk of PTS. Less than 1% of the population at risk.

955. As stated in section 8.3, **Volume 8, Outline Marine Mammal Mitigation Protocol (application reference: 8.25)** for piling has been submitted with the application. The MMMP will be finalised post-consent in consultation with the MMO and relevant SNCBs and will be based on the latest scientific understanding and guidance, as well as detailed project design. The implementation of the agreed mitigation measures within the MMMP for piling will reduce the risk of any permanent auditory injury (PTS) from the first strike of the soft-start, single strike of the maximum hammer energy and cumulative exposure.

956. The effective implementation of the MMMP for piling will reduce the risk of PTS to grey seal during piling at the Projects. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury (PTS) from increased underwater noise during construction (piling) for the Projects together**.

8.3.8.3.2 Impact 2: Disturbance or Behavioural Effects from Underwater Noise During Piling

957. The range of possible behavioural reactions that may occur as a result of exposure are described in section 8.3.6.3.2.

8.3.8.3.2.1 Assessment of Potential Effects of the Projects in Isolation

958. Russell (2016) showed that grey seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) and 15km (706.86km^2) for the installation of a single jacket pin pile foundation. This range has been used to determine the number of grey seal that may be disturbed during piling at DBS East, DBS West or the OECC (**Table 8-138**).

Table 8-138 Assessment of the Potential for Disturbance to Grey Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East or DBS West

Species	Potential disturbance range and area	Location	Assessment of effect	Potential adverse effect on site integrity
Monopiles				
Grey seal	25km, with a disturbance area of 1,963.5km^2	DBS East	62.8 (0.37% of BNNC SAC)	**No** Less than 5% of the population at risk.
		DBS West	106.0 (0.63% of BNNC SAC)	
		OECC	80.5 (0.48% of BNNC SAC)	
Jacket pin piles				
Grey seal	15km, with a disturbance area of 706.86km^2	DBS East	22.6 (0.13% of BNNC SAC)	**No** Less than 5% of the population at risk.
		DBS West	38.2 (0.23% of BNNC SAC)	
		OECC	29.0 (0.13% of BNNC SAC)	

959. A dose response curve assessment has also been applied to assess the potential disturbance to grey seal in the Berwickshire North Northumberland Coast SAC.

960. The estimated numbers (and percentage of the Berwickshire North Northumberland Coast SAC population) of grey seal disturbed as a result of underwater noise during piling are presented in **Table 8-139**. This assessment is based on the Berwickshire North Northumberland Coast SAC Carter *et al.* (2022) mean densities, and the Whyte *et al.* (2020) dose response curve.

961. It should be noted that this dose-response analysis is carried out in relation to pile driving noise only, and therefore does not account for the use of ADDs which may reduce localised grey seal presence densities prior to piling. This assessment can therefore be considered conservative.

962. The results presented in **Table 8-139** indicate there is the potential for an adverse effect for a monopile at either DBS West or the OECC. Therefore, population modelling was subsequently undertaken to determine whether this would lead to a population level effect.

Table 8-139 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East, DBS West, or the OECC in isolation Based on the Dose-Response Approach

Marine Mammal Species	Location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance due to a single, maximum energy monopile strike (SEL_{SS})			
Grey seal	DBS East	281.0 (1.7% of the BNNC SAC)	**No** Less than 5% of the population at risk.
	DBS West	1,154.8 (6.8% of the BNNC SAC)	**Yes** More than 5% of the population at risk.
	OECC	2,355.9 (13.9% of the BNNC SAC)	

8.3.8.3.2.1.1 Population modelling

963. The population modelling for grey seal is based on:

- A worst case of up to 3,791.7 grey seal disturbed;
  - Based on the dose response curve assessments (281.0 at DBS East, 1,154.8 at DBS West and 2,355.9individuals in the OECC; (**Table 8-139**).
- Up to 3 individuals could at risk of PTS at DBS East, DBS West and the OECC (combined total from all three locations; **Table 8-137**); and
- The above number of grey seal being at risk of impact for every piling day with a piling schedule of 4 years.

964. For the Berwickshire and North Northumberland Coast SAC population, by the end of 2032 (2 years after piling ends), the median population size for the impacted population is predicted to be 100% of the unimpacted population. Beyond 2034, the impacted population maintains relatively stable as far as 2052 which is the end point of the modelling (**Table 8-140**).

Table 8-140 Results of the iPCoD modelling for DBS East, DBS West and OECC sequentially scenario, giving the mean population size of grey seal population (BNNC SAC population) for years up to 2052 for both impacted and un-impacted population

Time period	Un-impacted pop mean	Impacted pop mean	Median impacted as % of unimpacted
Start	16,903	16,903	100.00%
End 2028	17,056	17,056	100.00%
End 2029	17.177	17,178	100.00%
End 2032	17,483	17,485	100.01%
End 2037	18,057	18,060	100.01%
End 2047	19,163	19,167	100.02%
End 2052	19,834	19,837	100.01%

965. **Plate 8-9** shows the mean unimpacted and the mean impacted population of grey seal within the Berwickshire North Northumberland Coast SAC population. The graph shows that with piling at DBS East, DBS West and the OECC, there is no significant impact on the population of grey seal. Therefore, the impact on the population is assessed as having no adverse effect on site integrity.

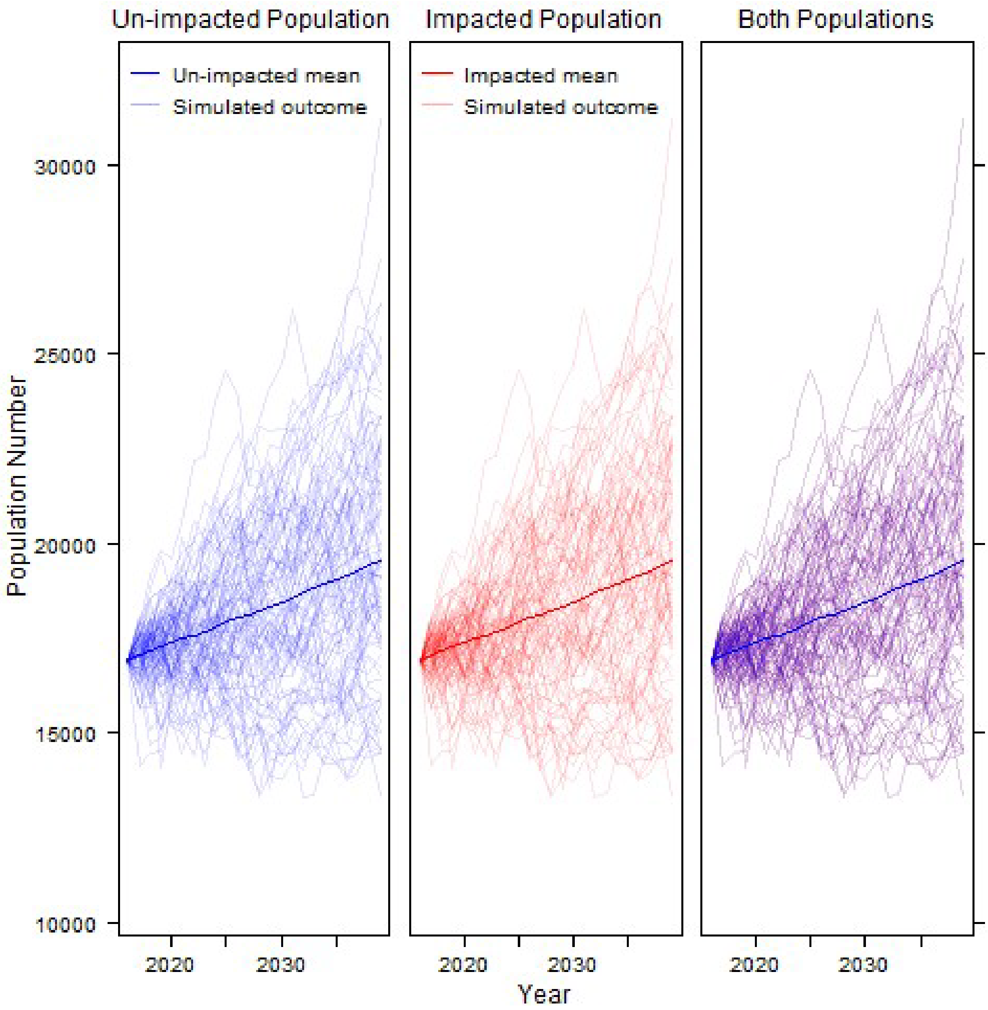


Plate 8-9 Simulated worst case grey seal population sizes (BNNC SAC population) for both the unimpacted and the impacted populations.

8.3.8.3.2.1.2 Potential disturbance from ADD activation

966. As part of the MMMP, an ADD would be required to encourage clearance of the PTS effect ranges. See section 8.3.2 for more information. The estimated number (and percentage of the Berwickshire and North Northumberland Coast SAC population) of grey seal disturbed as a result of underwater noise during piling after an ADD duration of 80 minutes, is presented in **Table 8-141**.

Table 8-141 Assessment of the Potential for Disturbance due to ADD Activation Based for Monopiles or Jacket Pin Piles at DBS East or DBS West in isolation

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes as required for monopiles at DBS East, DBS West & OECC			
Grey seal	DBS East	5.2 (0.03% of the BNNC SAC)	**No** Less than 5% of the population at risk.
	DBS West	8.8 (0.05% of the BNNC SAC)	
	OECC	6.7 (0.04% of the BNNC SAC)	

967. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in isolation**.

8.3.8.3.2.2 Assessment of Potential Effects of the Projects Together

968. As noted above, a study has shown that harbour seal are present in significantly reduced number up to a distance of 25km during piling (or a disturbance area of 1,963.5km^2) (Russell, 2016). This range has been used to determine the number of grey seal within the Berwickshire and North Northumberland Coast SAC that may be disturbed during piling at DBS East and DBS West together, based on two piles being installed at any one time (or a disturbance area of 3,927km^2), and for the installation of three jacket pin pile foundations at DBS East, DBS West and the OECC (with a disturbance area of 2,120.58km^2) (**Table 8-69**).

969. The estimated numbers (and percentage of the Berwickshire and North Northumberland Coast SAC population) of grey seal disturbed as a result of underwater noise during piling is presented in **Table 8-142**.

Table 8-142 Assessment of the Potential for Disturbance to Grey Seal Based on a Disturbance Range of 25km for Both Monopiles and Jacket Pin Piles at Either DBS East and DBS West Together

Species	Potential disturbance range and area	Assessment of effect	Potential adverse effect on site integrity
Grey seal	Monopiles at the two worst case concurrent locations (EDR – 25km, with a disturbance area of 3,927km^2)	168.8 (1.0% of BNNC SAC) [based on DBS East and West]	**No** Less than 5% of the population at risk.
	Jacket pin piles at three concurrent locations (EDR – 15km, with a disturbance area of 2,120.58km^2)	89.8 (0.49% of BNNC SAC) [based on one pin pile at each of the locations]	**No** Less than 5% of the population affected at risk.

970. The estimated numbers (and percentage of the Berwickshire and North Northumberland Coast SAC population) of that could be potentially disturbed as a result of underwater noise during piling at DBS East and DBS West together is presented in **Table 8-143**.

971. The results presented in **Table 8-143** indicate there is the potential for an adverse effect. Therefore, population modelling was subsequently undertaken to determine whether this would lead to a population level effect.

Table 8-143 Number of Individuals (and % of Reference Population) That Could be Disturbed During Piling at DBS East and DBS West Together Based on the Dose-Response Approach

Species	Project location	Assessment of effect	Potential adverse effect on site integrity
Instantaneous behavioural disturbance at maximum energy monopile strike (SEL_{ss}) at two locations (DBS East and DBS West together)			
Grey seal	DBS East and DBS West	1,435.8 (8.5% of the BNNC SAC)	**Yes**

Species	Project location	Assessment of effect	Potential adverse effect on site integrity
	Two piles at DBS West (as worst-case)	2,309.6 (13.6% of the BNCC SAC)	More than 5% of the population at risk.

8.3.8.3.2.2.1 Population modelling

972. For the population modelling section 8.3.8.3.2.1.1, the Projects worst case scenario was used, which is the installation of monopiles at DBS East and DBS West, plus the OECC installed sequentially, therefore resulting in more disturbance days. The parameters are described in **Volume 7**, **Appendix 11-4 (application ref: 7.11.11.4)** and 104 days of piling was modelling for DBS East over a two year period, followed by DBS West (104 monopiles over two years) and randomly one monopiles in the OECC.

973. There is no significant impact on the Berwickshire North Northumberland Coast SAC population of grey seal. Therefore, the impact on the population is assessed as having no adverse effect on site integrity as stated in section 8.3.8.3.2.1.1 (**Table 8-140** and **Plate 8-9**).

8.3.8.3.2.2.2 Potential disturbance from ADD activation

974. The estimated numbers (and percentage of the Berwickshire and North Northumberland Coast SAC population) of grey seal disturbed as a result of underwater noise during the ADD duration of 80 minutes, at multiple pile locations at the same time, is presented in **Table 8-144**.

Table 8-144 Assessment of the Potential for Disturbance due to ADD Activation for Monopiles or Jacket Pin Piles at DBS East and DBS West Together

Species	Location	Assessment of effect	Potential adverse effect on site integrity
ADD duration of 80 minutes (160 minutes) as required for two monopiles at DBS East and DBS West			
Grey seal	DBS East	10.4 (0.06% of the BNNC SAC)	**No**
	DBS West	17.6 (0.1% of the BNNC SAC)	

Species	Location	Assessment of effect	Potential adverse effect on site integrity
	DBS East and DBS West together	14.0 (0.08% of the BNNC SAC)	Less than 5% of the population at risk.

975. The population affected by disturbance from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance or behaviour effects from increased underwater noise during construction (piling) for the Projects in together**.

8.3.8.3.3 Impact 3a: Auditory Injury from Underwater Noise During Other Construction Activities

976. Potential sources of underwater noise during construction activities, other than piling, include seabed preparation, dredging, rock placement, trenching and cable installation. For more information see section 8.3.6.3.3.

977. Impact ranges for either PTS or TTS, for all other activities, are less than 100m (<0.03km^2; see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

8.3.8.3.3.1 Assessment of Potential Effects of the Projects Alone

978. The potential for PTS / TTS could result from underwater noise during other construction activities, such as cable laying and protection. These activities however would be temporary in nature, not consistent throughout the offshore construction period for the Projects and would be limited to only part of the overall construction period and area at any one time. The assessment for effects from underwater noise resulting from other construction activities is shown in **Table 8-145,** based on the results of the underwater noise modelling (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

Table 8-145 Maximum Number of Individuals (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities, Based on Underwater Noise Modelling for Each Individual Activity and For All Activities at the Same Time *at DBS East or DBS West*

Species	Potential Effect	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
PTS/TTS for each individual activity				
Grey seal	PTS/TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.001 (0.000006% of BNNC SAC)	**No** Less than 1% of the population at risk.
		DBS West	0.002 (0.00001% of BNNC SAC)	
		OECC	0.002 (0.00001% of BNNC SAC)	
PTS/TTS for four activities at the same time				
Grey seal	PTS/TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.004 (0.00002% of BNNC SAC)	**No** Less than 1% of the population at risk.
		DBS West	0.006 (0.00004% of BNNC SAC)	
		OECC	0.005 (0.00003% of BNNC SAC)	

979. The population affected by PTS / TTS during other construction activities from underwater noise at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from increased underwater noise during other construction for the Projects in isolation**.

8.3.8.3.3.2 Assessment of Potential Effects of the Projects Together

980. The assessment for the potential for PTS / TTS from underwater noise resulting from other construction activities for DBS East and DBS West has been assessed on eight activities occurring at any one time is shown in **Table 8-146**.

Table 8-146 Maximum Number of Individuals (and % of Reference Population) That Could be Impacted as a Result of Underwater Noise Associated with Non-Piling Construction Activities, Based on Underwater Noise Modelling for All Activities at DBS East and DBS West

Species	Potential Effect	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
TTS for eight activities at the same time			
Grey seal	PTS/TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	0.01 (0.00008% of BNNC SAC) [based on the worst case density at DBS West]	**No** Less than 1% of the population at risk.

981. The population affected by PTS / TTS during other construction activities from underwater noise at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from increased underwater noise during other construction for the Projects together**.

8.3.8.3.4 Impact 3b: Disturbance from Underwater Noise during Other Construction Activities

982. Grey seals within the potential disturbance area are considered to have limited capacity to avoid such effects, although any disturbance to individuals would be temporary and they would be expected to return to the area once the disturbance had ceased, or they had become habituated to the sound. For more information, see section 8.3.6.3.4.

8.3.8.3.4.1 Assessment of Potential Effects of the Projects Alone

983. An assessment of the maximum number of grey seal that could be at risk of disturbance due to other construction activities has been based on the 4km potential disturbance range as presented in **Table 8-147**. This is a precautionary approach as it is unlikely that grey seal would react in the same manner as harbour porpoise to the other construction activities that are expected to be taking place in the Offshore Development Area.

Table 8-147 Assessment of the Potential for Disturbance due to Other Construction Activities, including Cable Laying, Suction Dredging, Cable Trenching, and Rock Placement, for One and Four Activities Taking Place at Any One Time at either DBS East or DBS West in Isolation

Species	Potential Effect	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Disturbance for each individual activity				
Grey seal	- Cable laying - Trenching - Rock placement - Dredging	DBS East	1.6 (0.01% of BNNC SAC)	**No** Less than 5% of the population at risk.
		DBS West	2.7 (0.02% of BNNC SAC)	
		OECC	2.1 (0.01% of BNNC SAC)	
Disturbance for four activities at the same time				
Grey seal	- Cable laying - Trenching - Rock placement - Dredging	DBS East	6.4 (0.04% of BNNC SAC)	**No** Less than 5% of the population at risk.
		DBS West	10.9 (0.06% of BNNC SAC)	
		OECC	8.2 (0.05% of BNNC SAC)	

984. The population disturbed during other construction activities from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise during other construction for the Projects in isolation**.

8.3.8.3.4.2 Assessment of Potential Effects of the Projects Together

985. An assessment of the maximum number of individuals that could be at risk of disturbance due to other construction activities at DBS East and DBS West together has been assessed based on the 4km potential disturbance range, with up to eight activities occurring at any one time across the Projects (**Table 8-148**).

Table 8-148 Assessment of the Potential for Disturbance due to Other Construction Activities, Including Cable Laying, Suction Dredging, Cable Trenching, and Rock Placement, for Eight Activities Taking Place at Any One Time at DBS East and DBS West

Species	Potential Effect	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Disturbance for eight activities at the same time				
Grey seal	- Cable laying - Trenching - Rock placement - Dredging	DBS East and DBS West together (based on worst case densities)	21.7 (0.14% of BNNC SAC)	**No** Less than 5% of the population at risk.

986. The population disturbed during other construction activities from underwater noise at the Projects is less than 5%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise during other construction for the Projects together**.

8.3.8.3.5 Impact 4a: Auditory Injury from Underwater Noise due to the Presence of Vessels

987. During construction, there is the potential for up to 32 vessels to be present at either DBS East or DBS West in isolation, with up to six of those being within the OECC as stated in section .

988. For more information on the potential for PTS / TTS from underwater noise due to the presence of vessels, see section 8.3.6.3.5.

8.3.8.3.5.1 Assessment of Potential Effects of the Projects Alone

989. Impact ranges for PTS and TTS for large and medium vessels for all species are less than 100m (<0.03km^2; see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

990. The potential effect of PTS / TTS that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Project and would be limited to only part of the overall construction period and area at any one time.

991. The assessment of the potential effect for any PTS / TTS as a result of construction vessels, for either one vessel, or up to 32 vessels (26 in the Array Areas, and six in the OECC), shows less than 1% of the reference populations exposed to any effect (**Table 8-149**).

Table 8-149 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East, DBS West or OECC in isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
For one vessel			
Grey seal	DBS East	0.001 (0.00006% of the BNNC SAC)	**No** Less than 1% of the population at risk.
	DBS West	0.002 (0.00001% of the BNNC SAC)	
	OECC	0.001 (0.000007% of the BNNC SAC)	
For up to 32 vessels in the Array Areas and six in the OECC			
Grey seal	DBS East	0.03 (0.0002% of the BNNC SAC)	**No** Less than 1% of the population at risk.
	DBS West	0.05 (0.0003% of the BNNC SAC)	
	OECC	0.007 (0.00004% of the BNNC SAC)	

992. The population affected from underwater noise (PTS / TTS) due to the presence of vessels at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation**.

8.3.8.3.5.2 Assessment of Potential Effects of the Projects Together

993. The number of grey seal that could be impacted as a result of underwater noise from construction vessels has been assessed based on the number of animals that could be present in each of the modelled impact ranges applied to the number of vessels that could be on site at any one time (n=59). This assessment is based on the worst case density estimate across the project areas.

994. The potential effect for any PTS / TTS as a result of construction vessels, for up to 59 vessels in the Offshore Development Area (47 in the Array Areas, and 12 in the OECC), shows less than 1% of the reference population in relation to grey seal as exposed to any effect (**Table 8-150**).

995. The potential for PTS / TTS effects that could result from underwater noise of construction vessels would be temporary in nature, not consistent throughout the offshore construction period for the Projects of five to seven years and would be limited to only part of the overall construction period.

Table 8-150 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Construction Vessels at DBS East, DBS West and OECC Together

Species	Location	Maximum number of individuals (% of reference population) for up to 59 vessels	Potential adverse effect on site integrity
Grey seal	DBS East and DBS West	0.1 (0.0006% of the BNNC SAC) [based on the worst case density of DBS West]	**No** Less than 1% of the population at risk.

996. The population affected from underwater noise (PTS / TTS) due to the presence of vessels at the Projects is less than 1%. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal from increased underwater noise (PTS / TTS) due to the presence of vessels for the Projects together**.

8.3.8.3.6 Impact 4b: Disturbance from Underwater Noise due to the Presence of Vessels

997. Seals vary in their reaction to vessels depending on vessel type and proximity to haul out sites; as described in section 8.3.6.3.6.

8.3.8.3.6.1 Assessment of Potential Effects of the Projects Alone

998. There is the potential for up to 32 vessels to be present at the Projects at any one time; up to 26 within the DBS East or DBS West Array Areas, and up to six within the OECC. As described in section 8.3.5.2.6.1, instead of adding a 4km disturbance range around each vessel, a 4km buffer has been added around each Array Area to account for the overlap in disturbance areas for 26 vessels present in each Array Area (as shown on **Plate 8-3**). This results in a potential disturbance area of 696.01km^2 for DBS East, or 708.90km^2 for DBS West (as shown in **Table 8-29**). A further assessment has been undertaken to account for a maximum of six vessels in the OECC at one time, with a total disturbance area of 301.56km^2.

999. The potential disturbance effect on grey seals from vessels, for either DBS East or DBS West in isolation, is assessed in **Table 8-151**.

Table 8-151 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in isolation

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
For one vessel			
Grey seal	DBS East	1.6 (0.01% of the BNNC SAC)	**No** Less than 5% of the population at risk.
	DBS West	2.7 (0.02% of the BNNC SAC)	
	OECC	2.1 (0.01% of the BNNC SAC)	
For up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the OECC]			
Grey seal	DBS East	22.3 (0.13% of the BNNC SAC)	**No** Less than 5% of the population at risk.
	DBS West	38.3 (0.23% of the BNNC SAC)	
	OECC	12.4 (0.07% of the BNNC SAC)	

1000. Vessels transiting to and from the Offshore Development Area can also cause disturbance. Table 11-73 within **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)** presents a list of port options that will be used during construction. As a worst-case, the assessment of vessel disturbance during transit from DBS West to Lowestoft is used as that is the greatest distance.

1001. As described in section 8.3.5.2.6.1, the assessment of disturbance from vessel transits to and from the Projects has been based on the area of effect from one vessel transiting to and from the port location, with disturbance taking place over a full 24 hour period. This results in an effect area of 1,200km^2.

1002. **Table 8-152** presents the number of individuals that could be temporarily disturbed by the vessel transits, assuming that any vessel transit results in 24 hours of deterrence from the area as a worst-case. These assessments are based on the worst case density across the Offshore Development Area.

Table 8-152 Maximum Number of Individuals (and % of Reference Population) that Could Be Disturbed as a Result of Underwater Noise Associated with Transiting Vessels during construction

Species	Location	Maximum number of individuals (% of reference population)	Potential adverse effect on site integrity
Grey seal	DBS East	38.4 (0.23% of the BNNC SAC)	**No** Less than 5% of the population at risk.
	DBS West	64.8 (0.38% of the BNNC SAC)	
	OECC	49.2 (0.29% of the BNNC SAC)	

1003. The population affected by disturbance from underwater noise due to the presence of vessels at the Projects is less than 5%. In addition, the impact range will be constantly moving with the vessel, rather than being present across the entire transiting area. The above assessment is therefore considered highly precautionary, and there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation**.

8.3.8.3.6.2 Assessment of Potential Effects of the Projects Together

1004. To assess for vessel disturbance in DBS East and DBS West Array Areas together, the same approach has been used as described above; a 4km buffer has been added around the Array Areas, providing a potential effect area for disturbance of 1,404.91km^2 across both the Projects. For the OECC, there will be a maximum of 12 vessels at one time, with a total disturbance area of 603.12km^2.

1005. The potential effect on grey seals of disturbance from vessels in isolation is assessed in **Table 8-153**.

Table 8-153 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West together

Species	Location	Maximum number of individuals (% of reference population) potentially disturbed from 47 vessels within the Array Areas, and 12 in the OECC	Potential adverse effect on site integrity
Grey seal	DBS East and DBS West together	75.6 (0.45% of the BNNC SAC)	**No** Less than 5% of the population at risk.
	OECC	24.7 (0.15% of the BNNC SAC)	

1006. To assess for transiting vessels, the results would be the same as provided in section 8.3.8.3.6.1 and **Table 8-152** for DBS East or DBS West in isolation.

1007. The population affected by disturbance from underwater noise due to the presence of vessels at the Projects is less than 5%, the impact range will be constantly moving with the vessel. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from increased underwater noise due to the presence of vessels for the Projects in together**.

8.3.8.3.7 Impact 5: Barrier Effects as A Result of Underwater Noise During Construction

8.3.8.3.7.1 Assessment of Potential Effects of the Projects Alone

1008. Underwater noise during construction could have the potential to create a barrier effect, preventing movement or migration of grey seals between important feeding and / or breeding areas, or potentially increasing swimming distances if individuals avoid the site and go around it. However, the Array Areas are not located on any known migration routes for grey seals. A qualitative assessment of barrier effects on grey seal has been undertaken in section 8.3.6.3.7, and the information would be the same for grey seal in the Berwickshire and North Northumberland Coast SAC.

1009. DBS East Array Area is located 122km from the coast at closest point and DBS West Array Area 100km from land at closest point. The nearest seal haul-out site is at Berwickshire and North Northumberland Coast SAC is the Fast Castle colony, approximately 248km from landfall at its closest point. The haul-out site is 294km from DBS East and 259km from DBS West.

1010. Disturbance and any barrier effects would be temporary and for a relatively short duration (i.e., during active piling). It is unlikely that all grey seal potentially affected would be from the Berwickshire and North Northumberland Coast SAC, which is located at the closest point; 228km from DBS East Array Area and 194km from DBS West Array Area.

1011. Therefore, there would be no significant disturbance and **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential barrier effects from increased underwater noise during construction of the Projects in isolation**.

8.3.8.3.7.2 Assessment of Potential Effects of the Projects Together

1012. The assessment for DBS East and DBS West together would be the same as presented for DBS East or DBS West in isolation in section 8.3.8.3.7.1.

1013. There would be no significant disturbance and **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential barrier effects from increased underwater noise during construction of the Projects together**.

8.3.8.3.8 Impact 6: Increased Collision Risk with Vessels During Construction

1014. During offshore construction, there will be an increase in vessel traffic within the DBS Array Areas and the OECC. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area. For more information on the assessment methodology see section 8.3.6.3.8.

8.3.8.3.8.1 Assessment of Potential Effects of the Projects Alone

1015. There is currently limited information on the collision risk of marine mammals in the southern North Sea. To estimate the potential collision risk of vessels associated with DBS East Array Area or DBS West Array Area during construction, the potential risk rate per vessel has been calculated for grey seals, which is then used to calculate the total risk to grey seals due to the presence of an additional 32 vessels at any one time during construction (see section 11.6.1.6 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**). The collision risk has been estimated by using data from the CSIP and SMASS, see section 8.3.6.3.8.1 and **Table 8-83** for more information.

1016. The assessment in **Table 8-154** is based on an average of 772 vessel transits per year and predicts that up to two individual grey seal may be at risk of vessel collision for each year of construction (or 0.009% of the Berwickshire and North Northumberland Coast SAC population).

1017. This is a highly precautionary assumption, as it is unlikely that grey seal in the Offshore Development Area would be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number of vessel movements in the area, and that vessels within the Offshore Development Area would be stationary for much of the time or very slow moving.

1018. In addition, vessel movements, where practicable, will be incorporated into recognised vessel routes and hence to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. Vessel operators will use best practice to reduce any risk of collisions with marine mammals, such as reducing the speed of vessel transits wherever possible.

1019. While there would be minimal increase to collision risk, less than 1% of the SAC are at risk of the permanent effect, and there is therefore **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential vessel collision risk during construction for the Projects in isolation**.

Table 8-154 Predicted Number of Grey Seals at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence at DBS East and DBS West in Isolation and Together

	DBS East or DBS West in Isolation	DBS East or DBS West together
Collision risk rate[19]	0.0451	
Estimated total number of individuals in UK waters[20]	162,000	
Estimated number of individuals at risk within UK waters	7,300	
Annual number of vessel transits in UK and RoI for 2015[21]	3,852,030	
Number of marine mammals at risk of collision per vessel in UK waters	0.002	
Number annual vessel transits associated with construction	772	1,502
Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	Up to 2 per year (1.5)	Up to 3 per year
% reference population	0.009% of the BNNC SAC	0.02% of the BNNC SAC
Potential adverse effect on site integrity	**No** – Less than 1% of population affected	**No** – Less than 1% of population affected

[19] Where species specific data is not available, the species group data is used
[20] Based on the (SCOS, 2022) UK population estimates for seal species
[21] Latest publicly available data

8.3.8.3.8.2 Assessment of Potential Effects of the Projects Together

1020. As a precautionary assessment, the number of grey seal that could be at increased risk of collision with construction vessels, if DBS East and DBS West are constructed concurrently, has been based on the estimated maximum number of construction vessel transits for both array arrays of up to 1,781 (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

1021. To estimate the potential collision risk of vessels associated with DBS East and DBS West Array Areas during construction together, the same approach has been taken as for the Projects alone (see section 8.3.8.3.8.1).

1022. The increased number of vessel movements has been based on the estimated 1,502 return vessel trips per year during the five year construction period for DBS East and DBS West together (**Table 8-154**). The assessment in **Table 8-154** predicts that up to three individual grey seal may be at risk of vessel collision for each year of construction (or 0.02% of the Berwickshire and North Northumberland Coast SAC population).

1023. This is a highly precautionary, as it is unlikely that all grey seal would be at increased collision risk with vessels during construction, considering the existing number of vessel movements in the area, and that vessels within the windfarm would be stationary for much of the time or very slow moving. Taking into account the disturbance from vessels, the actual risk is likely to be very low or negligible for all species.

1024. While there would be minimal increase to collision risk, less than 1% of the SAC are at risk of the permanent effect, and there is therefore **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential vessel collision risk during construction for the Projects together**.

8.3.8.3.9 Impact 7: Changes to Prey Resources

1025. The potential effects on prey species during construction can result from:

- Physical seabed disturbance;
- Increased SSC and sediment re-deposition;
- Remobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Changes in fishing activity.

1026. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, provides an assessment of these effect pathways on the relevant fish and shellfish species, and concludes impacts of negligible to minor adverse significance in EIA terms. Any reductions in prey availability would be small scale, localised and temporary. It is considered highly unlikely that potential reductions in prey availability as a result of construction activities at the Projects would result in detectable changes to grey seal populations.

1027. Grey seal feed on a variety of prey species and are considered to be opportunistic feeders, feeding on a wide range of prey species and they have relatively large foraging ranges (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

1028. A full qualitative assessment has been provided for grey seal in section 8.3.6.3.9. The information provided as part of that assessment is also valid for grey seal of the Berwickshire and North Northumberland Coast SAC, for either the Projects in isolation or together. Therefore, there will be **no adverse effect on the integrity of The Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential changes in prey availability during construction for the Projects**.

8.3.8.3.10 Impact 8: Disturbance at Seal Haul-Out Sites

1029. The Berwickshire and North Northumberland Coast SAC is located, at closest point, 228km from DBS East Array Area, 194km from DBS West Array Area and 175km from the OECC. The nearest seal haul-out site related to the Berwickshire and North Northumberland Coast SAC is the Fast Castle colony, approximately 248km from landfall at its closest point. The haul-out site is 294km from DBS East and 259km from DBS West.

1030. Given the distance of the Berwickshire and North Northumberland Coast SAC from the Offshore Development Area, the assessment would be the same or less than the potential effect as for grey seal of the Humber Estuary SAC, provided in section 8.3.6.3.10.

1031. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance at seal haul-out sites during construction for the Projects alone or together**.

8.3.8.4 Potential Effects during Operation and Maintenance

1032. The potential effects during operation and maintenance that have been assessed for are:

- Auditory injury and disturbance or behavioural impacts resulting from operational WTGs;
- Auditory injury and disturbance or behavioural impacts resulting from underwater noise during maintenance activities, including cable protection and cable reburial;
- Auditory injury and disturbance from the underwater noise associated with the presence of vessels;
- Barrier effects as a result of underwater noise;
- Vessel interaction (collision risk);
- Changes to prey resources; and
- Disturbance to seal haul-outs.

8.3.8.4.1 Impact 1a: Auditory Injury due to Operational Wind Turbine Noise

1033. The effect of operational wind turbines on grey seal is described in section 8.3.5.3.1 and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

8.3.8.4.1.1 Assessment of Potential Effects of the Projects Alone

1034. The number of grey seal that could be at risk of auditory injury (PTS / TTS) as a result of underwater noise from operational wind turbines has been assessed based on the number of animals that could be present in the modelled effect area for either one or all turbines (**Table 8-155**).

Table 8-155 Predicted Effect Ranges (And Areas) for PTS/TTS from 24 hour Cumulative Exposure of Underwater Noise from Operational Turbines

Species	Effect	Operational wind turbine	Area of effect for up to 100 Wind turbines
Grey seal (PCW)	PTS or TTS	<0.1km ($0.031km^2$)	$3.1km^2$

1035. There is unlikely to be any significant risk of any auditory injury, as again the modelling indicates that an individual would have to remain less than 100m from a turbine for 24 hours (**Table 8-155**). However, as a precautionary approach the number of grey seals that could be at risk of auditory injury has been estimated (**Table 8-156**). As outlined previously this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been rounded up to 100m.

1036. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from increased underwater noise from operational wind turbines at the Projects in isolation**.

Table 8-156 Maximum Number of Individuals (and % of Reference Population) That Could be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East and DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Potential adverse effect on site integrity
Grey seal	DBS East	0.1 (0.0006% of BNNC SAC)	**No** Less than 1% of the population at risk.
	DBS West	0.2 (0.001% of BNNC SAC)	
	OECC	0.1 (0.0008% of BNNC SAC)	

8.3.8.4.1.2 Assessment of Potential Effects of the Projects Together

1037. As stated in section 8.3.6.4.1.2; the predicted impact ranges for PTS / TTS from 24 hour cumulative exposure of underwater noise from operational turbines is <0.1km, and the potential effect area for the 200 operational wind turbines at DBS East and DBS West together would be up to 6.28km^2.

1038. An assessment of the maximum number of individuals that could be at risk of auditory injury (PTS / TTS), due to the underwater noise associated with all operational wind turbines is presented in **Table 8-157**.

1039. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from operational wind turbines at the Projects together**.

Table 8-157 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operational Turbines at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for 200 wind turbines (highest density in the Projects)	Potential adverse effect on site integrity
Grey seal	0.3 (0.002% of BNNC SAC)	**No** Less than 1% of the population at risk.

8.3.8.4.2 Impact 1b: Disturbance due to Operational Wind Turbine Noise

1040. Detail on the potential for grey seal to be disturbed from operational wind turbine noise has been provided in section 8.3.6.4.2.

1041. Based on this, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from operational wind turbine noise at the Projects in isolation or together**.

8.3.8.4.3 Impact 2a: Auditory Injury from Underwater Noise Associated with Operation and Maintenance Activities

1042. The requirements for any potential operation and maintenance activities, such as additional rock placement or cable re-burial, are currently unknown, however the work required, and associated effects to grey seal, would be less than those during construction. Section 8.3.8.3.3 provides an assessment for the same activities during construction, concluding that there is no potential for a significant effect for the Projects in isolation or together.

1043. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from underwater noise associated with operation and maintenance activities at the Projects in isolation or together**.

8.3.8.4.4 Impact 2b: Disturbance from Underwater Noise Associated with Operation & Maintenance Activities

1044. As for other activities during construction (section 8.3.8.3.4), a 4km has also been used as a potential disturbance range for maintenance activities and activities. As noted above, the requirements for maintenance activities during operation are currently unknown and are expected to be less than required through construction (although would be undertaken sporadically over the longer-term period).

1045. As no potential for significant effect was identified through construction, for either the Projects in isolation or together, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from underwater noise associated with operation and maintenance activities at the Projects in isolation or together**.

8.3.8.4.5 Impact 3a: Auditory Injury from Underwater Noise due to the Presence of Vessels

8.3.8.4.5.1 Assessment of Potential Effects of the Projects Alone

1046. During the operation and maintenance phase there will be reduced number of vessels in the Array Areas (when compared to the construction phase), although they would be present sporadically for a longer time frame than for construction. The maximum number of vessels that could be on the Array Areas at any one time has been estimated at up to a total of 20 vessels per Project (Table 11-1 in **Volume 7**, **Chapter 11 Marine Mammals (application ref: 7.11)**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

1047. The assessment for auditory injury for vessels during the operational phase has been undertaken following the same approach as for the construction phase (see section 8.3.6.4.5.1).

1048. **Table 8-158** present the assessment for the potential for auditory injury (PTS / TTS) for the operational period of either DBS East or DBS West in isolation.

1049. There would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from underwater noise associated with operation and maintenance vessels at the Projects in isolation.**

Table 8-158 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for up to 20 vessels	Potential adverse effect on site integrity
Grey seal	DBS East	0.02 (0.0001% of BNNC SAC)	**No** Less than 1% of the population at risk.
	DBS West	0.03 (0.0002% of BNNC SAC)	
	OECC	0.02 (0.0001% of BNNC SAC)	

8.3.8.4.5.2 Assessment of Potential Effects of the Projects Together

1050. The assessment for auditory injury for vessels during the operational phase has been undertaken following the same approach as for the construction phase (see section 8.3.8.3.3.1 and 8.3.8.3.3.2).

1051. **Table 8-159** presents the assessment for the potential for auditory injury (PTS / TTS) for the operational period of DBS East and DBS West together.

1052. There would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to auditory injury from underwater noise associated with operation and maintenance vessels at the Projects together**.

Table 8-159 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East and DBS West Together

Species	Maximum number of individuals (% of reference population) for up to 21 vessels	Potential adverse effect on site integrity
Grey seal	0.03 (0.0002% of BNNC SAC) [based on the worst case density at DBS West]	**No** Less than 1% of the population at risk.

8.3.8.4.6 Impact 3b: Disturbance from Underwater Noise due to the Presence of Vessels

8.3.8.4.6.1 Assessment of Potential Effects of the Projects Alone

1053. The same approach to the assessment of disturbance from vessels during construction has been used for operation. While the number of vessels potentially present at either Project is less than for construction, the same area based approach would be used regardless of the number of vessels present at the Offshore Development Area or transiting to the Projects. Therefore, the assessment for disturbance from vessels presented in section 8.3.8.3.6.1, (**Table 8-151**) as presented for construction, is also valid for operation.

1054. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects in isolation**.

8.3.8.4.6.2 Assessment of Potential Effects of the Projects Together

1055. As described above, the same approach for the assessment of vessel disturbance during construction would be used for operation, and therefore the assessment for the operational phase would be the same as that shown in section 8.3.8.3.6.2 and **Table 8-152**.

1056. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects together**.

8.3.8.4.7 Impact 4: Barrier Effects

1057. The assessment is the same as for grey seal in the Humber Estuary SAC in section 8.3.6.4.7.

1058. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential barrier effects from underwater noise during operation and maintenance for the Projects in isolation or together**.

8.3.8.4.8 Impact 5: Increased Collision Risk with Vessels During Operation and Maintenance

1059. It is estimated that the maximum number of vessels that could be required on site at any one-time during operation and maintenance could be up to 20 at the DBS East or DBS West Array Area. which is considerably less than the 32 vessels that could be on site during construction, see section 8.3.8.3.8.

1060. The assessment of collision risk, as presented for the construction phase (section 8.3.8.3.8; **Table 8-154**), is based on the Offshore Development Area, within which additional vessels may be present, and is not based on the number of vessels present within that area. At either DBS East or DBS West, there may be up to 239 vessel round trips for the Projects alone, or up to 474 transits for the Projects together, which is significantly less than the round trips required for construction.

1061. Therefore, the assessment of the potential for increased collision risk with vessels during operation would be the same as the assessment as for construction, as the area of potential effect is the same.

1062. In line with the construction assessment, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to potential vessel collision risk during operation of the Projects in isolation and together**.

8.3.8.4.9 Impact 6: Changes to Prey Resources

1063. Any effect on prey species has the potential to affect grey seal, and as outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, the potential effects on fish species during operation and maintenance can result from:

- Permanent Habitat Loss;
- Temporary Habitat Loss, Physical Disturbance of The Seabed, Increased Suspended Sediment and Sediment Deposition;
- Underwater Noise;
- EMF; and
- Changes in Fishing Activity.

1064. The potential effects of physical disturbance, permanent and temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment underwater noise, EMF and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there would therefore be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal**.

8.3.8.4.10 Impact 7: Disturbance at Seal Haul-Out Sites

1065. The Berwickshire and North Northumberland Coast SAC is located, at closest point, 228km from DBS East Array Area, 194km from DBS West Array Area and 175km from the OECC. The nearest seal haul-out site is at Berwickshire and North Northumberland Coast SAC is the Fast Castle colony, approximately 248km from landfall at its closest point. The haul-out site is 294km from DBS East and 259km from DBS West.

1066. The assessment would be the same as for grey seal of the Humber Estuary SAC, provided in section 8.3.6.4.10.

1067. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due to disturbance at seal haul-out sites during the operation and maintenance phase of the Projects in isolation or together**.

8.3.8.5 Potential Effects during Decommissioning

1068. Potential effects on grey seal associated with decommissioning have not been assessed in detail, see section 8.3.6.5 for further information.

1069. Therefore, the potential effects on grey seal during decommissioning would be the same or less than those assessed for construction. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal at the Projects in isolation or together**.

8.3.8.6 Potential In-Combination Effects

1070. The in-combination assessment considers other schemes and activities where the predicted effects have the potential to combine with the potential effects during construction of the Projects. The construction phase has been assessed as the worst case for potential in-combination effects.

1071. The schemes screened into the in-combination assessment for grey seal are those that have potential connectivity with the SAC, the NE and SE seal MU's as shown by the Berwickshire and North Northumberland Coast SAC specific Carter *et al*. (2022) density mapping. For further information, see **Volume 7 Appendix 11-5 (application ref: 7.11.11.5)**.

1072. The Berwickshire and North Northumberland Coast SAC in-combination assessment considers schemes which have sufficient information available to undertake the assessment, and includes the potential effects of:

- Underwater noise;
- Barrier effects
- Vessel interaction;
- Disturbance to seal haul-out sites; and
- Changes to prey resources (including habitat loss).

1073. The screening identified that there is the potential for in-combination effects on grey seals as a result of disturbance from underwater noise during piling and other construction activities. All operational effects have been screened out of the assessment (see section 8.3.5.5). Further information on the screening of effects considered for the in-combination assessment is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

8.3.8.6.1 Impact 1: Disturbance from Underwater Noise

1074. The potential sources of in-combination underwater noise which could disturb grey seals, and which are screened into the assessment are[22]:

- Disturbance from underwater noise
  - Piling at other OWFs;
  - Other construction activities at OWFs (such as vessels, cable installation works, dredging, seabed preparation and rock placement);
  - High resolution geophysical surveys (such as for OWFs);
  - Aggregate extraction and dredging;
  - Seismic surveys;
  - Subsea cables and pipelines; and

[22] While there is the potential for disturbance effects from other industries, all have been screened out of assessment (see **Volume 6, Appendix A HRA Screening (application ref: 6.1.1)** for further detail).

    - o UXO clearance.
- Barrier effects of other OWFs
- Increased collision risk with vessels;
- Disturbance to seal haul-out sites; and
- Changes in prey resources

1075. The commitment to the mitigation measures agreed through the MMMP (in accordance with **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)**) for piling would reduce the risk of physical injury or permanent auditory injury (PTS) in grey seal. In light of this, and taking account of the type, scale and extent of potential effects arising from the Projects' assessment, which concluded no adverse effect on integrity for grey seal due to physical injury or PTS from construction (see section 8.3.8.3.1).

1076. All OWFs with construction dates that have the potential to overlap with the construction dates for DBS East and / or DBS West have the potential for other construction activities (such as seabed preparation, dredging, trenching, cable installation, rock placement and vessels) to occur at the same time as other construction activities at the Projects.

1077. The OWFs screened in have all been assessed for the worst case scenario of piling at the same time as the Projects. Therefore, other construction activities at OWFs that could have an in-combination effect on the Projects are not considered further.

8.3.8.6.1.1 In-combination Impact 1a: Assessment of Underwater Noise from Piling at Other OWFs

1078. A list of UK and European OWF schemes that may have the potential for overlapping piling with the Projects is provided in **Volume 7, Appendix 11-6 (application ref: 7.11.11.6)** and has been used to inform the assessment for in-combination effects due to piling at other OWFs.

1079. For grey seal at the Berwickshire and North Northumberland Coast SAC, other OWFs were included (see **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**. In the assessment against the SAC population where the Carter *et al.* (2022) densities for the individuals associated with the Berwickshire and North Northumberland Coast SAC show presence within the 5km x 5km grid cells that overlap with the other OWF (or where there is a presence of seals within the potential disturbance area of the other OWF, e.g. within 25km for other OWFs that may be piling). However, not all OWFs included have concluded there is the potential for LSE in their own assessments.

1080. Of the UK and European OWFs screened in for having a construction period that could potentially overlap with the construction of the Projects, the below are relevant to grey seal and could be piling at the same time, which is currently estimated to take place in 2027 to 2031 for DBS East and DBS West;

- Berwick Bank;
- Dudgeon Extension;
- East Anglia Hub (East Anglia TWO);
- Greenvolt;
- Hornsea Project Three
- Hornsea Project Four;
- Outer Dowsing;
- Sheringham Shoal Extension; and
- West of Orkney.

1081. It is important to note the actual duration for active piling time which could disturb grey seals is only a very small proportion of the potential construction period (for example, of up to approximately 108 days DBS East or DBS West and one day for the OECC, based on the estimated maximum duration to install individual piles).

1082. As shown in **Table 8-160** below, DBS East or DBS West if constructed in isolation could disturb 9% or 14% respectively of the Berwickshire and North Northumberland Coast SAC population, if piling was undertaken at the same time as all other schemes. If DBS East and West were constructed together, up to 16% of the Berwickshire and North Northumberland Coast SAC population may be disturbed.

1083. For the one piling event in the OECC, up to 22% of the Berwickshire and North Northumberland Coast SAC population may be disturbed (**Table 8-160**).

Table 8-160 Quantitative Assessment for in-Combination Disturbance for Grey Seal from Piling at Other OWFs

Project	Assessment approach	Maximum number of individuals potentially disturbed during single piling
DBS East	Dose response curve assessment	281.0
DBS West	Dose response curve assessment	1,154.8
DBS OECC*	Dose response curve assessment	2,355.9
Berwick Bank	Dose response curve assessment (apportioned for those associated with the BNNC SAC) (SSE Renewables, 2022)	532
Dudgeon Extension	No potential for LSE at the BNCC SAC (Equinor New Energy Limited, 2022)	-
East Anglia Hub (East Anglia TWO)	No potential for LSE at the BNCC SAC (East Anglia TWO Limited, 2019)	-
Greenvolt	No potential for LSE at the BNCC SAC (Flotation Energy, 2022)	-
Hornsea Project Three	Dose response curve assessment (Orsted Power (UK) Ltd, 2018)	48.2
Hornsea Project Four	Dose response curve assessment, with 32% apportioned to the BNCC SAC (Orsted Hornsea Project Four Ltd, 2022)	476.5
Outer dowsing	No potential for LSE at the BNCC SAC (Outer Dowsing Offshore Wind, 2023)	-
Sheringham Shoal Extension	No potential for LSE at the BNCC SAC (Equinor New Energy Limited, 2022)	-

Project	Assessment approach	Maximum number of individuals potentially disturbed during single piling
West of Orkney	No potential for LSE at the BNCC SAC (Offshore Wind Power Limited, 2022)	-
Total number of grey seal with DBS East		**1,505.7 (8.9% of the BNNC SAC)**
Total number of grey seal with DBS West		**2,379.5 (14.1% of the BNNC SAC)**
Total number of grey seal with DBS OECC		**3,580.6 (21.2% of the BNNC SAC)**
Total number of grey seal with the Projects together*		**2,660.5 (15.7% of the BNNC SAC)**
Total number of grey seal without the Projects		**1,224.7 (7.2% of the BNNC SAC)**

**The OECC would not pile on the same day as DBS East or DBS West*

1084. In order to determine if piling from the Projects, along with other OWFs, has the potential for a SAC population level of effect, population modelling was carried out using the iPCoD model. The methodology is described in **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**.

1085. For the in-combination scenario assessed (based on the data provided in **Table 8-160**, and in **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**) for the Berwickshire and North Northumberland Coast SAC population, the iPCoD model predicts no change in the grey seal population size over a 25 year period (**Table 8-161; Plate 8-10**).

1086. The median population size was predicted to be 100% of the un-impacted population size at the end of 2028 (1 year after the piling has commenced). By the end of 2052, which is the end point of the modelling, at the median impacted to un-impacted ratio remains 100%.

1087. For the Berwickshire North Northumberland C SAC grey seal population, there is no potential for a significant effect with a less than a 1% population level effect over both the first six years, and the 25 year modelled periods (**Table 8-161; Plate 8-10**). Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal at the Projects in isolation or together**.

Table 8-161Results of the iPCoD Modelling for the Cumulative Assessment, Giving the Mean Population Size of the BNNC SAC Grey Seal Population (for years up to 2052 for Both Impacted and Un-Impacted Populations in Addition to the Median Ratio between their Population Sizes

Time period	Un-impacted pop mean	Impacted pop mean	Median impacted as % of unimpacted
Start	16906	16906	100.00%
End 2028	16993	16991	99.98%
End 2029	17109	17103	99.96%
End 2032	17401	17388	99.92%
End 2037	17994	17980	99.92%
End 2047	19119	19104	99.92%
End 2052	19706	19691	99.92%

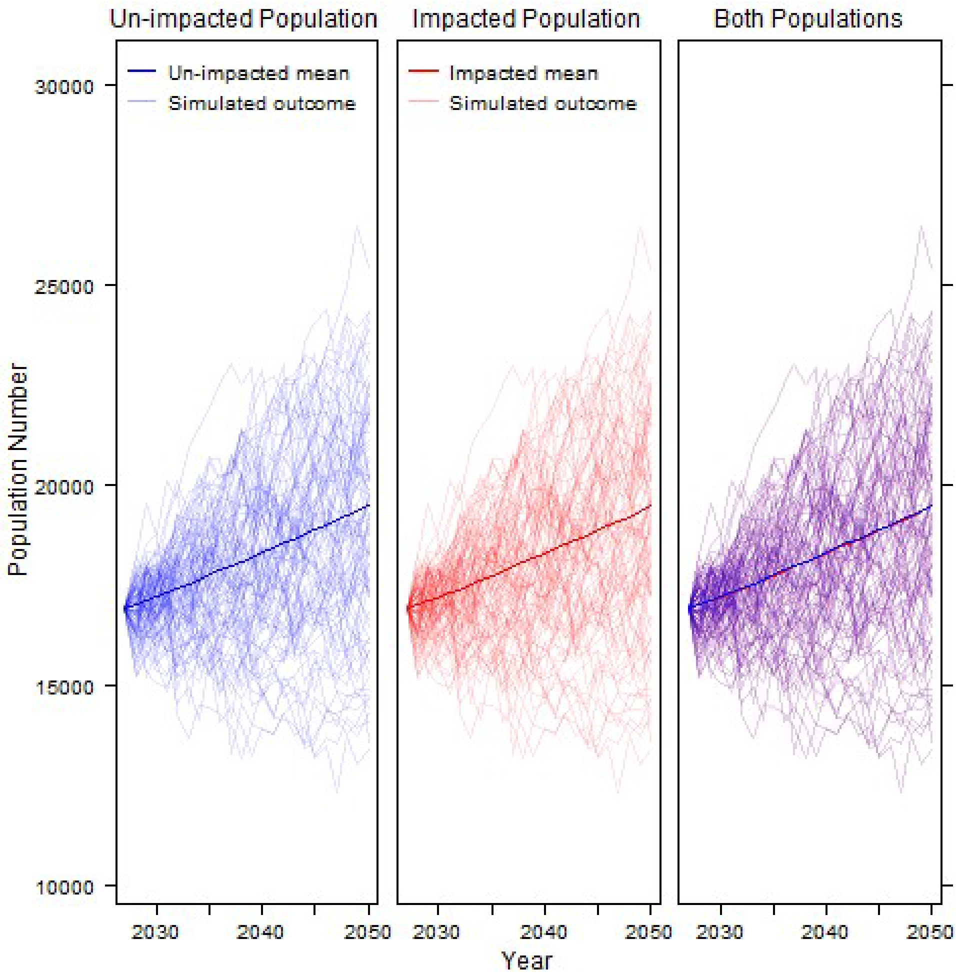


Plate 8-10 Simulated Worst case Berwickshire and North Northumberland Coast SAC Grey Seal Population Sizes for Both the Un-Impacted and the Impacted Populations

8.3.8.6.1.2 In-combination Impact 1b: Assessment of Disturbance from Other Industries and Activities

1088. During the construction period for DBS East and / or DBS West, there is the potential for disturbance to marine mammals associated with other potential noise sources, including:

- Geophysical surveys associated with other OWFs;
- Aggregate extraction and dredging;
- Seismic surveys;
- Subsea cable and pipelines; and
- UXO clearance.

8.3.8.6.1.2.1 Disturbance from Geophysical Surveys

1089. See section 8.3.6.6.1.3 for detail on the approach to the assessment for in-combination geophysical surveys for grey seal.

1090. As the location of the potential geophysical surveys is currently unknown, the following assessment for grey seal uses the average density estimate across the Carter *et al.* (2022) mean density dataset for the Berwick and Northumberland North Coast SAC of 0.028km^2. This assessment assumes that there could be up to one geophysical survey within the area at which grey seal associated with the Berwick and Northumberland North Coast SAC may be present (**Table 8-162**).

1091. For up to one geophysical surveys, there is the potential for 2.1 grey seals (0.01% of the Berwick and Northumberland North Coast SAC) to be disturbed. If the geophysical surveys were undertaken at the same time as construction of DBS East or West in isolation, less than 1% of the Berwick and Northumberland North Coast SAC population may be disturbed. Therefore, there would be no significant disturbance and no adverse effect on integrity of the Berwick and Northumberland North Coast SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects along with two geophysical surveys.

Table 8-162 Quantitative Assessment for In-Combination Disturbance of Grey Seal due to up to Two Geophysical Surveys at OWFs

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		< 1% of the BNNC SAC
One geophysical survey	0.028	78.54	2.2 0.01% of the BNNC SAC population
Total number of grey seal (DBS East or West in isolation and together)			**<1.01% of the BNNC SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.8.6.1.2.2 Disturbance from Aggregate Extraction and Dredging

1092. Taking into account the small potential effect ranges, distances of the aggregate extraction and dredging schemes from the Projects, the potential for contribution to in-combination effects is very small. For more information see section 8.3.6.6.1.3.

1093. The following assessment for grey seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for the Berwick and Northumberland North Coast SAC of 0.028km² (**Table 8-163**). Of the six schemes screened in (**Volume 7, Appendix 11-6 (application ref: 7.11.11.6)**), only one (Inner Dowsing) has connectivity with the Berwick and Northumberland North Coast SAC, as identified through the Carter *et al.* (2022) Berwick and Northumberland North Coast SAC density mapping.

1094. With the aggregate extraction project in-combination with the construction of DBS East and / or West in isolation, less than 1% of the Berwick and Northumberland North Coast SAC population may be disturbed.

Table 8-163 Quantitative Assessment for In-Combination Disturbance of Grey Seal due to One Aggregate Extraction and dredging activities Near the Projects

Potential in-combination effect	Marine mammal density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		<1% of the BNNC SAC population
One aggregate extraction and dredging project	0.028	1.13	0.03 (0.0002% of the BNNC SAC population)
Total number of grey seal (DBS East or West in isolation and together)			**<1% of the BNNC SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.8.6.1.2.3 Disturbance from Seismic Surveys

1095. For more information on the approach to assessment for in-combination seismic surveys for grey seal see section 8.3.6.6.1.3.

1096. As the location of the potential seismic surveys is currently unknown, the following assessment for grey seal uses the average density estimate across the Carter et al. (2022) relative density dataset for the Berwick and Northumberland North Coast SAC of 0.028km². This therefore assumes that there could be up to two seismic surveys within the area at which grey seal associated with the Berwick and Northumberland North Coast SAC may be present (**Table 8-164**).

1097. For two seismic surveys, there is the potential for up to 51 grey seals (0.30% of the Berwick and Northumberland North Coast SAC population) may be disturbed from seismic surveys (**Table 8-164**). For up to two seismic surveys undertaken at the same time as construction of DBS East or West in isolation or together, with no other in-combination activities, less than 1.5% of the Berwick and Northumberland North Coast SAC population may be disturbed.

1098. Therefore, there would be no significant disturbance and there is no potential for adverse effect on integrity of the Berwick and Northumberland North Coast SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects as well as two seismic surveys (**Table 8-164**).

Table 8-164 Quantitative Assessment for In-Combination Disturbance of Grey Seal due to up to Two Seismic Surveys with the Projects

Potential in-combination effect	**Marine mammal density (/km²)**	**Potential in-combination effect area (km²)**	**Maximum number of individuals potentially disturbed (% of reference population)**
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		<1% of the BNNC SAC population
Up to two seismic surveys	0.028	1,815.8	50.8 (0.30% of the BNNC SAC population)
Total number of grey seal (DBS East or West in isolation or together)			**<1.30% of the BNNC SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.8.6.1.2.4 Disturbance from Subsea Cables and Pipelines

1099. One subsea cable scheme was screened in for assessment; Sea Link (**Volume 7, Appendix 11-6 (application ref: 7.11.11.6)**). However, this scheme is not located in the area identified to have connectivity with the Berwick and Northumberland North Coast SAC (based on the Carter *et al.* (2022) Berwick and Northumberland North Coast SAC density mapping). Therefore, subsea cable and pipeline schemes are not considered further for the Berwick and Northumberland North Coast SAC.

8.3.8.6.1.2.5 Disturbance from UXO Clearance

1100. It is currently not possible to estimate the number of potential UXO clearance events that could be undertaken at the same time as construction and potential piling activity at DBS East and / or DBS West, and therefore, on a worst case basis, the potential for one high-order clearance and one low-order clearance has been assessed as having the potential to take place at the same time. For more information see section 8.3.6.6.1.3.

1101. As the location of the potential UXO clearance campaigns are currently unknown, the following assessment for grey seal uses the average density estimate across the Carter *et al.* (2022) relative density dataset for the Berwick and Northumberland North Coast SAC of 0.028km^2. This therefore assumes that there could be up to one high-order and one low-order UXO clearance within the area at which grey seal associated with the Berwick and Northumberland North Coast SAC may be present (**Table 8-165**).

1102. For one high-order UXO clearance, there is a potential for up to 43 grey seal (0.25% of the Berwick and Northumberland North Coast SAC population) be disturbed (**Table 8-165**). For up to one high-order and one low-order UXO clearance undertaken at the same time as construction of DBS East and / or West, less than 2% of the Berwick and Northumberland North Coast SAC population could potentially be disturbed. Therefore, there would be no significant disturbance and there is no potential for adverse effect on integrity of the Berwick and Northumberland North Coast SAC in relation to the conservation objectives for grey seal in-combination with piling at the Projects as well as UXO Clearance (**Table 8-165**).

Table 8-165 Quantitative Assessment for Cumulative Disturbance of Grey Seal due to UXO Clearance Near the Projects

Potential in-combination effect	**Marine mammal density (/km²)**	**Potential in-combination effect area (km²)**	**Maximum number of individuals potentially disturbed (% of reference population)**
Piling at the Projects*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		<1% of the BNNC SAC population
One high-order UXO clearance	0.028	1,520.5	42.6 (0.25% of the BNNC SAC population)
One low-order UXO clearance	0.028	1.02	0.03 (0.0002% of the BNNC SAC population)
Total number of grey seal (DBS East or West in isolation or together)			**<1.3% of the BNNC SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.8.6.1.3 Summary of In-Combination Effect 1: Assessment of Disturbance from All Noisy Activities Associated with Offshore Industries

1103. Each of the above described other noise sources are quantitively assessed together in **Table 8-166**.

1104. It should be noted that while the schemes included within the in-combination assessment for disturbance from other activities and industries were done so based on the current knowledge of their possible construction or activity windows, it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the grey seals that could be at risk of disturbance during the offshore construction period of the Projects.

1105. As shown in **Table 8-166** below, for all in-combination schemes and activities, whether DBS East and West were constructed separately or together, less than 1.6% of the Berwickshire and North Northumberland Coast SAC population would be disturbed, and therefore there is **no potential for an adverse effect on integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal**.

Table 8-166 Quantitative Assessment for All Noisy Activities with the Potential for In-Combination Disturbance Effects for Grey Seals

Potential in-combination effect	Marine mammal density (/km^2)	Potential in-combination effect area (km^2)	% of BNNC SAC population
Piling at other OWFs including the worst case disturbance from the Project*	iPCoD modelling undertaken, population level effect over both the first six years and 25 year modelled periods.		<1% of the BNCC SAC
One geophysical survey	0.028	78.54	0.01% of the BNNC SAC
Aggregate extraction and dredging schemes	0.028	1.13	0.0002% of the BNNC SAC
Two seismic surveys	0.028	1,815.8	0.30% of the BNNC SAC
One high-order UXO clearance	0.028	1,520.5	0.25% of the BNNC SAC
One low-order UXO clearance	0.028	1.02	0.0002% of the BNNC SAC
Total number of grey seal (DBS East or West in isolation or together)			**<2% of the BNNC SAC population**
Total number of grey seal without the Projects			**0.56% of the BNNC SAC population**

**The OECC would not pile on the same day as DBS East or DBS West*

8.3.8.6.2 Impact 2: Barrier Effects

1106. The potential for in-combination barrier effects would be the same as described in section 8.3.6.6.2. Therefore, there would be **no adverse effect due to barrier effects on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal**.

8.3.8.6.3 Impact 3: Vessel Interaction

1107. The in-combination effects from an increase in the number of vessels and vessel movements can pose a potential collision risk for grey seal.

1108. As outlined in section 8.3.8.3.8, the increased collision risk due to project vessels, even using a very precautionary approach, could result in up to four individuals being at risk of vessel collision per year (**Table 8-154**

1109. Table 8-154) for the construction phase related vessel collision risk, prior to best practice management measures. This amount would be reduced for operation and maintenance phase related vessel collision risk due to the construction phase being the worst case in terms of vessel numbers (see section 8.3.8.4.8).

1110. As stated in **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**, vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where grey seal are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and with a vessel speed limit of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with grey seal. It is expected that other offshore schemes and industries would follow similar measures in order to reduce the potential for collision risk of grey seal with vessels.

1111. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low.

1112. In addition, based on the assumption that grey seal would be disturbed as a result of underwater noise from piling, other construction activities, operational and maintenance activities and vessels, there should be no potential for increased collision risk with vessels.

1113. Therefore, there would be **no adverse effect on integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal due an increase in collision risk with construction vessels**.

8.3.8.6.4 Impact 4: Disturbance to Seal Haul-Out Sites

1114. The nearest seal haul-out site to the Projects is the Fast Castle colony, approximately 248km from landfall at its closest point, and 294km from DBS East and 259km from DBS West. It is therefore not expected that DBS East or DBS West would have the potential for any significant effect on the seal haul-out sites of Berwickshire and North Northumberland Coast SAC. However, there is the potential for disturbance form transiting vessels, depending on the port location(s).

1115. The inclusion of vessel best practice measures (as provided within the **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**), such as the reduction of vessel transit speeds wherever practicable, and the avoidance of transiting within 1km of any seal haul-out site, would effectively minimise any potential for disturbance to seal haul-out sites.

1116. It is assumed that all other schemes would follow the same best practice measures with regards to avoiding disturbance at haul-out sites. In addition, where seal haul-out sites are near to a vessel corridor, the seals present in that area would be used to vessels transiting past the area.

1117. Therefore, there would be **no adverse effect on integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for harbour seal due an increase in disturbance to seal haul-out sites**.

8.3.8.6.5 Impact 5: Changes to Prey Availability

1118. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Therefore, there would be **no adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal arising due to changes in prey availability**.

8.3.8.7 Summary of Potential Effects on Site Integrity

1119. The assessment of the potential effects for the Projects in isolation or together has been summarised in relation to the BNNC SAC conservation objectives for grey seal (**Table 8-167**).

1120. Mitigation measures are presented in **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** and will be reviewed in the final MMMP prior to construction. The MMMP will provide mitigation or management measures to reduce the potential for any significant disturbance of grey seal as a result of in-combination effects from underwater noise.

1121. As shown in **Table 8-167**, there is no potential for an adverse effect on integrity of the Berwickshire and North Northumberland Coast SAC in relation to the conservation objectives for grey seal, either alone or in-combination.

Table 8-167 Summary of the Potential Effects of the Project, Including In-Combination Effects on the BNNC SAC in Relation to the Conservation Objectives for Grey Seal (X = No Potential for AEoI; ✓ = Potential for AEoI)

Conservation objectives	Projects' alone effects					In-combination effects				
	Auditory injury and disturbance from underwater noise	Barrier effects	Disturbance at seal haul-out sites	Vessel interaction	Changes to prey resources	Disturbance from underwater noise	Barrier effects	Vessel interaction	Disturbance to seal haul-out sites	Changes to prey resources
The populations of qualifying species.	X	X	X	X	X	X	X	X	X	X
The distribution of qualifying species within the site.	X	X	X	X	X	X	X	X	X	X

8.3.9 Moray Firth SAC

8.3.9.1 Site Description

1122. The Moray Firth SAC in north-east Scotland supports the only known resident population of bottlenose dolphin in the North Sea (NatureScot, 2021). The Moray Firth is approximately 487km from DBS East Array Area at closest point and 534km from DBS West Array Area. Individuals are present all year round within the Moray Firth SAC with over 50% of the east coast population utilising the area (Arso Civil *et al.* 2019). The population generally maintain a coastal distribution which extends south to the Firth of Forth (Hague *et al.* 2020).

8.3.9.1.1 Qualifying Features

8.3.9.1.1.1 Bottlenose Dolphin

1123. Bottlenose dolphin within the Moray Firth SAC are in favourable (maintained) condition (NatureScot, 2021). The latest conservation status assessment for bottlenose dolphin in UK waters was classed as 'unknown' (JNCC, 2019).

1124. The population estimate for the Moray Firth SAC is 224 individuals (Coefficient of Variation (CV) = 0.02; 95% Confidence Interval (CI) = 214-234) (Arso Civil *et al.* 2019; IAMMWG, 2023).

1125. Historically, very few sightings of bottlenose dolphin were recorded further south on the east coast of the UK. In recent years an increase in bottlenose dolphins along the coastline of north-east England have been reported. A total of 48 individuals sighted along the north-east coast were attributed to being part of the Moray Firth population using photo-identification (Hackett, 2022).

1126. During the site specific digital aerial surveys of both DBS East Array Area and DBS West Array Area, undertaken from March 2021 to February 2022, no bottlenose dolphin were recorded. However, one sighting was recorded as unidentified dolphin, which could have been attributed to bottlenose dolphin and has not been included in the assessments.

1127. There is currently no density estimate for bottlenose dolphin in and around the Moray Firth SAC from the SCANS survey or at any other sources.

1128. The density estimate from SCANS-IV survey block NS-C used for the assessment of bottlenose dolphin as the Projects are within this area. This results in a density estimate of 0.0419 bottlenose dolphin per km^2 (Gilles *et al.* 2023).

8.3.9.1.2 Conservation Objectives

1129. To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving FCS.

1130. To ensure that the integrity of Moray Firth SAC is maintained or restored in the context of environmental changes by meeting the following objectives for each qualifying feature:

- To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status; and
- 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.

8.3.9.1.3 Potential Effects Summary

1131. For the purposes of the assessments, the potential effects are considered in relation to the Moray Firth SAC Conservation Objectives as outlined in **Table 8-168**.

Table 8-168 Potential Effects in Relation to the Conservation Objectives of the Moray Firth SAC for Bottlenose Dolphin

Conservation Objective for bottlenose dolphin	Potential Effect
1. To ensure that the qualifying features of Moray Firth SAC are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.	1. Physical and permanent auditory injury (PTS) from underwater noise will be mitigated and therefore there is no potential for LSE. Significant disturbance as a result of increased underwater noise levels has the potential to have an adverse effect on bottlenose dolphin and will be considered further. Any potential increased collision risk with vessels will be considered further.

Conservation Objective for bottlenose dolphin	Potential Effect
2. 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: 2a. The population of bottlenose dolphin is a viable component of the site.	2a. Physical and permanent auditory injury (PTS) from underwater noise will be mitigated and therefore there is no potential for LSE. Significant disturbance as a result of increased underwater noise levels has the potential to have an adverse effect on bottlenose dolphin and will be considered further. Any potential increased collision risk with vessels will be considered further.
2b. The distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance.	2b. Significant disturbance as a result of increased underwater noise levels has the potential to have an adverse effect on bottlenose dolphin and will be considered further.
2c. The supporting habitats and processes relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin are maintained.	2c. No potential LSE. There will be no potential for any change to the distribution and extent of the habitats in the Cardigan Bay SAC supporting bottlenose dolphin. There will be no potential for any change to the availability of prey for bottlenose dolphin in the Cardigan Bay SAC. Although potential changes to prey availability in and around the Windfarm Site will be considered further.

8.3.9.2 Potential Effects During Construction

1132. Potential effects during construction may arise through disturbance from activities during the installation of offshore infrastructure. The potential displacement from important habitat areas and impacts on prey species are also considered.

1133. Underwater noise during piling will not be assessed for the Moray Firth SAC, as piling for the Projects is offshore, it will not have an impact on the population associated with the Moray Firth SAC due to the coastal nature of their distributions. However, disturbance associated with underwater noise from other construction activities and the presence of vessels offshore will be considered as these activities may occur closer to shore in the OECC.

1134. The potential effects during construction assessed for bottlenose dolphin of the Moray Firth SAC are:

1135. Auditory injury and disturbance or behavioural impacts resulting from underwater noise during other construction activities, including seabed preparations, rock placement and cable installation;

- Auditory injury and disturbance or behavioural impacts resulting from the deployment of construction vessels;
- Barrier effects as a result of underwater noise;
- Vessel interaction (collision risk); and
- Changes to prey resource.

8.3.9.2.1 Impact 1a: Auditory Injury from Underwater Noise during Other Construction Activities

1136. Potential sources of underwater noise during construction activities, other than piling are discussed further in section 8.3.5.2.3.

1137. To determine the potential risk for auditory injury (PTS / TTS) from underwater noise during dredging, trenching, cable laying and rock placement, site specific underwater noise modelling was undertaken to estimate the noise levels and determine the potential effects ranges for bottlenose dolphin. See **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** for further information on the underwater noise modelling.

1138. The results of the underwater noise modelling (**Table 8-169**) indicate that bottlenose dolphin would have to be less than 100m (precautionary maximum range) from the continuous noise source for 24 hours, to be exposed to noise levels that could induce PTS or TTS.

Table 8-169 Predicted Effect Ranges (and Areas) for PTS/TTS from 24 hour Cumulative Exposure During other Construction Activities

Species	Cable laying / Dredging / Trenching / Rock placement	Four activities together
Bottlenose dolphin	<0.1km (<0.03 km^2)	0.18km^2

8.3.9.2.1.1 Assessment of Potential Effects of the Projects Alone

1139. The number of bottlenose dolphin that could be affected as a result of underwater noise during construction activities other than piling has been assessed based on the number of animals that could be present in each of the modelled impact ranges, or for up to four activities undertaken at the same time (**Table 8-170**).

1140. The potential for auditory injury effects that could result from underwater noise during other construction activities, including cable laying and protection would be temporary in nature, not consistent throughout the offshore construction period for the Projects and would be limited to only part of the overall construction period and area at any one time.

1141. Given the small number of individuals affected, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to auditory injury from underwater noise during other construction activities for the Projects in isolation**.

Table 8-170 Maximum Number of Individuals (and % of Reference Population) that Could be Affected as a Result of Underwater Noise Associated with Non-Piling Construction Activities

Species	Potential Effect	Location	Maximum number of individuals (% of population) at risk of auditory injury (PTS/TTS)	Potential adverse effect on site integrity
Bottlenose dolphin	One activity: - Cable laying - Trenching - Rock placement - Dredging	OECC only, for the construction of either of the Projects	0.001 (0.0006% of Moray Firth SAC)	**No** Less than 1% of the population at risk.
	Up to four activities at the same time	OECC only, for the construction of either of the Projects	0.005 (0.002% of Moray Firth SAC)	**No** Less than 1% of the population at risk.

8.3.9.2.1.2 Assessment of Potential Effects of the Projects Together

1142. As a worst-case, the maximum number of bottlenose dolphin from each Project has been assessed to indicate the maximum number of individuals that could be affected from the Projects together, if they are developed concurrently. As noted above, only those activities that are undertaken within the OECC are relevant for bottlenose dolphin of the Moray Firth SAC, with the potential for up to four different activities to be undertaken at the same time. Therefore, the assessment as presented in **Table 8-170** for the Projects alone (with up to four activities within the OECC) is also relevant for the Projects together.

1143. Given the small number of individuals affected, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to auditory injury from underwater noise during other construction activities for the Projects together**.

8.3.9.2.2 Impact 1b: Disturbance from Underwater Noise During Other Construction Activities

1144. If the response is displacement from the area, it is predicted that bottlenose dolphin will return once the activity has been completed. Therefore, any effects from underwater noise as a result of construction activities other than piling noise will be both localised and temporary. There is unlikely to be potential for any significant disturbance effect on marine mammals.

1145. As for the assessments of other construction noise in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, the following assessments are based on the 4km disturbance as recorded for harbour porpoise due to the construction activities associated with OWFs (Benhemma-Le Gall *et al.* 2021). This is over precautionary as it is unlikely bottlenose dolphin would respond to underwater noise disturbance at the same level as harbour porpoise. Further information on this approach is provided in section 8.3.5.2.4 and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

1146. Given that the bottlenose dolphin population of the Moray Firth SAC are predominantly a coastal population, individuals associated with the SAC would only be at risk of disturbance from activities undertaken in the coastal area, close to the shoreline. Therefore, the following assessments are based on the activities that may be undertaken at the same time in the OECC only.

8.3.9.2.2.1 Assessment of Potential Effects of the Projects Alone

1147. The following assessment is based on the maximum number of individuals that could be at risk of disturbance due to other construction activities, using the 4km potential disturbance range for each assessed activity (with an effect area of 50.27km^2) (**Table 8-171**).

1148. Given that less than 5% of the population would be at risk from disturbance, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to the disturbance from increased underwater noise during other construction activities for the Projects in isolation**.

Table 8-171 Assessment of the Potential for Disturbance Due to Other Construction Activities, for One and Multiple Activities Taking Place at Any One Time Either at DSB East or DBS West in Isolation

Species	Potential effect	Location	Maximum number of individuals (% of population) at risk of disturbance	Potential adverse effect on site integrity
Bottlenose dolphin	One activity: - Cable laying - Trenching - Rock placement - Dredging	OECC only, for the construction of either of the Projects	2.1 (0.94% of Moray Firth SAC)	**No** Less than 5% of the population at risk.
	Up to four activities at the same time	OECC only, for the construction of DBS East and DBS West	8.4 (3.76% of Moray Firth SAC)	**No** Less than 5% of the population at risk.

8.3.9.2.2.2 Assessment of Potential Effects of the Projects Together

1149. The following assessment for DBS East and DBS West together is based on the maximum number of individuals that could be at risk of disturbance due to four other construction activities being undertaken within the OECC at the same time. As noted above, only those activities that are undertaken within the OECC are relevant for bottlenose dolphin of the Moray Firth SAC, with the potential for up to four different activities to be undertaken at the same time. Therefore, the assessment as presented in **Table 8-171** for the Projects alone (with up to four activities within the OECC) is also relevant for the Projects together.

1150. Given that less than 5% of the population would be at risk from disturbance, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to the disturbance from increased underwater noise during other construction activities for the Projects together**.

8.3.9.2.3 Impact 2a: Auditory Injury from Underwater Noise due to the Presence of Vessels

1151. Vessel movements to and from any port will be incorporated within existing vessel routes and therefore any increase in disturbance as a result of underwater noise from vessels during construction will be within the Array Areas and OECC only. Therefore, there is no direct overlap with the Moray Firth SAC for underwater noise and the presence of vessels when cable laying. In addition, the majority of the vessel transit would be offshore, rather than inshore, and therefore, for bottlenose dolphins, the majority of the effect would be for the wider North Sea population, rather than for the Moray Firth SAC population, which may be exposed to vessel transit disturbance while the vessel was entering and exiting the port only. Therefore, only vessels at the Projects themselves are considered for the Moray Firth population.

1152. Further information on vessel transits is provided in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11**).

1153. As noted above, bottlenose dolphin are only at risk of disturbance within the OECC, as they are predominantly a coastal population. For the construction of DBS East and West in isolation, there is the potential for up to six vessels to be present at any one time, and for the Projects together, there is the potential for up to 12 vessels to be within the OECC. However, only a small proportion of those would be within close proximity to the coastline, and it has been assumed that approximately 50% of the vessels in the OECC at any one time might be within 2km of the coastline. This would equate to up to three vessels within 2km of the coastline for either DBS East or DBS West at any one time, and up to six for both Projects together. This is deemed a precautionary approach, as it is unlikely that more than that would be present in the inshore region at any one time.

1154. To determine the potential risk for PTS and TTS from underwater noise of vessels underwater noise modelling was undertaken (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3**)). Underwater noise modelling was undertaken for medium and large vessels. Medium vessels are less than 100m in length, while large vessels are over 100m.

8.3.9.2.3.1 Assessment of Potential Effects of the Projects Alone

1155. The results of the underwater noise modelling (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) shows that bottlenose dolphin would have to be less than 100m (precautionary maximum range) from the vessel for 24 hours, to be exposed to noise levels that could induce auditory injury (PTS / TTS) based on the Southall *et al.* (2019) thresholds and criteria.

1156. The following assessment is based on the maximum number of individuals that could be at risk of auditory injury due to vessel presence within the inshore region of the OECC only (**Table 8-172**).

1157. Given that less than 1% of the population would be at risk of auditory injury, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to auditory injury (PTS/TTS) from increased underwater noise due to the presence of vessels for the Projects alone**.

Table 8-172 Assessment of the Potential for Risk of Auditory Injury Due to Vessel Presence, for One or Multiple Vessels within the OECC at Any One Time Either at DSB East or DBS West Alone

Species	Location	Maximum number of individuals (% of population) at risk of auditory injury	Potential adverse effect on site integrity
For one vessel the inshore region of the OECC			
Bottlenose dolphin	OECC only, for the construction of either DBS East or DBS West	0.001 (0.0006% of the Moray Firth SAC)	**No** Less than 1% of the population at risk.
For up to three vessels in the inshore region of the OECC			
Bottlenose dolphin	OECC only, for the construction of either DBS East or DBS West	0.004 (0.002% of the Moray Firth SAC)	**No** Less than 1% of the population at risk.

8.3.9.2.3.2 Assessment of Potential Effects of the Projects Together

1158. The above assessment (**Table 8-172**) is based on the maximum number of individuals that could be at risk of auditory injury due to vessel presence within the inshore region of the OECC only. It is not expected that there would be an increase in vessels in the inshore area when the Projects are considered together and the three vessels (**Table 8-172)** would represent the worst case.

1159. Given that less than 1% of the population would be at risk from auditory injury, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to auditory injury (PTS / TTS) from increased underwater noise due to the presence of vessels for the Projects together**.

8.3.9.2.4 Impact 2b: Disturbance from Underwater Noise due to the Presence of Vessels

1160. Bottlenose dolphin within the potential disturbance area is considered to have limited capacity to avoid such effects, although any disturbance to marine mammals would be temporary and they would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

1161. The following assessments follow the approach as outlined in section 8.3.5.2.6 and **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**, using the 4km disturbance range for each vessel (Benhemma-Le Gall *et al.* 2021). This is considered to be an over-precautionary approach, as it is unlikely that (a) bottlenose dolphin would respond to the same level as harbour porpoise, (b) the 4km disturbance range is based on vessels undertaking construction activities, rather than solely the presence of those vessels, and (c) this approach does not take into account any potential overlap in disturbance areas, that would reduce the overall area of effect used to inform the assessments.

1162. As noted above, there is the potential for up to three vessels to be present within the inshore region of the OECC for the construction of either DBS East or DBS West. Further information on the assessment technique is provided in **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**.

8.3.9.2.4.1 Assessment of Potential Effects of the Projects Alone

1163. The potential effect on bottlenose dolphin due to the disturbance from vessels is assessed in **Table 8-173**.

1164. The number of bottlenose dolphin potentially affected by disturbance from underwater noise due to the presence of vessels at the Projects is less than 5%. Therefore, there would be **no potential for an adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to disturbance from increased underwater noise due to the presence of vessels for the Projects in isolation**.

Table 8-173 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West in isolation

Species	Location	Maximum number of individuals (% of population) at risk of disturbance	Potential adverse effect on site integrity
For one vessel in the inshore region of the OECC			
Bottlenose dolphin	OECC only, for the construction of either DBS East or DBS West	2.1 (0.94% of the Moray Firth SAC)	**No** Less than 5% of the population at risk.
For up to three vessels in the inshore region of the OECC			
Bottlenose dolphin	OECC only, for the construction of either DBS East or DBS West	6.3 (2.82% of the Moray Firth SAC)	**No** More than 5% of the population at risk.

8.3.9.2.4.2 Assessment of Potential Effects of the Projects Together

1165. The potential effect on bottlenose dolphin due to the disturbance from vessels is assessed in **Table 8-173**. It is not expected that there would be an increase in vessels in the inshore area when the Projects are considered together and the three vessels (**Table 8-173**) would represent the worst case.

1166. In addition, as noted in section 8.3.1, vessel best practice measures will be in place to reduce the potential for disturbance to any marine mammal. The measures that would reduce disturbance include following existing vessel routes, reducing the number of vessels and transits as much as possible, reducing the vessel speed wherever practicable, and following RWEs 'Working in Proximity to Wildlife in the Marine Environment Code of Conduct'. These measures would reduce the potential for vessel disturbance.

1167. Therefore, with the best practice measures as noted above, there would be **no potential for an adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to disturbance from increased underwater noise due to the presence of vessels for the Projects together**.

8.3.9.2.5 Impact 3: Barrier Effects as A Result of Underwater Noise During Construction

8.3.9.2.5.1 Assessment of Potential Effects of the Projects Alone

1168. Underwater noise during construction could have the potential to create a barrier effect, preventing movement of bottlenose dolphin, or potentially increasing swimming distances if they avoid the area. As noted above, bottlenose dolphin are known to move along the coast and are therefore unlikely to be affected as a result of underwater noise at the DBS East and DBS West Array Areas.

1169. The worst case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area and longest duration) scenarios.

1170. The maximum number of bottlenose dolphin that could be affected during construction is due to vessel presence within the inshore region of the OECC; less than seven dolphins, in the unlikely case of three vessels all being present within the inshore region of the OECC (**Table 8-173**). It should be noted that vessels are likely to be present during works at the landfall only, which would be temporary. Therefore, any potential for a barrier to movement would be temporary and localised, within a small area of the inshore region only.

1171. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to potential barrier effects as a result of underwater noise during construction for DBS East or DBS West in isolation**.

8.3.9.2.5.2 Assessment of Potential Effects of the Projects Together

1172. The worst case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area and longest duration) scenarios.

1173. The maximum number of bottlenose dolphin that could be affected during construction is due to vessel presence within the inshore region of the OECC; less than seven dolphins, in the case of three vessels all being present within the inshore region of the OECC (**Table 8-173**). It should be noted that vessels are likely to be present during works at the landfall only, which would be temporary. Therefore, any potential for a barrier to movement would be temporary and localised, within a small area of the inshore region only.

1174. There would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to potential barrier effects as a result of underwater noise during construction for the DBS East and West together**.

8.3.9.2.6 Impact 4: Increased Collision Risk with Vessels During Construction

8.3.9.2.6.1 Assessment of Potential Effects of the Projects Alone

1175. During the offshore construction phase of the Projects there will be an increase in vessel traffic within the offshore sites. However, it is anticipated that vessels would follow an established shipping route to the relevant ports in order to minimise vessel traffic in the wider area.

1176. There is currently limited information on the collision risk of bottlenose dolphin North Sea. To estimate the potential collision risk of vessels associated with the OECC during construction, the potential risk rate per vessel has been calculated for bottlenose dolphin, which is then used to calculate the total risk to the Moray Firth population. As noted above, only those vessels associated with the construction in the OECC are relevant for the Moray Firth bottlenose dolphin population; with an average of 772 transits per year which have the potential to pass through the coastal area although this is highly precautionary assessment (see section 11.6.1.6 of **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**). The collision risk has been estimated by using data from the CSIP and SMASS.

1177. CSIP and SMASS records and investigate all marine mammal strandings in the UK and recorded 183 strandings of bottlenose dolphin; one of which was recorded as physical trauma from an unknown cause. This results in a collision risk rate of 0.0233 (**Table 8-174**).

Table 8-174 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collisions with Vessels

Species	Number of strandings	Number of post-mortems where cause of death established	Cause of death: physical trauma of unknown cause	Cause of death: physical trauma following probable impact from vessels	Collision risk rate (%) (number attributed to vessels strike / other physical trauma as proportion of total known cause of death)
Bottlenose dolphin	183	43	1	0	0.0233

1178. To inform this assessment, the total number of bottlenose dolphin in UK waters has been compared against the total vessels present in UK waters, as well as the potential collision risk rate of each species based on the CSIP and SMASS data. The total UK populations for bottlenose dolphin is taken from IAMMWG (2023). The total presence of vessels in UK waters is taken from the total vessel transits within the 2015 AIS data, which is the latest publicly available.

1179. The assessment in **Table 8-175** predicts that up to one individual may be at risk of vessel collision if construction took place for 25 years (or 0.02% of the Moray Firth SAC population).

1180. This is a highly precautionary assumption, as it is unlikely that bottlenose dolphin in the OECC would be at increased collision risk with vessels during construction, considering the minimal number of vessel movements compared to the existing number of vessel movements in the area, and that vessels within the Offshore Development Area would be stationary for much of the time or very slow moving.

1181. Vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals (see **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**).

1182. Therefore, there would be no increased collision risk of bottlenose dolphin and **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential collision risk with vessels for the Projects in isolation or together**.

Table 8-175 Predicted Number of Bottlenose Dolphin at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (AEoI Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West in Isolation and Together.

	DBS East or DBS West in Isolation	DBS East or DBS West together
Collision risk rate[23]	0.0233	
Estimated total number of individuals in UK waters[24]	7,252	
Estimated number of individuals at risk within UK waters	169	
Annual number of vessel transits in UK and RoI for 2015[25]	3,852,030	
Number of marine mammals at risk of collision per vessel in UK waters	0.00004	

[23] Where species specific data is not available, the species group data is used
[24] Based on the (IAMMWG, 2023) UK population estimates for cetacean species
[25] Latest publicly available data

	DBS East or DBS West in Isolation	DBS East or DBS West together
Number annual vessel transits associated with construction	772	1,502
Additional marine mammals at risk due to increase in vessel number (collision rate vessel increase)	Up to one individual every 25 years of construction (n=0.04)	Up to one bottlenose dolphin every 10 years of construction (n=0.01)
% reference population	0.02% of Moray Firth SAC population at risk.	0.03% of Moray Firth SAC population at risk.
Potential adverse effect on site integrity	**No** – Less than 1% of population affected	**No** – Less than 1% of population affected

8.3.9.2.6.2 Assessment of Potential Effects of the Projects Together

1183. As a precautionary assessment, the number of bottlenose dolphin that could be at increased risk of collision with construction vessels, if DBS East and DBS West are constructed concurrently, has been based on the estimated maximum number of construction vessel if both Projects were to be constructed together; up to 1,502 transits per year over the five year construction period (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

1184. To estimate the potential collision risk of vessels associated with DBS East and DBS West Array Areas during construction together, the same approach has been taken as for the Projects alone (see section 8.3.9.2.6.1). The results of the assessment are presented in **Table 8-175**, which results in up to one bottlenose dolphin being at risk of collision for every 10 years of wind farm construction.

1185. While there would be minimal increase to collision risk, less than 1% of the SAC are at risk of the permanent effect, and there is therefore **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential vessel collision risk during construction for the Projects together**.

8.3.9.2.7 Impact 5: Changes to Prey Resources

1186. The potential effects on prey species during construction can result from:

- Physical seabed disturbance;
- Increased SSC and sediment re-deposition;
- Remobilisation of contaminated sediments;
- Underwater noise and vibration; and
- Changes in fishing activity.

1187. Bottlenose dolphin feed on a variety of prey species and are considered to be opportunistic feeders, feeding on a wide range of prey species and they have relatively large foraging ranges (see **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

1188. As explained in section 8.3.5.2.8.2 any reductions in prey availability would be small scale, localised and temporary. It is considered highly unlikely that potential reductions in prey availability as a result of construction activities at the Projects would result in detectable changes to bottlenose dolphin populations. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** provides an assessment of these impact pathways on the relevant fish and shellfish species and concludes significance of effects of negligible to minor adverse significance in EIA terms.

1189. The potential effects of physical disturbance, temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment, underwater noise and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there will be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential changes in prey availability during construction for the Projects in isolation or together**.

8.3.9.3 Potential effects during Operation and Maintenance

1190. The potential effects during operation and maintenance that have been assessed for are:

- Auditory injury and disturbance or behavioural effects resulting from underwater noise during maintenance activities, including cable protection and cable reburial;
- Auditory injury and disturbance or behavioural effects resulting from underwater noise due to the presence of vessels;
- Barrier effects as a result of underwater noise;
- Vessel interaction (collision risk); and
- Changes to prey resources.

8.3.9.3.1 Impact 1a: Auditory Injury from Underwater Noise Associated with Operation and Maintenance Activities

1191. The requirements for any potential operation and maintenance activities, such as additional rock placement or cable re-burial, are currently unknown. However, the work required and associated effects to bottlenose dolphin of the Moray Firth SAC, would be less than those assessed for the construction phase. Section 8.3.9.2.1 provides an assessment for the same activities during construction, concluding that there is no potential for a significant effect for the Projects in isolation or together.

1192. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to auditory injury (PTS / TTS) from underwater noise associated with operation and maintenance activities at the Projects in isolation or together**.

8.3.9.3.2 Impact 1b: Disturbance from Underwater Noise Associated with Operation & Maintenance Activities

1193. As for other activities during construction (section 8.3.9.2.2.1), a 4km range has also been used as a potential disturbance range for maintenance activities and activities. As noted above, the requirements for maintenance activities during operation are currently unknown and are expected to be less than required through construction (although would be undertaken sporadically over the longer-term period).

1194. As no potential for significant effect was identified through construction, for either the Projects in isolation or together, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to disturbance from underwater noise associated with operation and maintenance activities at DBS East or DBS West in isolation or together**.

8.3.9.3.3 Impact 2a: Auditory Injury from Underwater Noise due to the Presence of Vessels

1195. During the operation and maintenance phase there will be reduced number of vessels in the OECC (when compared to the construction phase), although they would be present sporadically for a longer time frame than for construction. The number, type and size of vessels will vary depending on the activities taking place at any one time.

8.3.9.3.3.1 Assessment of Potential Effects of the Projects Alone

1196. During operation, there may be up to 20 vessels present within the Projects at any one time, however, only two of those are expected to be within the OECC (**Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**). Therefore, the potential effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than of those during construction (see section 8.3.9.2.3).

1197. As a precautionary approach, the potential for auditory effect (PTS / TTS) due to two vessels during operation has been assessed in **Table 8-176**.

1198. There would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, due to auditory injury from underwater noise associated with operation and maintenance vessels at the Projects in isolation**.

Table 8-176 Maximum Number of Individuals (and % of SAC) That Could Be at Risk of Auditory Injury as a Result of Underwater Noise Associated with Operation and Maintenance Vessels at DBS East or DBS West in Isolation

Species	Location	Maximum number of individuals (% of reference population) for up to two vessels	Potential adverse effect on site integrity
Bottlenose dolphin	OECC only, for either DBS East or DBS West alone	0.03 (0.01% of Moray Firth SAC)	**No** Less than 1% of the population at risk.

8.3.9.3.3.2 Assessment of Potential Effects of the Projects Together

1199. During operation, there may be up to 21 vessels present at the Projects at any one time, compared to the 59 vessels that would be on site during construction. However, only two of those may be within the OECC. Therefore, the potential effects associated with underwater noise and disturbance from vessels during operation and maintenance would be less than of those during construction (see section 8.3.9.2.3), and the same as those assessment for the Projects alone during operation (**Table 8-176**).

1200. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to disturbance from underwater noise associated with operation and maintenance vessels at the Projects together**.

8.3.9.3.4 Impact 2b: Disturbance from Underwater Noise due to the Presence of Vessels

1201. The same approach to the assessment of disturbance from vessels during construction has been used for operation, using the 4km range presented by Benhemma-Le Gall *et al.* (2021).

1202. As noted above, during operation of either Project alone, or together, there is the potential for two vessels to be present within the OECC. Therefore, the following assessment assumes a potential disturbance area for two vessels (**Table 8-177**). This approach is considered to be over-precautionary for the reasons outlined in section 8.3.9.2.4.

1203. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to disturbance from underwater noise associated with operation and maintenance vessels at the DBS East or DBS West in isolation or together**.

Table 8-177 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed as a Result of Underwater Noise Associated with Construction Vessels at DBS East or DBS West In isolation

Species	Potential effect	Location	Maximum number of individuals (% of population) at risk of disturbance	Potential adverse effect on site integrity
Bottlenose dolphin	Two vessels within the OECC	OECC only, for the construction of the Projects either alone or together	4.2 (1.88% of the Moray Firth SAC)	**No** Less than 5% of the population at risk.

8.3.9.3.5 Impact 3: Barrier Effects

1204. No barrier effects as a result of underwater noise during operation and maintenance are anticipated at DBS East and DBS West, either in isolation or together.

1205. The maximum number of bottlenose dolphin that could be affected during operation is due to vessel presence within the inshore region of the OECC; up to four dolphins, in the unlikely case of two vessels being present within the inshore region of the OECC (**Table 8-177**). It should be noted that vessels are likely to be present in the inshore region when works are required at the landfall only, which would be temporary and are not expected to be regularly required through operation. Therefore, any potential for a barrier to movement would be temporary and localised, within a small area of the inshore region only.

1206. Therefore, there would be no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential barrier effects from underwater noise during operation and maintenance for DBS East or DBS West in isolation or together.

8.3.9.3.6 Impact 4: Increased Collision Risk with Vessels During Operation and Maintenance

8.3.9.3.6.1 Assessment of Potential Effects of the Projects Alone

1207. The approach to assessment for vessel collision risk during operation is the same as that for construction (see section 8.3.9.2.6).

1208. As a precautionary assessment, the number of bottlenose dolphin that could be at increased risk of collision with operation and maintenance vessels, if DBS East and DBS West are constructed in isolation, has been based on there being up to 239 annual vessel transits to the OECC (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

1209. The results of the assessment are presented in **Table 8-178**, which results in less one bottlenose dolphin being at risk of collision for over the wind farm operational period.

1210. While there would be minimal increase to collision risk, less than 1% of the SAC are at risk of the permanent effect, and there is therefore **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential vessel collision risk during construction for the Projects together**.

Table 8-178 Predicted Number of bottlenose dolphin at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence at DBS East and DBS West in Isolation and Together

Species	Number annual vessel transits associated with construction	Additional bottlenose dolphin at risk due to increase in vessel number (collision rate vessel increase) per year	% of Moray Firth SAC
Bottlenose dolphin	239	Les than one bottlenose dolphin every 100 years (n=0.01)	0.005% at risk.
	474	Up to one bottlenose dolphin every 50 years (n=0.02)	0.01% at risk.

8.3.9.3.6.2 Assessment of Potential Effects of the Projects Together

1211. The approach to assessment for vessel collision risk during operation is the same as that for construction (see section 7.3.9.6.2).

1212. As a precautionary assessment, the number of bottlenose dolphin that could be at increased risk of collision with operation and maintenance vessels for both DBS East and DBS West together (**Table 8-178**) has been based on the estimated maximum number of vessels visits per year; up to 474 transits per year (see **Volume 7, Chapter 11 Marine Mammals (application ref: 7.11)**).

1213. While there would be minimal increase to collision risk, less than 1% of the SAC are at risk of the permanent effect, and there is therefore **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential vessel collision risk during construction for the Projects together**.

8.3.9.3.7 Impact 5: Changes to Prey Resources

1214. Any effect on prey species has the potential to affect bottlenose dolphin. As outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, the potential effects on fish species during operation and maintenance can result from:

- Permanent habitat loss;
- Temporary habitat loss, physical disturbance of the seabed;
- Increased suspended sediment and sediment deposition;
- Re-mobilisation of contaminated sediments;
- Underwater noise;
- EMF; and
- Changes in fishing activity.

1215. Any effects on prey species have the potential to affect marine mammals. **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** found no difference in the significance of effect on receptors when assessed for DBS East and / or DBS West in isolation or together. Further information of the potential effects from the individuals' impacts is provided in section 8.3.5.3.9

1216. The potential effects of physical disturbance, permanent and temporary habitat loss, increased SSC, re-mobilisation of contaminated sediment underwater noise, EMF and changes in fishing activity on changes in prey availability are localised and short in duration. Therefore, there will be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due to potential changes in prey availability during construction for the Projects in isolation or together**.

8.3.9.4 Potential Effects During Decommissioning

1217. Potential effects on bottlenose dolphin associated with decommissioning have not been assessed in detail, as further assessments will be carried out ahead of any decommissioning works to be undertaken, taking account of known information at that time, including relevant guidelines and requirements. A detailed decommissioning programme will be provided to the regulator prior to construction that will give details of the techniques to be employed and any relevant mitigation measures required.

1218. Decommissioning would most likely involve the removal of the accessible installed components comprising:

- All of the wind turbine components; part of the foundations (those above seabed level); and
- The sections of the infield cables close to the offshore structures, as well as sections of the export cables.

1219. The process for removal of foundations is generally the reverse of the installation process. There would be no piling, and foundations may be cut to an appropriate level.

1220. It is not possible to provide details of the methods that will be used during decommissioning at this time. However, is it expected that the activity levels will be comparable to construction (with the exception of pile driving noise which would not occur).

1221. The potential effects on bottlenose dolphin during decommissioning would be the same or less than those assessed for construction. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in relation to the decommissioning phase of the Projects in isolation or together**.

8.3.9.5 Potential in-combination effects

1222. The in-combination assessment considers other schemes and activities where the predicted effects have the potential to combine with the potential effects during construction of the Projects. The construction phase has been assessed as the worst case for potential in-combination effects.

1223. The schemes screened into the in-combination assessment for bottlenose dolphin are those that are located in the relevant MUs. For bottlenose dolphin, any schemes occurring in the CES MU have been screened in. Full information on the screening is provided in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

1224. The marine mammal in-combination assessment will consider schemes which have sufficient information available to undertake the assessment, and will include the potential effects of:

- Underwater noise;
- Barrier Effects
- Vessel interaction; and
- Changes to prey resources (including habitat loss).

1225. The in-combination screening identified that there is the potential for cumulative effects on bottlenose dolphins as a result of disturbance from underwater noise during other construction activities. All operational effects have been screened out of the assessment (see section 8.3.5.5). Further information on the screening of effects considered for the in-combination assessment is provided in the **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

8.3.9.5.1 Impact 1 Disturbance from Underwater Noise

1226. The potential sources of in-combination underwater noise which could disturb bottlenose dolphin, and which are screened into the assessment are:

- Other construction activities at OWFs (such as vessels, cable installation works, dredging, seabed preparation and rock placement); and
- Other construction activities at other marine renewable schemes (e.g. wave and tidal) (such as vessels, cable installation works, dredging, seabed preparation and rock placement);
  - Aggregate extraction and dredging;
  - Oil and gas installation / decommissioning schemes;
  - Seismic surveys;
  - Subsea cables and pipelines;
  - Other marine industries, such as gas storage, offshore mines, and carbon capture;
  - High resolution geophysical surveys (such as for OWFs); and
  - UXO clearance.

1227. It is intended that this approach to assessing the potential effects of disturbance from underwater noise will reduce some of the uncertainties and complications in using the different assessments from HRAs, based on different noise models, thresholds and criteria, as well as different approaches to density estimates.

8.3.9.5.1.1 In-combination Impact 1a: Assessment of underwater noise from other activities (other than piling) at other OWFs

1228. All OWFs with construction dates that have the potential to overlap with the construction dates for DBS East and / or DBS West have the potential for other construction activities (such as seabed preparation, dredging, trenching, cable installation, rock placement and vessels) to occur at the same time as other construction activities at the Projects.

1229. OWFs screened in for other construction activities that could have an in-combination effect with other construction activities at the Projects are:

- Berwick Bank;
- Dudgeon Extension;
- Green Volt;
- Seagreen 1A; and
- Sheringham Shoal Extension

1230. During the construction of DBS East and / or DBS West, there is the potential for overlap with the non-piling construction activities at other OWFs. Noise sources which could cause potential disturbance during OWF construction activities, other than pile driving, can include vessels, seabed preparation, cable installation works and rock placement.

1231. The In-combination includes all schemes that could have non-piling construction activities during the DBS East and / or DBS West construction period.

1232. The potential disturbance from OWFs during non-piling construction activities, such as vessel noise, seabed preparation, rock placement and cable installation, has been based on the disturbance area for construction activities taking place at DBS East and / or DBS West.

1233. **Table 8-179** show the quantitative assessments for bottlenose dolphin from other OWF construction activities that could be happening at the same time as the Projects.

1234. Based on 3.8% of the Moray Firth SAC population being potentially disturbed, there would be no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination with construction activities at other OWF.

Table 8-179 Quantitative assessment for the potential disturbance of bottlenose dolphin from various activities that could be happening at the same time as the Projects

Project	bottlenose dolphin density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
DBS OECC	0.0419	50.26	2.1
Berwick Bank	0.0298	50.26	1.5
Dudgeon Extension	0.03	50.26	1.5
Green Volt	0.0298	50.26	1.5
Seagreen 1A	0.0298	50.26	1.5
Sheringham Shoal Extension	0.01	50.26	0.5
Total number of bottlenose dolphin (with the Projects)			**8.6 (3.8% of the Moray Firth SAC Population)**
Total number of bottlenose dolphin (without the Projects)			**6.5 (2.9% of the Moray Firth SAC Population)**

8.3.9.5.1.2 In-combination Impact 1b: Assessment of disturbance from other industries and activities

1235. During the construction period for DBS East and / or DBS West, there is the potential for disturbance to marine mammals associated with other potential noise sources, including:

- Geophysical surveys;
- Aggregate extraction and dredging;
- Oil and gas installation schemes;
- Seismic surveys;
- Subsea cable and pipelines; and
- UXO clearance.

1236. For the installation of oil and gas infrastructure, marine renewable schemes, and disposal sites, all potential schemes have been screened out. Further information on the CEA screening (and these results) are provided in the in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**.

8.3.9.5.1.2.1 Disturbance from Geophysical Surveys

1237. As a worst case, it has been assumed that all bottlenose dolphin within 5km of the survey source, a total area of 78.54km^2 could be disturbed.

1238. For geophysical surveys with SBP, it is realistic and appropriate to base the assessments on the potential effect area around the vessel, as the potential for disturbance would be around the vessel at any one time. Therefore, bottlenose dolphin would not be at risk throughout the entire area surveyed in a day, as animals would return once the vessel had passed, and the disturbance had ceased.

1239. It is assumed, as a worst case scenario, that there could potentially be up to one geophysical survey in the North Sea at any one time as explained in section 8.3.5.5.1.3, during construction of the Projects, with a total disturbance area of 78.54km^2 (**Table 8-180**).

1240. For up to one geophysical survey undertaken at the same time as construction of DBS East or West, with no other in-combination activities, less than 5% of the Moray Firth SAC population may be disturbed. Therefore, there would be no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination with DBS East and / or DBS West OECC as well as with two geophysical surveys.

Table 8-180 Quantitative assessment for in-combination disturbance of bottlenose dolphin due to up to two geophysical surveys at OWFs

Project	bottlenose dolphin density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
DBS OECC	0.0419	50.26	2.1 (0.9% of the Moray Firth SAC population)
One Geophysical survey	0.0419	78.54	3.3 (1.5% of the Moray Firth SAC population)
Total number of bottlenose dolphin (with the Projects)			**8.6 (3.9% of the Moray Firth SAC Population)**
Total number of bottlenose dolphin (without the Projects)			**6.6 (2.9% of the Moray Firth SAC Population)**

8.3.9.5.1.2.2 Disturbance from Aggregate Extraction and Dredging

1241. Taking into account the small potential effect ranges, and distances of the aggregate extraction and dredging schemes from the Projects, the potential for contribution to in-combination effects is very small. Therefore, risk of PTS for bottlenose dolphin from aggregate extraction and dredging has been screened out from further consideration in the in-combination assessment.

1242. As a precautionary approach, a total of two aggregate extraction and dredging schemes taking place in the nearshore are included in the in-combination assessment for the potential in-combination disturbance. A disturbance range of 600m would result in a potential disturbance area of 1.13km^2 for each scheme, or up to 2.26km^2 for two aggregate schemes (**Table 8-181**).

1243. For up to two aggregate extraction and dredging schemes undertaken at the same time as construction activity in the Projects OECC, with no other in-combination activities, less than 5% of the Moray Firth SAC population may be disturbed. Therefore, there would be no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination with DBS East and / or DBS West OECC as well as with aggregate and dredging schemes.

Table 8-181 Quantitative assessment for cumulative disturbance of bottlenose dolphin due to up to two aggregate extraction and dredging activities near the Projects

Project	bottlenose dolphin density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
DBS OECC	0.0419	50.26	2.1 (0.9% of the Moray Firth SAC population)
Up to two aggregate extraction and dredging schemes	0.0419	2.26	0.095 (0.042% of the Moray Firth SAC population)
Total number of bottlenose dolphin (with the Projects)			**2.5 (1.1% of the Moray Firth SAC Population)**
Total number of bottlenose dolphin (without the Projects)			**0.095 (0.042% of the Moray Firth SAC Population)**

8.3.9.5.1.2.3 Disturbance from Seismic Surveys

1244. There are no oil and gas blocks or current developments within the 12nm in the southern North Sea that would require seismic surveys to be undertaken within 5km of the coast (expected range of the coastal Moray Firth bottlenose dolphins) at the same time as construction activity at DBS East and / or DBS West OECC. Therefore, seismic surveys that could be taking place in-combination with the Projects are not considered further at this time.

8.3.9.5.1.2.4 Disturbance from Subsea Cable and Pipelines

1245. Only one subsea cable has been screened into the in-combination assessment; Sea Link. This scheme is currently at scoping stage and therefore there is limited information available on potential effects and disturbance ranges for which to inform an in-combination assessment with DBS East and / or DBS West.

1246. The disturbance ranges that could be generated during the cabling works and vessels would be up to 4km (with a disturbance area of 50.26km^2), for grey seal. This has been used to inform the assessments for subsea cable and pipeline schemes, as activities would be similar, in the absence of any additional information for the project screened in for assessment.

1247. For the potential for in-combination disturbance from subsea cable and pipeline schemes undertaken at the same time as construction of the Projects, with no other in-combination activities, less than 2% of the Moray Firth SAC population could be impacted (**Table 8-182**). Therefore, there is no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination with DBS East and / or DBS West or the OECC as well as with subsea and pipeline schemes.

Table 8-182 Quantitative assessment for cumulative disturbance of bottlenose dolphin due to subsea cable and pipeline schemes near the Projects

Project	Bottlenose dolphin density (/km^2)	Impact area (km^2)	Maximum number of individuals potentially disturbed
DBS OECC	0.0419	50.26	2.1 (0.94% of the Moray Firth SAC population)
Cable and pipeline schemes	0.0419	50.26	2.1 (0.94% of the Moray Firth SAC population)

Project	Bottlenose dolphin density (/km²)	Impact area (km²)	Maximum number of individuals potentially disturbed
Total number of bottlenose dolphin (with the Projects)			**4.2 (1.88% of the Moray Firth SAC Population)**
Total number of bottlenose dolphin (without the Projects)			**2.1 (0.94% of the Moray Firth SAC Population)**

8.3.9.5.1.2.5 Disturbance from UXO Clearance

1248. It is currently not possible to estimate the number of potential UXO clearance events that could be undertaken at the same time as construction activity at DBS East and / or DBS West OECC, and therefore, on a worst case basis, the potential for one high-order clearance and one low-order clearance has been assessed as having the potential to take place at the same time.

1249. The potential effect area during a single UXO clearance event, based on the modelled worst case effect range at the Projects for TTS / fleeing response (weighted SEL) of 1.4km (6.16km^2) for high-order clearance and) 360m (0.41km^2) for low-order clearance.

1250. However, as outlined in the BEIS (2020) RoC HRA, due to the nature of the sound arising from the detonation of UXO, i.e. each blast lasting for a very short duration, marine mammals, are not predicted to be significantly displaced from an area, any changes in behaviour, if they occur, would be an instantaneous response and short-term. Guidance suggests that disturbance behaviour is not predicted to occur from UXO clearance if undertaken over a short period of time (JNCC, 2010).

1251. Mitigation measures required for UXO clearance include the use of low-order clearance techniques, which could include a small donor charge, rather than full high-order detonation which is only used as a last resort. It is therefore highly unlikely that more than one UXO high-order detonation would occur at exactly the same time or on the same day as another UXO high-order detonation, even if they had overlapping UXO clearance operation durations. The in-combination assessment is therefore based on potential for disturbance from one UXO high-order detonation without mitigation (worst case), as well as one low-order clearance event.

1252. For the potential for in-combination disturbance from one high-order and one low order UXO clearance schemes undertaken at the same time as construction of the Projects, with no other in-combination activities, less than 2% of the Moray Firth SAC population could be impacted (**Table 8-183**). Therefore, there is no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination with DBS East and / or DBS West OECC as well as with one high-order and one low-order UXO clearance.

Table 8-183 Quantitative assessment for cumulative disturbance of bottlenose dolphin due to UXO clearance near the Projects

Project	**bottlenose dolphin density (/km²)**	**Impact area (km²)**	**Maximum number of individuals potentially disturbed**
DBS OECC	0.0419	50.26	2.1 (0.94% of the Moray Firth SAC population)
High-order UXO clearance	0.0419	6.16	0.3 (0.14% of the Moray Firth SAC population)
Low-order UXO clearance	0.0419	0.41	0.02 (0.009% of the Moray Firth SAC population)
Total number of bottlenose dolphin (with the Projects)			**2.4 (1.09% of the Moray Firth SAC Population)**
Total number of bottlenose dolphin (without the Projects)			**0.32 (0.15% of the Moray Firth SAC Population)**

8.3.9.5.1.3 Summary of In-combination Effect 1: Assessment of Disturbance from all Noisy Activities Associated with Offshore Industries

1253. Each of the above-described noise sources are quantitively assessed together in **Table 8-184**.

1254. It should be noted that while the schemes included within the in-combination assessment for disturbance from other activities and industries were done so based on the current knowledge of their possible construction or activity windows, and it is very unlikely that all activities would be taking place on the same day or in the same season, and therefore this likely represents an over-precautionary and worst case estimate of the grey seals that could be at risk of disturbance during the four year offshore construction period of the Projects.

1255. The majority of bottlenose dolphin at risk of disturbance is from construction activities at other OWFs potentially disturbing less than 3% of the Moray Firth SAC population (**Table 8-184**).

1256. Therefore, with the other possible in-combination activities there is **no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination with DBS East and / or DBS West OECC as well as all possible noisy activities**.

Table 8-184 Quantitative assessment for all noisy activities with the potential for in-combination disturbance effects for bottlenose dolphin

Potential in-combination effect	Bottlenose dolphin density (/km²)	Potential in-combination effect area (km²)	Maximum number of individuals potentially disturbed (% of reference population)
DBS OECC construction activities	0.0419	50.26	2.1 (0.94% of the Moray Firth SAC population)
Construction activities at other OWFs	Various	201.08	6.5 (2.9% of the Moray Firth SAC Population)
Up to two aggregate extraction and dredging schemes	0.0419	2.26	0.095 (0.04% of the Moray Firth SAC population)
Cable and pipeline schemes	0.0419	50.3	2.1 (0.94% of the Moray Firth SAC population)
One High-order UXO clearance	0.0419	6.16	0.3 (0.12% of the Moray Firth SAC population)
One Low-order UXO clearance	0.0419	0.41	0.02 (0.008% of the Moray Firth SAC population)
Total number of bottlenose dolphin (DBS East or West together)			**11.11 (4.95% of the Moray Firth SAC population)**
Total of bottlenose dolphin without the Projects			**9.01 (4.01% of the Moray Firth SAC population)**

8.3.9.5.2 Impact 2 Barrier Effects

1257. Underwater noise during construction could have the potential to create a barrier effect, preventing movement of bottlenose dolphin or potentially increasing swimming distances if they avoid the area. Bottlenose dolphins are known to move along the coast and are therefore unlikely to be affected as a result of underwater noise at the OWF sites.

1258. The worst case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial and temporal (i.e. largest area and longest duration) scenarios. Therefore, there would be no significant disturbance of bottlenose dolphin and **no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin in-combination due to potential barrier effects as a result of underwater noise during construction**.

8.3.9.5.3 Impact 3 Vessel Interaction

1259. The in-combination effects from an increase in the number of vessels and vessel movements can pose a potential collision risk for bottlenose dolphin.

1260. As outlined in sections 8.3.9.2.6 and 8.3.9.3.6, the increased collision risk due to project vessels, even using a very precautionary approach, would result in less than one individual (0.0233 bottlenose dolphin) being at risk of vessel collision per year (**Table 8-175**) for construction phase related vessel collision risk. This amount would be reduced for operation and maintenance phase related vessel collision risk due to the construction phase being the worst case in terms of vessel numbers (see section 8.3.9.2.6).

1261. As outlined in **Volume 8, Outline Project Environmental Management Plan (application ref: 8.21)**, vessel movements, where possible, will be incorporated into recognised vessel routes and hence to areas where bottlenose dolphin are accustomed to vessels, in order to reduce any collision risk. All vessel movements will be kept to the minimum number that is required to reduce any potential for collision risk, and with a vessel speed limit of 10 knots. Additionally, vessel operators will use good practice to reduce any risk of collisions with bottlenose dolphin. It is expected that other offshore schemes and industries would follow similar measures in order to reduce the potential for collision risk of bottlenose dolphin with vessels.

1262. Vessels associated with aggregate extraction and dredging are large and typically slow moving, using established transit routes to and from ports. Therefore, the potential increased collision risk with vessels is considered to be extremely low.

1263. In addition, based on the assumption that bottlenose dolphin would be disturbed as a result of underwater noise from piling, other construction activities, operational and maintenance activities and vessels, there should be no potential for increased collision risk with vessels. Therefore, there would be **no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin due an increase in collision risk with construction vessels**.

8.3.9.5.4 Impact 4 Changes to Prey Availability

1264. Potential effects on prey species can result from:

- Increased SSCs and sediment re-deposition; and
- Underwater noise (leading to mortality, physical injury, auditory injury or behavioural responses).

1265. The potential effects on fish species during operation and maintenance can include:

- Physical disturbance and loss or changes to seabed habitat;
- introduction of hard substrate;
- operational noise; and
- EMF.
- During decommissioning, potential effects on fish species can include:
- Physical disturbance;
- Loss or changes to habitat;
- Increased SSCs;
- Re-mobilisation of contaminated sediments; and
- Underwater noise.

1266. Some of the effects could be adverse with fish species moving away or being lost from an area, while some effects could have a beneficial effect, such as possible changes in species composition and the aggregation of prey around seabed structures.

1267. The potential effects on bottlenose dolphin as a result of any changes to prey availability can include changes in:

- Distribution;
- Abundance and community structure;
- Increased competition with other marine mammal species;
- Increased susceptibility to disease and contaminants; and
- Implications for reproductive success.

1268. These changes could potentially affect individuals throughout their range or at different times of the year. However, any changes to prey tend to be localised and temporary in nature. In addition, if prey species are disturbed from an area, it is highly likely that bottlenose dolphin will also be disturbed from the area over a potentially wider range than prey species.

1269. The in-combination assessment on potential changes to prey availability has assumed that any potential effects on bottlenose dolphin prey species from underwater noise (including piling) would be the same or less than those for bottlenose dolphin. Therefore, there would be no additional effects other than those assessed for bottlenose dolphin. As such, if prey species are potentially disturbed from an area as a result of underwater noise, bottlenose dolphin will also be disturbed from the same or greater area. Therefore, any changes to prey availability would not affect bottlenose dolphin as they would already be disturbed from the same area.

1270. Any effects on prey species are likely to be intermittent, temporary and highly localised, with potential for recovery following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential habitat in the surrounding area. Therefore, there would be **no adverse effect on the integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin arising due to changes in prey availability**.

8.3.9.6 Summary of Potential Effects on Site Integrity

1271. The assessment of the potential effects for the Projects in isolation or together has been summarised in relation to the Moray Firth SAC conservation objectives for bottlenose dolphin (**Table 8-185**).

1272. Mitigation measures are presented in **Volume 8, Outline Marine Mammal Mitigation Protocol (application ref: 8.25)** and will be reviewed in the final MMMP prior to construction. The MMMP will provide mitigation or management measures to reduce the potential for any significant disturbance of bottlenose dolphin as a result of in-combination effects from underwater noise.

1273. There would be **no adverse effect on integrity of the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin, either alone or together, when in-combination with other schemes**.

Table 8-185 Summary of the potential effects of the Project, including in-combination effects on the Moray Firth SAC in relation to the conservation objectives for bottlenose dolphin (X = no potential for AEoI; ✓ = potential for AEoI)

Conservation objectives	The Projects effects					In-combination effects			
	Auditory injury and disturbance from underwater noise	Barrier effects	Vessel interaction	Changes to water quality	Changes to prey resources	Disturbance from underwater noise	Barrier effects	Vessel interaction	Changes to prey resources
Bottlenose dolphin is a viable component of the site	X	X	X	X	X	X	X	X	X
There is no significant disturbance of the species	X	X	X	X	X	X	X	X	X
The condition of supporting habitats and processes and the availability of prey is maintained	X	X	X	X	X	X	X	X	X

X = No potential for any adverse effect on integrity of the site in relation to the conservation objectives

8.3.10 Other European Sites

8.3.10.1 Conservation Objectives

1274. All the screened in European Designated Sites use the OSPAR Conservation Objectives:

- To protect, conserve and restore species, habitats and ecological processes which have been adversely affected by human activities;
- To prevent degradation of, and damage to, species, habitats and ecological processes, following the precautionary principle; and
- To protect and conserve areas that best represent the range of species, habitats and ecological processes in the maritime area.

8.3.10.2 Doggersbank SAC

8.3.10.2.1 Site Overview

1275. The Doggersbank SAC has been recognised as an SAC since June 2016 and is designated by the Netherlands, The SAC is a designated site for the marine mammals harbour porpoise, harbour seal and grey seal (EUNIS, 2019).

1276. The Doggersbank SAC covers an area of 4,735km^2. The SAC's closest point to the Projects is 43km.

8.3.10.2.2 Qualifying Feature

8.3.10.2.2.1 Harbour Porpoise

1277. There is no site-specific data on harbour porpoise estimates available. Hence, a wider search approach was applied. More reliable data on abundance data could be derived from data collected in all Dutch waters.

1278. Harbour porpoise densities for the Dutch Delta region were estimated at 0.71 per km^2 in summer 2019, totalling to 14,713 individuals (Geelhoed *et al.* 2020).

8.3.10.2.2.2 Harbour seal

1279. A range of 101 and 250 individual harbour seals were counted (Natura 2000). Within the greater area of the Dutch Delta, harbour seal counts ranged from 677- 2581 from (2011-2021) (Central Bureau of Statistics *et al.* 2023).

8.3.10.2.2.3 Grey seal

1280. A maximum of 400 individual grey seals were counted (Natura 2000). Within the greater area of the Dutch Delta, harbour seal counts ranged from 677- 2581 from (2011-2021) (Central Bureau of Statistics *et al.* 2023).

8.3.10.2.3 Assessment

1281. To assess the site most appropriately, despite the lack of site-specific species population data, a precautionary approach for the assessment has been used.

1282. The SNS SAC (section 8.3.5) is deemed as the worst case scenario because the Array Areas lies within the SAC boundaries. Given the distance between the Projects and Doggersbank SAC the potential effects on harbour porpoise would likely to be less than those assessed in the SNS SAC.

1283. Tracking data of harbour seals (Carter *et al.* 2022 (**Plate 8-11**); 2020 (**Plate 8-12**)) show some trips from the southeast of the UK and the Belgian-French coastline, although there is a higher level of connectivity with The Wash and North Norfolk Coast SAC. This suggests that harbour seals from the Doggersbank SAC could potentially utilise this corridor as well, possibly becoming affected by activities at the Projects, such as vessel collision and underwater noise.

1284. Grey seal tracking data (Carter *et al.* 2022 (**Plate 8-11**), 2020 (**Plate 8-12**); Vincent *et al.* 2017 **(Plate 8-13**) showed grey seals tagged in Britain are more likely to use the wider offshore North Sea area, with limited examples of tracked grey seals swimming to the north coast of France, Belgium, or Germany. Grey seals tagged in France are more likely to travel along the north coast of France and Belgium, although there is movement of seals to south-east England. This suggests that grey seals in Doggersbank SAC are less likely to be connected to the DBS East and DBS West area than the Humber Estuary SAC.

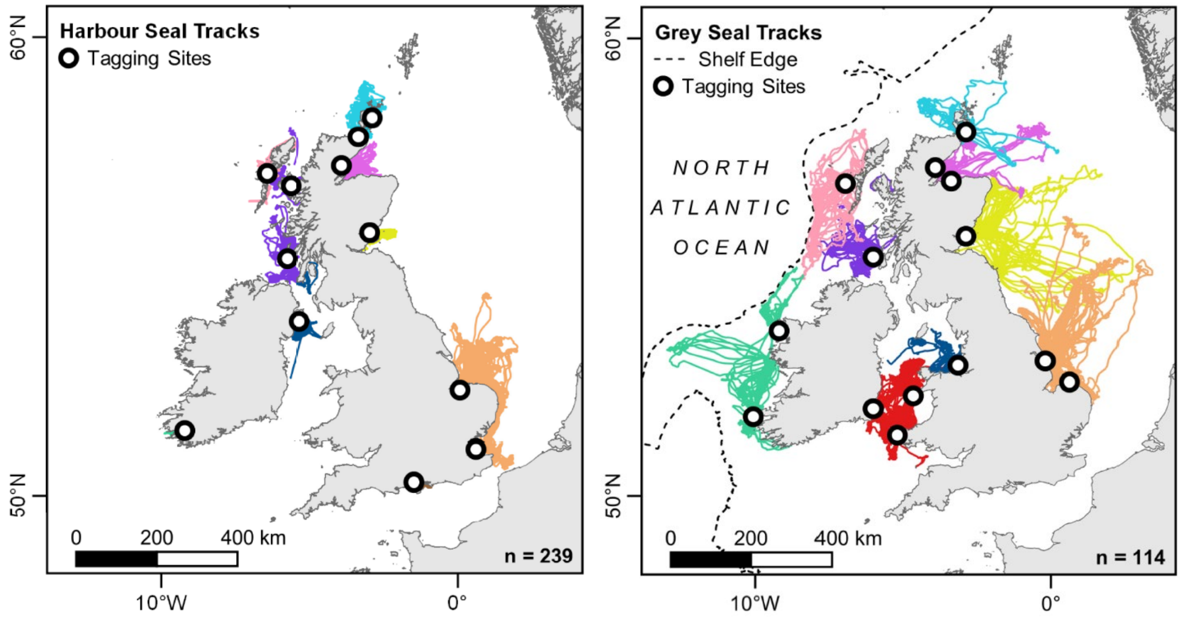


Plate 8-11 Tracking data for harbour seals and grey seals, colour-coded by habitat preference region (data shown have been cleaned to remove erroneous location estimates, trips between regions and locations during the corresponding species' breeding season) (Carter et al. 2022)

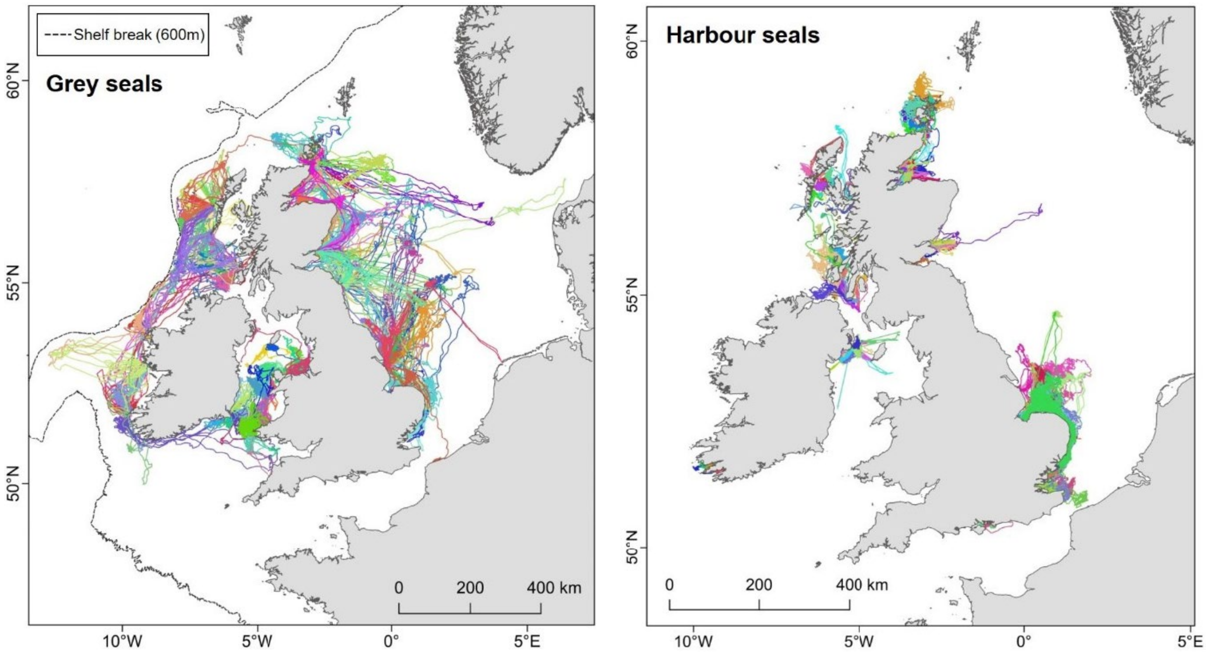


Plate 8-12 Tracking data for grey and harbour seals (coloured by individual (grey seals = 114; harbour seals = 239)) (Carter et al. 2020)

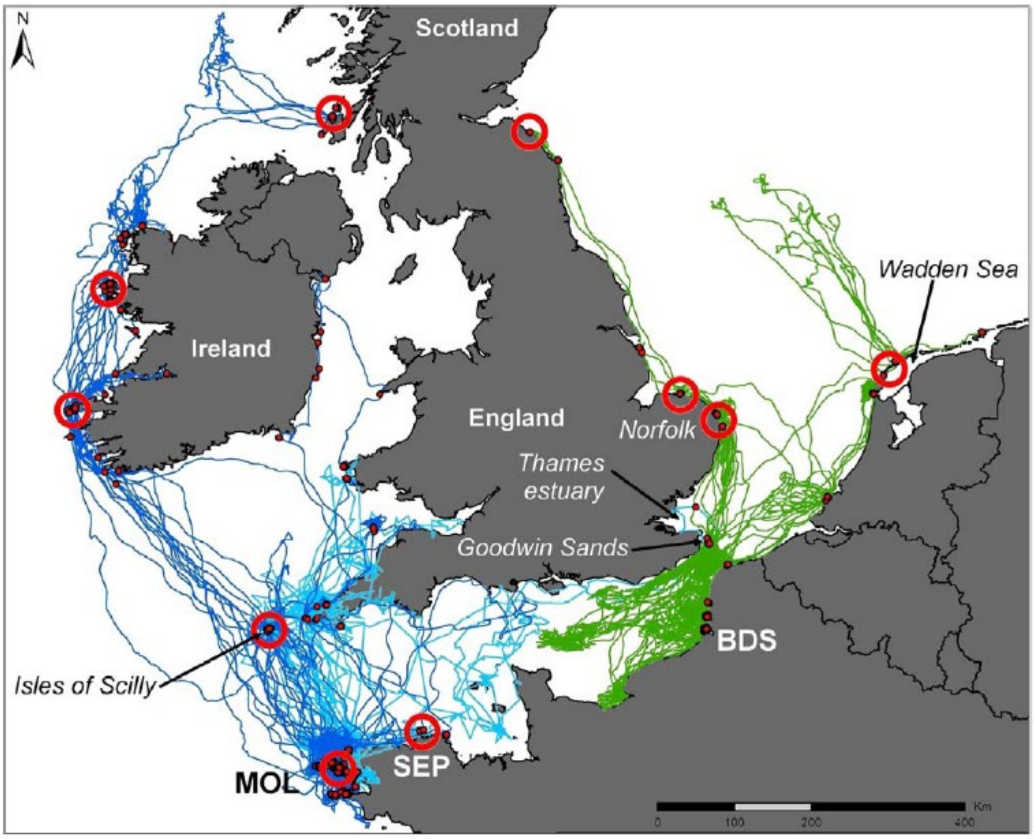


Plate 8-13 Grey seal telemetry tracks from Molene archipelago (MOL) (15 individuals from 1999 to 2003, in light blue, and 19 individuals from 2010 to 2013, in dark blue) and Baie de Somme (BDS) (11 individuals tracked in 2012, in green) (Vincent et al. 2017)

1285. **Table 8-186** summarise the assessment of potential effects on Doggersbank SAC on the species that were screened in for further assessment as a qualifying feature, based on the assessments undertaken for the SNS SAC for harbour porpoise (section 8.3.5), Humber Estuary for grey seal (section 8.3.6), and The Wash and North Norfolk Coast SAC for harbour seal (section 8.3.7), under the assumption that greater connectivity is expected for the sites within the UK, and therefore the greater potential for effect would be present (and assessed) for the UK sites as noted above.

1286. Disturbance from underwater noise for Projects alone and in combination with other schemes and activities is unlikely to result any significant disturbance or barrier effects for foraging harbour porpoise, harbour seal or grey seal. Under these circumstances, there is **no adverse effect on the integrity of the Doggersbank SAC in relation to the conservation objectives for harbour porpoise, grey seal and harbour seal**.

Table 8-186 Summary of potential construction effects for qualifying features of the Doggersbank SAC (x = no potential for adverse effect on site integrity; ✓ = potential for adverse effect on site integrity)

Qualifying features	Underwater noise from piling	Underwater noise from other noisy activities	Underwater noise from vessels	Underwater noise from operational WTGs	Barrier effects from underwater noise	Collision risk	Prey availability / habitat quality	Water quality	In-combination
Construction phase									
Harbour porpoise	X	X	X	N/A	X	X	X	X	X
Grey seal	X	X	X	N/A	X	X	X	X	X
Harbour seal	X	X	X	N/A	X	X	X	X	X
Operational phase									
Harbour porpoise	N/A	X	X	X	X	X	X	X	N/A
Grey seal	N/A	X	X	X	X	X	X	X	N/A
Harbour seal	N/A	X	X	X	X	X	X	X	N/A
Decommissioning phase									
Harbour porpoise	N/A	X	X	N/A	X	X	X	X	N/A
Grey seal	N/A	X	X	N/A	X	X	X	X	N/A
Harbour seal	N/A	X	X	N/A	X	X	X	X	N/A

8.3.10.3 Klaverbank SAC

8.3.10.3.1 Site Overview

1287. The Klaverbank SAC, designated by the Netherlands has been recognised as an SAC since June 2016. The SAC is a designated site for the marine mammals harbour porpoise, harbour seal and grey seal (EUNIS, 2020).

1288. The Klaverbank SAC covers an area of 1,539km^2. The SAC's closest point to the Projects is 43km.

8.3.10.3.2 Qualifying Feature

8.3.10.3.2.1 Harbour porpoise

1289. Harbour porpoise densities for the Dutch Delta region were estimated at 0.71 per km^2 in summer 2019, totaling to 14,713 individuals (Geelhoed *et al.* 2020).

8.3.10.3.2.2 Harbour seal

1290. A range of 101 and 250 individual harbour seals were counted (Natura 2000). Within the greater area of the Dutch Delta, harbour seal counts ranged from 677- 2581 from (2011-2021) (Central Bureau of Statistics *et al.* 2023).

8.3.10.3.2.3 Grey seal

1291. A maximum of 400 individual grey seals were counted (Natura 2000). Within the greater area of the Dutch Delta, harbour seal counts ranged from 677- 2581 from (2011-2021) (Central Bureau of Statistics *et al.* 2023).

8.3.10.3.3 Assessment

1292. To assess the site most appropriately, despite the lack of site-specific species population data, a precautionary approach for the assessment has been used. The SNS SAC (section 8.3.5) is deemed as the worst case scenario because the Projects lie within the SAC boundaries.

1293. Given the slightly longer distance between the Projects and Klaverbank SAC, the effects on harbour porpoise would likely to be similar or less than those assessed in the SNS SAC.

1294. Tracking data of harbour seals (Carter *et al.* 2022 (**Plate 8-11**)) showed some trips from the southeast of the UK and the Belgian-French coastline, although there is a higher level of connectivity with The Wash and North Norfolk Coast SAC. This suggests that harbour seals from the Klaverbank SAC could potentially utilise this corridor as well, possibly becoming affected by activities at the Projects, such as vessel collision and underwater noise.

1295. Grey seal tracking data (Carter *et al.* 2022 (**Plate 8-11**); 2020 (**Plate 8-12**); Vincent *et al.* 2017 (**Plate 8-13**)) showed grey seals tagged in Britain are more likely to use the wider offshore North Sea area, with limited examples of tracked grey seals swimming to the north coast of France, Belgium, or Germany. Grey seals tagged in France are more likely to travel along the north coast of France and Belguim, although there is movement of seals to south-east England. This suggests that grey seals in Klaverbank SAC are less likely to be connected to the Offshore Development Area compared to the grey seals in the Humber Estuary SAC.

1296. **Table 8-187** summarises the assessment of potential effects on Klaverbank SAC on the species that were screened in for further assessment as a qualifying feature, based on the assessments undertaken for the SNS SAC for harbour porpoise (section 8.3.5), Humber Estuary for grey seal (section 8.3.6), and The Wash and North Norfolk Coast SAC for harbour seal (section 8.3.7), under the assumption that greater connectivity is expected for the sites within the UK, and therefore the greater potential for effect would be present (and assessed) for the UK sites as noted above.

1297. Disturbance from underwater noise for Projects alone and in combination with other schemes and activities is unlikely to result any significant disturbance or barrier effects for foraging harbour porpoise, harbour seal or grey seal, especially taking into the proposed mitigation approach for harbour porpoise in the SNS SAC. Under these circumstances, there is **no adverse effect on the integrity of the Klaverbank SAC in relation to the conservation objectives for harbour porpoise, grey seal and harbour seal**.

Table 8-187 Summary of potential construction effects for qualifying features of the Klaverbank (x = no potential for adverse effect on site integrity; ✓= potential for adverse effect on site integrity)

Qualifying features	Underwater noise from piling	Underwater noise from other noisy activities	Underwater noise from vessels	Underwater noise from operational WTGs	Barrier effects from underwater noise	Collision risk	Prey availability / habitat quality	Water quality	Disturbance to seal haul-out sites	In-combination
Construction phase										
Harbour porpoise	X	X	X	N/A	X	X	X	X	X	X
Grey seal	X	X	X	N/A	X	X	X	X	X	X
Harbour seal	X	X	X	N/A	X	X	X	X	X	X
Operational phase										
Harbour porpoise	N/A	X	X	X	X	X	X	X	X	N/A
Grey seal	N/A	X	X	X	X	X	X	X	X	N/A
Harbour seal	N/A	X	X	X	X	X	X	X	X	N/A
Decommissioning phase										
Harbour porpoise	N/A	X	X	N/A	X	X	X	X	X	N/A
Grey seal	N/A	X	X	N/A	X	X	X	X	X	N/A
Harbour seal	N/A	X	X	N/A	X	X	X	X	X	N/A

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