RWE Renewables UK Dogger Bank South (West) Limited

RWE Renewables UK Dogger Bank South (East) Limited

Dogger Bank South Offshore Wind Farms

Environmental Statement

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Appendix 11-4: iPCoD Methodology

Appendix 11-5: Cumulative Effect Assessment Screening

Appendix 11-6: UXO Marine Mammal Impact Assessment

Glossary

Term	Definition
Accommodation Platform	An offshore platform (situated within either the DBS East or DBS West Array Area) that will provide accommodation and mess facilities for staff when carrying out maintenance activities for the Projects.
Array Areas	The DBS East and DBS West offshore Array Areas, where the wind turbines, offshore platforms and array cables will be located. The Array Areas do not include the Offshore Export Cable Corridor or that part of 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).
Collision	The act or process of colliding (crashing) between two moving objects.
Concurrent	Installation of monopiles or pin piles happening at the same time at the DBS Projects.
Concurrent Scenario	A potential construction scenario for the Projects where DBS East and DBS West are both constructed at the same time.
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.
Cumulative impact	The combined impact of the Projects in combination with the effects of a number of different (defined cumulative) schemes, on the same single receptor/resource.

Term	Definition
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Project (NSIP).
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) East Survey Area	The original Crown Estate Lease Area plus 4km buffer that was surveyed via the site specific digital aerial surveys.
Dogger Bank South (DBS) Offshore Wind Farms	The collective name for the two Projects, DBS East and DBS West.
Dogger Bank South (DBS) West Survey Area	The original Crown Estate Lease Area plus 4km buffer that was surveyed via the site specific digital aerial surveys.
Effect	Term used to express the consequence of an impact. The significance of an effect is determined by correlating the magnitude of the impact with the value, or sensitivity, of the receptor or resource in accordance with defined significance criteria.
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).

Term	Definition
Evidence Plan Process (EPP)	A voluntary consultation process with specialist stakeholders to agree the approach, and information to support, the Environmental Impact Assessment (EIA) and Habitats Regulations Assessment (HRA) for certain topics.
Expert Topic Group (ETG)	A forum for targeted engagement with regulators and interested stakeholders through the EPP.
Habitats Regulations	Conservation of Habitats and Species Regulations 2017 and Conservation of Offshore Marine Habitats and Species Regulations 2017.
Habitats Regulations Assessment (HRA)	The process that determines whether or not a plan or project many have an adverse effect on the integrity of a European Site or European Offshore Marine Site.
Impact	Used to describe a change resulting from an activity via the Projects, i.e. increased suspended sediments / increased noise.
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.
Offshore Converter Platforms (OCPs)	The OCPs are fixed structures located within the Array Areas that collect the AC power generated by the wind turbines and convert the power to DC, before transmission through the Offshore Export Cables to the Project's Onshore Grid Connection Points.

Term	Definition
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).
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.
Safety zones	Legislated under the Energy Act 2004, safety zones are rolling buffer areas which protect construction activities by preventing unauthorised vessels from entering their boundary.
Scoping opinion	The report adopted by the Planning Inspectorate on behalf of the Secretary of State.
Scoping report	The report that was produced in order to request a Scoping Opinion from the Secretary of State.
Scour protection	Protective materials to avoid sediment erosion from the base of the wind turbine foundations and offshore substation platform foundations due to water flow.
Sequential	Installation of monopiles or pin piles happening one after another at the DBS Projects.
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.

Term	Definition
Survey Area	The area that was surveyed from the digital aerial surveys such as DBS East plus 4km buffer and DBS West plus 4km buffer.
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
AIS	Automatic Identification System
ASCOBANS	Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas
BAP	Biodiversity Action Plan
BEIS	Department of Business, Energy and Industrial Strategy
BSI	British Standards Institution
CEA	Cumulative Effects Assessment
Cefas	Centre for Environment, Fisheries and Aquaculture
CGNS	Celtic and Greater North Seas
CI	Confidence Interval
CEA	Cumulative Impact Assessment
CIEEM	Chartered Institute of Ecology and Environmental Management
CL	Confidence Level
CODA	Cetacean Offshore Distribution and Abundance in the European Atlantic
CPOD	Cetacean Porpoise Detector
CSIP	Cetacean Strandings Investigation Programme
CV	Coefficient of Variation
DAERA	Department of Agriculture, Environment and Rural Affairs
DBS	Dogger Bank South

Term	Definition
DCO	Development Consent Order
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
DEPONS	Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea
DESNZ	Department for Energy Security & Net Zero
ECC	Export Cable Corridor
EDR	Effective Deterrence Range
EEA	European Economic Area
EEZ	European Economic Zone
EIA	Environmental Impact Assessment
EMF	Electromagnetic Field
EPP	Evidence Plan Process
EPS	European Protected Species
ES	Environmental Statement
ETG	Expert Topic Groups
FCS	Favourable Conservation Status
GNS	Greater North Sea
HF	High Frequency
HRA	Habitat Regulations Assessment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IAMMWG	Inter-Agency Marine Mammal Working Group
ICES	International Council for the Exploration of the Sea

Term	Definition
IPC	Infrastructure Planning Commission (now PINS and SoS)
iPCoD	Interim Population Consequence of Disturbance
IPMP	In Principle Monitoring Plan
IUCN	International Union for Conservation of Nature
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
km	Kilometres
LAT	Lowest Astronomical Tide
LF	Low Frequency
MCZ	Marine Conservation Zone
ML	Marine Licence
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MPS	Marine Policy Statement
MU	Management Unit
NE	North East
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine and Fisheries Service
NPS	National Policy Statements
NS	North Sea
NSIP	Nationally Significant Infrastructure Project
O&M	Operation and Maintenance
OECC	Offshore Export Cable Corridor
OESEA	Offshore Energy Strategic Environmental Assessment

Term	Definition
OSP	Offshore Substation Platform
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment
OWF	Offshore Wind Farm
PCW	Phocid in Water
PEIR	Preliminary Environmental Information Report
PEMP	Project Environmental Management Plan
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
RMS	Root Mean Square
SAC	Special Area of Conservation
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCOS	Special Committee on Seals
SE	South East
SEL	Sound Exposure Level
SEL_{cum}	Sound Exposure Level from cumulative exposure
SEL_{ss}	Sound Exposure Level from single strike
SIP	Site Integrity Plan
SMRU	Sea Mammal Research Unit
SNCBs	Statutory Nature Conservation Bodies
SNS	Southern North Sea
SoS	Secretary of State
SPL	Sound Pressure Level
SPL_{peak}	peak Sound Pressure Level

Term	Definition
SSC	Suspended Sediment Concentration
TTS	Temporary Threshold Shift
UK	United Kingdom
UXO	Unexploded Ordnance
VHF	Very High Frequency

11 Marine Mammal Ecology

11.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the likely significant effects of the Projects on marine mammal ecology. The chapter provides an overview of the existing environment for the proposed Offshore Development Area, followed by an assessment of likely significant effects for the construction, operation, and decommissioning phases of the Projects.

2. The assessment should be read in conjunction with the following linked chapters in **Volume 7**:

- **Chapter 8 Marine Physical Environment (application ref: 7.8)** (assessments inform this chapter due to indirect effects);
- **Chapter 9 Benthic Ecology (application ref: 7.9)** (assessments inform this chapter due to indirect effects on prey species);
- **Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** (assessments inform this chapter due to indirect effects on prey species);
- **Chapter 13 Commercial Fisheries (application ref: 7.13)** (assessments inform this chapter due to indirect effects on prey species); and
- **Chapter 14 Shipping and Navigation (application ref: 7.14)** (assessments inform this chapter due to collision risk effects).

3. Additional information in **Volume 7** to support the marine mammal assessment includes:

- **Appendix 11-1 Marine Mammal Consultation Responses (application ref: 7.11.11.1)**;
- **Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**;
- **Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**;
- **Appendix 11-4 iPCoD Modelling (application ref: 7.11.11.4**
- **Appendix 11-5 CEA Screening (application ref: 7.11.11.5)**; and
- **Appendix 11-6 Unexploded Ordnance Clearance Information and Assessment (application ref: 7.11.11.6)**.

4. Note that effects on the Dogger Bank Special Area of Conservation (SAC) are considered in the **Volume 6, Report to Inform Appropriate Assessment (RIAA) (application ref: 6.1)**.

11.2 Consultation

5. Consultation with regard to marine mammals has been undertaken in line with the general process described in **Volume 7, Chapter 7 Consultation (application ref: 7.7)** and the **Consultation Report (application ref: 5.1)**. The key elements to date include EIA Scoping, formal consultation on the Preliminary Environmental Information Report (PEIR) under section 42 of the Planning Act 2008 and the ongoing Evidence Plan Process (EPP) via the marine mammals Expert Topic Group (ETG).

6. The feedback received throughout this process has been considered in preparing the ES. This chapter has been updated following consultation in order to produce the final assessment submitted within the Development Consent Order (DCO) application. **Volume 7, Appendix 11-1 (application ref: 7.11.11.1)** provides a summary of the consultation responses received to date relevant to this topic, and details how the comments have been addressed within this chapter.

11.3 Scope

7. Site characterisation has been undertaken using site specific data for Dogger Bank South (DBS) East and DBS West Offshore Wind Farms, collectively known as DBS Offshore Wind Farms ('the Projects'), as well as existing data from other offshore wind farms (OWFs) in the area and other available information for the region (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**). The key species, and therefore the focus of the assessments, are:

- Harbour porpoise, *Phocoena phocoena;*
  - Present throughout the year, although there may be variations in seasonal occurrence.
- Bottlenose dolphin, *Tursiops truncatus;*
  - Historically not common in the Offshore Development Area, with limited data, however, with a recent increase in sightings along the coast, the species has been included on a precautionary basis.
- Common dolphin, *Delphinus delphis*;
  - Seasonal occurrence in low numbers.
- White-beaked dolphin, *Lagenorhynchus albirostris*;
  - Seasonal occurrence in low numbers.
- Minke whale, *Balaenoptera acutorostrata*;
  - Seasonal occurrence in low numbers.
- Grey seal, *Halichoerus grypus*;

    - Present throughout the year.
- Harbour seal, *Phoca vitulina*;
    - Present throughout the year.

11.3.1 Study Area

8. The marine mammals study area has been defined on the basis that marine mammals are highly mobile and transitory in nature. It is, therefore, necessary to examine species occurrence not only within the DBS East and DBS West Array Areas and Offshore Export Cable Corridor, but also over the wider area.

9. For the marine mammal species in the assessments, the following study areas have been defined, based on the relevant Management Units (MUs) (Inter-Agency Marine Mammal Working Group (IAMMWG) 2023), current knowledge and understanding of the biology of each species (see **Volume 7, Appendix 11-2, Marine Mammal Information Report (application ref: 7.11.11.2)** Plate 11-8; Plate 11-11 and Plate 11-14):

- Harbour porpoise: North Sea (NS) MU;
- Bottlenose dolphin: Greater North Sea (GNS) MU and the Coastal East Scotland (CES) MU, which are only used to assess for coastal activities;
- Common dolphin: Celtic and Greater North Seas (CGNS) MU;
- White-beaked dolphin: CGNS MU;
- Minke whale: CGNS MU;
- Grey seal: South-east (SE) England and North-east (NE) England Sea region; and
- Harbour seal: SE England MU.

10. The status and activity of marine mammals known to occur within or adjacent to the Projects are considered in the context of regional population dynamics at the scale of the wider North Sea, depending on the data available for each species and the extent of the agreed reference population.

11. The DBS West Array Area is located approximately 100km from the shore (at its closest point) from Flamborough Head, with DBS East approximately 122km from shore. The minimum and maximum water depths within the Array Areas at the time of the site-specific geophysical survey ranged from 14.24m to 41.8m below the lowest astronomical tide (LAT) (Fugro, 2023).

12. There is the potential for seals from haul-out sites to move along the coast and to forage in and around the proposed Offshore Development Area. Key haul-out sites for both seal species within the vicinity of the Projects sites include:

- Filey Brigg (located 28km from the landfall location at the closest point).
- Other haul-out sites are located at Ravenscar (52km at closest point), Donna Nook (62km at closest point), the Tees (93km at closest point) and the Wash (108km at closest point) (see section 11.5 for further details).

13. Further seal haul-out sites located in the wider seal MUs are listed in **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**.

11.3.2 Realistic Worst Case Scenario

11.3.2.1 General Approach

14. The realistic worst case design parameters for likely significant effects scoped into the ES for the marine mammal assessment are summarised in **Table 11-1**. These are based on the project parameters described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**, which provides further details regarding specific activities and their durations.

15. In addition to the design parameters set out in **Table 11-1**, consideration is also given to the different Development Scenarios still under consideration and the possible phasing of the construction as set out in sections 11.3.2.2 to 11.3.2.4.

Table 11-1 Realistic Worst Case Design Parameters

<table>
<tr><th rowspan="2">Impact</th><th colspan="4">Parameter</th></tr>
<tr><th>DBS East in isolation</th><th>DBS West in isolation</th><th>DBS West and DBS East concurrently or sequentially</th><th>Notes and rationale</th></tr>
<tr><td colspan="5">Construction</td></tr>
<tr><td colspan="5">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.</td></tr>
<tr><td rowspan="3">Impact 1 and 2: Underwater noise and vibration from piling</td>
<td><u>Array Area</u>
• 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)
<u>Offshore Export Cable Corridor</u>
• Up to one ESP (which could be located within the Array Area)</td>
<td><u>Array Area</u>
• 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)
<u>Offshore Export Cable Corridor</u>
• Up to one ESP (which could be located within the Array Area)</td>
<td><u>Array Areas</u>
• 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)
<u>Offshore Export Cable Corridor</u>
• Up to one ESP (which could be located within the Array Area)</td>
<td>Construction buffer Zone measures 1km surrounding each Array Area, and 500m surrounding the Inter-Platform Cable Corridor. Construction vessels may occupy this area but no construction will occur 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.</td></tr>
<tr><td colspan="3"><u>Foundations</u>
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.</td><td>N/A</td></tr>
<tr><td colspan="3"><u>Piling</u>
Monopile</td><td>In Sequential Scenario, max piles per day is identical to DBS East and DBS West in isolation, just</td></tr>
</table>

Impact	Parameter			
	DBS East in isolation	DBS West in isolation	DBS West and DBS East concurrently or sequentially	Notes and rationale
	Max piles per day -4 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			spread over a longer time period. Max piles per day assumes two simultaneous monopile events or three simultaneous pin-pile events.
Impact 3: Underwater noise from other construction activities	Sea bed clearance methods: Pre-lay grapnel run, boulder clearance, sand wave levelling, dredging Cable installation methods: Jet-trenching / ploughing / dredging / mechanical trenching / mass flow excavation / rock cutting / burial sledge			Noise from the vessel would be a higher impact, but each have been assessed.
	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	
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.	

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
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 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)**			
	Total area of disturbance within Array Areas – 11,207,499m² **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 – 11,518,999m²** **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**	
	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**	**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 – 29,302,899m³ **Maximum volume of displaced sediment during cable trenching – 5,865,000m³**	**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 – 62,424,700m³ **Maximum volume of displaced sediment during cable trenching – 13,116,000m³**	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**
	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 Drill arisings from four offshore platform monopile foundations = 2,815m³	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 Drill arisings from four offshore platform monopile foundations = 2,815m³	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 Drill arisings from eight monopile foundations = 5,630m³	
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.			

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
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 to **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 would not be confirmed until nearer the start of construction. There are well known seal-haul out sites along the coast, distances recorded from landfall zone are: North of Skipsea: Filey Brigg 27km Ravenscar 50km Tess 95km South of Skipsea: Donna Nook 62km The Wash 118km
Operation and Maintenance				
Impact 1: Underwater noise from operational turbines	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.
	Underwater noise parameters described in **Volume 7, Appendix 11-3 Underwater Noise Modelling Report (application ref: 7.11.11.3)**			Worst case assessment is 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	

<table>
<tr><th rowspan="2">Impact</th><th colspan="4">Parameter</th></tr>
<tr><th>DBS East in isolation</th><th>DBS West in isolation</th><th>DBS West and DBS East concurrently or sequentially</th><th>Notes and rationale</th></tr>
<tr><td>Impact 3 and 5: Underwater noise from vessel and vessel collision</td><td>Maximum number of vessels on site at any one time: 20
Up to 239 annual round trips to port.</td><td>Maximum number of vessels on site at any one time: 20
Up to 239 annual round trips to port.</td><td>Maximum number of vessels on site at any one time: 21
Up to 474 annual round trips to port</td><td></td></tr>
<tr><td>Impact 4: Barrier effects from underwater noise</td><td colspan="3">Maximum impact ranges from operation and maintenance phase underwater noise assessments (as above).</td><td>The maximum spatial area of potential impact, and duration of impacts, are considered to cause the worst-case barrier impact.</td></tr>
<tr><td rowspan="2">Impact 6: Changes to prey resources</td><td colspan="3">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)</td><td rowspan="2">The worst case scenario for maximum area of habitat loss / disturbance of seabed from jack-up vessel deployments, cable repair, replacement and reburial footprint.</td></tr>
<tr><td>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
Area of seabed disturbance from jacking-up activities over Projects lifetime – 306,900m^2 (10,230m^2 per year x 30 year lifespan)
Area of seabed disturbance from array cable repairs over Projects lifetime – 54,000m^2 (Nine events x 6,000m^2 per event)
Area of seabed disturbance from inter-platform cable repairs over Projects lifetime – 12,000m^2 (Two events x 6,000m^2 per event)</td><td>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
Area of seabed disturbance from jacking-up activities over Projects lifetime – 306,900m^2 (10,230m^2 per year x 30 year lifespan)
Area of seabed disturbance from array cable repairs over Projects lifetime – 54,000m^2 Nine events x 6,000m^2 per event)
Area of seabed disturbance from inter-platform cable repairs over Projects lifetime – 12,000m^2 (Two events x 6,000m^2 per event)</td><td>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
Area of seabed disturbance from jacking-up activities over Projects lifetime – 613,800m^2 (20,460m^2 per year x 30 year lifespan)
Area of seabed disturbance from array cable repairs over Projects lifetime – 102,000m^2 (17 events x 6,000m^2 per event)
Area of seabed disturbance from inter-platform cable repairs over Projects lifetime – 36,000m^2 (Six events x 6,000m^2 per event)</td></tr>
</table>

Impact	Parameter			
	DBS East in isolation	**DBS West in isolation**	**DBS West and DBS East concurrently or sequentially**	**Notes and rationale**
	Offshore Export Cable Corridor Total area of habitat loss within the Offshore Export Cable Corridor – **1,203,825m²** Area of seabed disturbance from export cable repairs over Projects lifetime – **42,000m²** (Seven events x 6,000m² per event)	**Offshore Export Cable Corridor** Total area of habitat loss within the Offshore Export Cable Corridor – **992,484m²** Area of seabed disturbance from export cable repairs over Projects lifetime – **30,000m²** (Five events x 6,000m² per event)	**Offshore Export Cable Corridor** Total area of habitat loss within the Offshore Export Cable Corridor – **2,139,889m²** Area of seabed disturbance from export cable repairs over Projects lifetime – **72,000m²** (12 events x 6,000m² per event)	
	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 Projects lifetime – 24,000m³ (Two events x 12,000m³ per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 1,534,500m³ (51,150m³ per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 84,000m³** Volume of displaced sediment from export cable repairs over Projects lifetime – 84,000m³ (seven events x 12,000m² per event)	**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 Projects lifetime – 24,000m³ (Two events x 12,000m³ per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 1,534,500m³ (51,150m³ per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 60,000m³** Volume of displaced sediment from export cable repairs over Projects lifetime – 60,000m³ (Five events x 12,000m² per event	**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 Projects lifetime – 72,000m³ (Six events x 12,000m³ per event) Volume of displaced sediment from jacking-up activities over Projects lifetime – 3,069,000m³ (102,300m³ per year x 30 year lifespan) **Maximum estimated volume of displaced sediment during maintenance activities in the Offshore Export Cable Corridor – 144,000m³** Volume of displaced sediment from export cable repairs - over Projects lifetime – 144,000m³ (12 events x 12,000m² per event)	

Impact	Parameter			
	DBS East in isolation	DBS West in isolation	DBS West and DBS East concurrently or sequentially	Notes and rationale
	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.				

11.3.2.2 Development Scenarios

16. Following Statutory Consultation high voltage alternating current (HVAC) technology (previously assessed in PEIR) was removed from the Projects' Design Envelope (see **Volume 7, Chapter 4 Site Selection and Assessment of Alternatives (application ref: 7.4)** for further information). As a result, only high voltage direct current (HVDC) technology will be taken forward for assessment purposes. The ES considers:

- Either DBS East or DBS West is built In Isolation (the In Isolation Scenario); or
- DBS East and DBS West are both built either Sequentially or Concurrently.

17. An In Isolation Scenario has been assessed within the ES on the basis that theoretically one Project could be taken forward without the other being built out. If an In Isolation project is taken forward, either DBS East or DBS West may be constructed. As such the offshore assessment considers both DBS East and DBS West In Isolation.

18. In order to ensure that a robust assessment has been undertaken, all Development Scenarios have been considered to ensure the realistic worst case scenario for each topic has been assessed. A summary is provided here, and further details are provided in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

19. The three Development Scenarios to be considered for assessment purposes are outlined in **Table 11-2**.

Table 11-2 Development Scenarios and Construction Durations

Development Scenario	Description	Total Maximum Construction Duration (Years)	Maximum construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
In Isolation	Either DBS East or DBS West is built In Isolation	Five	Five	Four

Development Scenario	Description	Total Maximum Construction Duration (Years)	Maximum construction Duration Offshore (Years)	Maximum construction Duration Onshore (Years)
Sequential	DBS East and DBS West are both built sequentially, either Project could commence construction first with staggered / overlapping construction	Seven	A five year period of construction for each project with a lag of up to two years in the start of construction of the second project (excluding landfall duct installation) – reflecting the maximum duration of effects of seven years.	Construction works (i.e. onshore cable civil works, including duct installation) to be completed for both Projects simultaneously in the first four years, with additional works at the landfall, substation zone and cable joint bays in the following two years. Maximum duration of effects of six years.
Concurrent	DBS East and DBS West are both built Concurrent reflecting the maximum peak effects	Five	Five	Four

20. The In Isolation, Concurrent and Sequential Development Scenarios all allow for flexibility to build out either or both Projects using a phased approach offshore. Under a phased approach the maximum timescales for individual elements of the construction are assessed.

21. Any differences between the Projects, or differences that could result from the manner in which the first and the second Projects are built (concurrent or sequential and the length of any lag) are identified and discussed where relevant in section 11.6. For each potential impact, the worst case construction scenario for the In Isolation Scenario and the Concurrent or Sequential Scenario is presented. The worst case scenario presented for the concurrent or Sequential Scenario will depend on which of these is the worst case for the potential impact being considered. The justification for what constitutes the worst case is provided, where necessary, in section 11.6.

11.3.2.3 Operation Scenarios

22. Operation scenarios are described in detail in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. The assessment considers the following scenarios:

- Only DBS East in operation;
- Only DBS West in operation; and
- DBS East and DBS West operating concurrently with or without a lag of up to two years between each Project commencing operation.

23. If the Projects are built out using a phased approach, there would also be a phased approach to starting the operational stage. The worst case scenario for the operational phases for the Projects have been assessed. See section 5.1.1 of **Volume 7, Chapter 5 Project Description (application ref: 7.5)** for further information on phasing scenarios for the Projects.

24. The operational lifetime of each Project is expected to be 30 years.

11.3.2.4 Decommissioning Scenarios

25. Decommissioning scenarios are described in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction, however for the purpose of this assessment it is assumed that decommissioning of the Projects could be conducted separately, or at the same time.

11.3.3 Embedded Mitigation

26. This section outlines the mitigation relevant to the marine mammal assessment, which has been incorporated into the design of the Projects or constitutes standard mitigation measures for this topic (**Table 11-3**). Mitigation is also detailed within the **Volume 8, Commitments Register (application ref: 8.6)** and cross-referenced within **Table 1-3**. Where other mitigation measures are proposed, these are detailed in the impact assessment (section 11.4).

Table 11-3 Embedded Mitigation Measures

Parameter	Embedded Mitigation Measures	Where commitment is secured
Underwater Noise		
Soft-start and ramp-up	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).	Marine Mammal Mitigation Protocol (MMMP) for Piling DML 1 & 2 - Conditions 15 & 20 - 22 DML 3 & 4-Condition 13 & 18 - 20
Seasonal restrictions for Marine Mammals	There will be no piling activity within the Offshore Export Cable Corridor during the winter season (October to March 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)**.	DML 3 & 4 - Condition 24
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 13
Vessel collision risk		
Best practice to reduce	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.	PEMP DML 1 & 2 - Condition 15 DML 3 & 4-Condition 13

Parameter	Embedded Mitigation Measures	Where commitment is secured
vessel 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. An Outline Project Environmental Management Plan (PEMP) (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.	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. 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 the Outline PEMP (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.	Pollution Environmental Management Plan (PEMP) Marine Pollution Contingency Plan (MPCP) DML 1 & 2 - Condition 15 DML 3 & 4-Condition 13 DML 5 - Condition 11

11.3.3.1 Other Mitigation

27. In addition to the mitigation measures as outlined above, The Applicants have also committed to the following measures (**Table 11-4**).

Table 11-4 Additional Mitigation Measures

Parameter	Additional Mitigation Measures	
MMMP for Piling Activities		
MMMP for piling activities	The MMMP, produced in accordance with the content of the Outline MMMP (application ref: X) for piling will be developed in the pre-construction period and based upon best available information, methodologies, industry best 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 MMMP (application ref: 8.25)** has been submitted alongside the ES.	DML 1 & 2 - Condition 15 & 20 - 22 DML 3 & 4-Condition 13 & 18-20 DML 5 - Condition 11 & 14-16

Parameter	Additional Mitigation Measures	
Site Integrity Plan (SIP)		
Southern North Sea Special Area of Conservation (SAC) 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: 8.26)**, 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

11.4 Assessment Methodology

11.4.1 Policy, Legislation and Guidance

11.4.1.1 National Policy Statements

28. The assessment of potential impacts upon marine mammals has been made with specific reference to the relevant National Policy Statements (NPS) including the Overarching NPS for Energy (EN-1), the NPS for Renewable Energy Infrastructure (EN-3) and the NPS for Electricity Networks Infrastructure (EN-5). These were published in November 2023 and were designated in January 2024. The specific assessment requirements for marine mammal ecology (DESNZ, 2023a; 2023b), as detailed in the NPS, are summarised in **Table 11-5**.

Table 11-5 NPS Assessment Requirements

NPS Requirement	NPS Reference	ES Section Reference
NPS for Renewable Energy Infrastructure (EN-1)		
Where the development is subject to EIA the Applicant should ensure that the ES clearly sets out any effects on internationally, nationally, and locally designated sites of ecological or geological conservation importance (including those outside England), on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity, including irreplaceable habitats.	Paragraph 5.4.17	Any internationally, nationally, and locally designated sites, where marine mammals are a qualifying feature, were identified in the **Volume 6, Habitats Regulation Assessment (HRA) Screening (application ref: 6.1.1)**. Any potential effects on these sites were assessed in **Volume 6, RIAA (application ref: 6.1)**.
The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests	Paragraph 5.4.19	Measures to conserve the biodiversity of marine mammals by means of mitigation are presented in section 11.8 and in the **Volume 8, Outline MMMP (application ref: 8.25)**.
The design of Energy NSIP proposals will need to consider the movement of mobile / migratory species such as birds, fish and marine and terrestrial	Paragraph 5.4.22	Detailed consideration and assessment of all species that have the potential to interact is provided

NPS Requirement	NPS Reference	ES Section Reference
mammals and their potential to interact with infrastructure. As energy infrastructure could occur anywhere within England and Wales, both inland and onshore and offshore, the potential to affect mobile and migratory species across the UK and more widely across Europe (transboundary effects) requires consideration, depending on the location of development		throughout the ES, in particular in section 11.5, 11.6, 11.7,11.9.
Applicants should include appropriate avoidance, mitigation, compensation, and enhancement measures as an integral part of the proposed development. In particular, the applicant should demonstrate that: • During construction, they will seek to ensure that activities will be confined to the minimum areas required for the works • The timing of construction has been planned to avoid or limit disturbance • During construction and operation best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements • Habitats will, where practicable, be restored after construction works have finished • Opportunities will be taken to enhance existing habitats rather than replace them, and where practicable, create new habitats of value within	Paragraph 5.4.35	Measures to conserve the biodiversity of marine mammals by means of mitigation are presented in section 11.8 and in **Volume 8, Outline MMMP (application ref: 8.25)**.

NPS Requirement	NPS Reference	ES Section Reference
the site landscaping proposals. Where habitat creation is required as mitigation, compensation, or enhancement, the location and quality will be of key importance. In this regard habitat creation should be focused on areas where the most ecological and ecosystems benefits can be realised.		
NPS for Renewable Energy Infrastructure (EN-3)		
The UK Government has obligations to protect the marine environment with a network of well managed Marine Protected Areas (MPAs), which also includes Highly Protected Marine Areas (HPMAs). MCZs together with HPMAs, SACs SPAs, and Ramsar sites and marine elements of SSSIs form an ecologically coherent network of MPAs. Government has set a target for MPA condition under the Environment Act 2021. Given the scale of offshore wind deployment required to meet 2030 and 2050 ambitions, applicants will need to give close consideration to impacts on MPAs, either alone or in combination, and employ the mitigation hierarchy, and if necessary, provide compensation (both individually and in combination with other plans or projects) which may be needed to approve their projects.	Paragraph 2.8.41 and 2.8.42	Any SAC, where marine mammals are a qualifying feature, were identified in **Volume 6, HRA Screening (application ref: 6.1.1)**. Any potential effects, alone or in combination, on these sites were assessed in **Volume 6, RIAA (application ref: 6.1)**.
Applicants must undertake a detailed assessment of the offshore ecological, biodiversity and physical impacts of their proposed development, for all phases of the lifespan of that development, in	Paragraph 2.8.91	The ES provides a detailed assessments for all phases of the lifespan of the Project, the construction phase (section 11.6.1), the operation and maintenance

NPS Requirement	NPS Reference	ES Section Reference
accordance with the appropriate policy for offshore wind farm EIAs, HRAs and MCZ assessments (See sections 4.3 and 5.4 of EN-1).		phase (section 11.6.2) and the decommissioning phase (section 11.6.3). Equally, **Volume 6, RIAA (application ref: 6.1)** has considered these phases of the Project in the assessment.
Applicants should assess the potential of their proposed development to have net positive effects on marine ecology and biodiversity, as well as negative effects.	Paragraph 2.8.93	All potential effects from the Project on marine mammals, have been assessed in section 11.6.
Applicants should consult at an early stage of pre-application with relevant statutory consultees and energy not-for profit organisations/non-governmental organisations as appropriate, on the assessment methodologies, baseline data collection, and potential avoidance, mitigation and compensation options should be undertaken.	Paragraph 2.8.94	Consultation on assessment methodologies and baseline data collection as part of the EPP via the Marine Mammal ETG meetings has been detailed in **Volume 7**, **Appendix 11-1 (application ref: 7.11.11.1)** and **Volume 7**, **Appendix 11-2 (application ref: 7.11.2)**.
In developing proposals applicants must refer to the most recent best practice advice originally provided by Natural England under the Offshore Wind Enabling Action Programme, and/or their relevant SNCB.	Paragraph 2.8.95	Best practice guidance by Natural England and other SNCB have been applied in the **Volume 8, Outline MMMP (application ref: 8.25)**. and the **Volume 8, In Principle SIP (application ref: 8.26)**.
Any relevant data that has been collected as part of post-construction ecological monitoring from existing, operational offshore wind farms should be referred to where appropriate.	Paragraph 2.8.96	Where available, relevant ecological data from existing OWFs were incorporated in the baseline information in **Volume 7**, **Appendix 11-2 (application ref: 7.11.11.2)**.

NPS Requirement	NPS Reference	ES Section Reference
Construction activities, including installing wind turbine foundations by pile driving, geophysical surveys, and clearing the site and cable route of unexploded ordinance (UXOs) may reach noise levels which are high enough to cause disturbance, injury, or even death to marine mammals. All marine mammals are protected under Part 3 of the Habitats Regulations (cetaceans within Schedule 2 and seal species within Schedule 4). If construction and associated noise levels are likely to lead to an offence under Part 3 of the Habitats Regulations (which would include deliberately disturbing, injuring or killing), applicants will need to apply for a wildlife licence to allow the activity to take place.	Paragraph 2.8.127 to 2.8129	Section 11.3.2 provides an overview of the worst-case scenario for possible piling works. sections 11.6.1.1 and 11.6.1.2 provides an assessment of pile driving (including noise modelling results). It is anticipated that an application for a Marine Wildlife Licence would be submitted post-consent (section 11.12).
The development of offshore wind farms can also impact fish species (see paragraphs 2.8.245 – 2.8.249), which can have indirect impacts on marine mammals if those fish are prey species.	Paragraph 2.8.130	Section 11.6 provides an assessment from any indirect effects as a result of impacts on prey species and the risk of collision with construction and maintenance vessels.
<u>Impacts</u> Where necessary, assessment of the effects on marine mammals should include details of: • Likely feeding areas and impacts on prey species and prey habitat; • Known birthing areas / haul out sites for breeding and pupping; • Migration routes;	Paragraph 2.8.131	Section 11.5 and **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)** provide a description of the existing environment and future environment, including likely feeding areas and prey, seal haul-out sites, migration routes and protected areas. Section 11.6.1 details the assessment of impacts

NPS Requirement	NPS Reference	ES Section Reference
• Protected sites; • Baseline noise levels; • Predicted noise levels in relation to mortality, PTS and Temporary Threshold Shift (TTS); • Operational noise; • Duration of the potentially disturbing activity including cumulative / in-combination effects with other plans or projects; • Collision risk; • Entanglement risk; and • Barrier risk.		during construction, including pile driving. Section 11.6.2 provides the assessment of operational noise. Cumulative effects are considered in section 11.7. Sections 11.6.1.6 and 11.6.25 detail the assessment of collision risk with vessels during construction, operation and maintenance. Sections 11.6.1.5 and 11.6.2.4 detail the assessment of potential barrier effects from underwater noise. Potential effects on protected sites are assessed in the **Volume 6, RIAA (application ref: 6.1)**.
The scope, effort and methods required for marine mammal surveys should be discussed with the relevant statutory nature conservation body (SNCB).	Paragraph 2.8.132	The requirements of the marine mammal surveys were discussed with the relevant SNCBs.
The applicant should discuss any proposed noisy activities with the relevant statutory body and must reference the JNCC and SNCB underwater noise guidance (JNCC *et al.* 2020) and any successor of this guidance, in relation to noisy activities (alone and in-combination with other plans or projects) within SACs SPAs, and Ramsar sites, in addition to the JNCC mitigation guidelines (https://jncc.gov.uk/our-	Paragraph 2.8.133 to 2.8.134	Section 11.6.1 details the assessment of impacts during construction, including pile driving and mitigation measures. The Applicants have discussed proposed piling activities with Natural England through the EPP as outlined in **Volume 7, Appendix 11.2 (application ref: 7.11.11.2)**.

NPS Requirement	NPS Reference	ES Section Reference
work/marine-mammals-and-noise-mitigation/) for piling, explosive use, and geophysical surveys. Where assessment shows that noise from construction and UXO clearance may reach noise levels likely to lead to noise thresholds being exceeded (as detailed in the JNCC guidance) or an offence as described in paragraph 2.8.129 above, the applicant must look at possible alternatives or appropriate mitigation		
The applicant should develop a Site Integrity Plan (SIP) to allow the cumulative impacts of underwater noise to be reviewed closer to the construction date, when there is more certainty in other plans and projects.	Paragraph 2.8.135	As mentioned in section 11.3.3 a SIP will be produced by the Projects. The **Volume 8, In Principle SIP (application ref: 8.26)** has been submitted with the DCO application and will be finalised pre construction based on the most up to date guidance available.
<u>Mitigation</u> Monitoring of the surrounding area before and during the piling procedure can be undertaken by various methods including marine mammal observers and passive acoustic monitoring. Active displacement of marine mammals outside potential injury zones can be undertaken using equipment, such as acoustic deterrent devices. Soft start procedures during pile driving may be implemented. This enables marine mammals in the area disturbed by the sound levels to move away from the piling before physical or auditory injury is caused.	Paragraph 2.8.237	The proposed monitoring and mitigation are outlined in section 11.3.3 and 11.8.

NPS Requirement	NPS Reference	ES Section Reference
Where noise impacts cannot be avoided, other mitigation should be considered, including alternative installation methods and noise abatement technology, spatial/temporal restrictions on noisy activities, alternative foundation types.	Paragraph 2.8.238	Mitigation to reduce the impacts from underwater noise is provided in **Volume 8, Outline MMMP (application ref: 8.25)** with the DCO application. As outlined in section 11.8, **Volume 8, Outline MMMP (application ref: 8.25)** and the mitigation measures required will be further developed in the pre-construction period and will be based upon best available information and methodologies at that time, in consultation with the relevant SNCBs and MMO.
Applicants should undertake a review of up-to-date research and all potential mitigation options presented as part of the application, having consulted the relevant JNCC mitigation guidelines (https://jncc.gov.uk/our-work/marine-mammals-and-noise-mitigation/)	Paragraph 2.8.239	Potential mitigation options are presented in section 11.3.3 and 11.3.3.1 and in **Volume 8, Outline MMMP (application ref: 8.25)** which will be finalised pre-construction in consultation with the relevant SNCBs and the MMO.
Secretary of State (SoS) decision making The SoS should be satisfied that the preferred methods of construction, in particular the construction method needed for the proposed foundations and the preferred foundation type, where known at the time of application, are designed to reasonably minimise significant impacts on marine mammals. Unless suitable noise mitigation measures can be imposed by	Paragraph 2.8.312 to 2.8.313	**Volume 7, Chapter 5 Project Description (application ref: 7.5)** describes the foundation options under consideration. Section 11.3.2 describes the worst-case scenario for marine mammals.

NPS Requirement	NPS Reference	ES Section Reference
requirements to any development consent the SoS may refuse the application.		
The conservation status of cetaceans and seals are of relevance and the SoS should be satisfied that cumulative and in-combination impacts on marine mammals have been considered.	Paragraph 2.8.314	The conservation status of relevant marine mammal species is included in section 11.4.1.6. The cumulative and in-combination effects on marine mammals have been assessed in section 11.7 and in **Volume 6, RIAA (application ref: 6.1)** respectively.

11.4.1.2 National and Regional Marine Policies

29. In addition to the NPS, there are a number of pieces of legislation, policy and guidance applicable to the assessment of marine mammals. These include:

- Legislation:
  - The Marine Strategy Regulations 2010.
- Policy:
  - The Marine Policy Statement (MPS) (HM Government, 2011); and
  - The East Inshore and East Offshore Marine Plans (HM Government, 2014) and North East Inshore and North East Offshore Marine Plans (HM Government, June 2021).

30. Further detail is provided in Volume 7, Appendix 11-2 (application ref: 7.11.11.2) and Volume 7, Chapter 3 Policy and Legislative Context (application ref: 7.3).

11.4.1.3 National and International Legislation for Marine Mammals

31. **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)** provides an overview of national and international legislation in relation to marine mammals.

11.4.1.4 Guidance Documents for Marine Mammals

32. The principal guidance documents used to inform the assessment of potential impacts on marine mammals include, but are not limited to:

- The Protection of Marine European Protected Species (EPS) from Injury and Disturbance: Draft Guidance for the Marine Area in England and Wales and the UK Offshore Marine Area (Joint Nature Conservation Committee (JNCC *et al.*.2010);
- Offshore Wind Marine Environmental Assessments: Best Practice Advice for Evidence and Data Standards for marine mammal baseline monitoring, best advice for EPP and post monitoring for marine mammals (Natural England, 2022);
- Guidelines for Ecological Impact Assessment in the UK and Ireland: Terrestrial, Freshwater, Coastal and Marine (Chartered Institute of Ecology and Environmental Management (CIEEM) 2019);
- Environmental Impact Assessment for offshore renewable energy projects – guide (British Standards Institution (BSI),2015);
- Approaches to Marine Mammal Monitoring at Marine Renewable Energy Developments Final Report (Sea Mammal Research Unit Ltd (SMRU Ltd) on behalf of The Crown Estate 2010);
- Guidelines for Data Acquisition to Support Marine Environmental Assessments of Offshore Renewable Energy Projects (Cefas 2011);
- Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (JNCC, Department of Agriculture, Environment and Rural Affairs (DAERA) and Natural England 2020);
- A review of noise abatement systems for offshore wind farm construction noise, and the potential for their application in Scottish Waters (Verfuss *et al.* 2019);
- Reducing Underwater Noise (NIRAS, SMRU Consulting, and The Crown Estate 2019);
- JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC 2010a); and
- Statutory Nature Conservation Agency Protocol for Minimising the Risk of Injury to Marine Mammals from Piling Noise (JNCC 2010b).

11.4.1.5 Protected Species and Marine Wildlife Licence Guidance

33. All cetacean species are listed as EPS under Annex IV of the EU Council Directive 92/43/EEC (Habitats Directive) and are therefore protected from the deliberate killing (or injury), capture and disturbance throughout their range. Within the UK, The Habitats Directive is implemented through the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (collectively the 'Habitats Regulations'). Under the Habitats Regulations, it is an offence to:

- Deliberately capture, injure or kill any cetacean species;
- Deliberately disturb them; or
- Damage or destroy a breeding site or resting place.

34. Grey and harbour seal are also protected under the Habitats Regulations, as well as Conservation of Seals Act 1970. Further information is provided in **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**.

35. If required, a Marine Wildlife Licence application will be submitted to the MMO post-consent. At that point in time, the Project Design Envelope will have been further refined through detailed design and procurement activities and further detail will be available on the techniques selected for construction, as well as the mitigation measures that will be in place following the development of MMMPs for piling and UXO clearance.

11.4.1.6 Conservation Status of Marine Mammals

36. **Table 11-6** provides the current conservation status of marine mammal species occurring in UK and adjacent waters, based on the most recent 2013-2018 reporting by JNCC in 2019.

Table 11-6 Conservation Status of Marine Mammal Species Occurring in UK and Adjacent Waters, Relevant to The Projects (JNCC, 2019)

Species	Conservation Status Assessment
Harbour porpoise	Unknown
Bottlenose dolphin	Unknown
White-beaked dolphin	Unknown
Minke whale	Unknown
Grey seal	Favourable
Harbour seal	Unfavourable-inadequate

37. The International Union for Conservation of Nature (IUCN)'s Red List of Threatened Species provides assessments of the conservation status of animals evaluated at a global scale using the IUCN Red List Categories and Criteria, with the aim of determining their relative risk of extinction. Assessments are updated periodically to reflect new information. Where sufficient information exists, the majority of marine mammal species occurring in UK waters fall into the lowest category of 'least concern' (**Table 11-7**).

Table 11-7 Global IUCN Red List of Threatened Species Assessments for Marine Mammal Species Relevant to The Project

Species	IUCN Red List Status	Year Assessed
Harbour porpoise	Least Concern	2020
Bottlenose dolphin	Least Concern	2018
White-beaked dolphin	Least Concern	2018
Minke whale	Least Concern	2018
Grey seal	Least Concern	2016
Harbour seal	Least Concern	2016

11.4.2 Data and Information Sources

11.4.2.1 Site Specific Surveys

38. In order to provide site specific and up to date information on which to base the impact assessment, a site-specific digital aerial survey was conducted for both marine mammals and seabirds. APEM Ltd collected high resolution digital aerial still imagery for marine megafauna (combined with ornithology surveys) over the original Crown Estate Lease Areas including a 4km buffer (the DBS East and DBS West Survey Area; **Plate 11-1** and **Plate 11-2**; **Volume 7, Appendix 11-2 Marine Mammal Information Report (application ref: 7.11.11.2)**.

39. **Table 11-8** shows the numbers of marine mammals recorded during the digital aerial surveys in the DBS East and DBS West Survey Area from March 2021 to February 2023. The results indicate that harbour porpoise is present in the highest numbers, followed by grey seal, and then dolphin/porpoise species which for a worst-case scenario can be considered as harbour porpoises. These numbers are the raw count, therefore only present a relative abundance and not total abundances.

Table 11-8: APEM Surveys Species Counts for DBS East Survey Area; DBS West Survey Area And 4km Buffer (March 2021 to February 2023)

Species	DBS East Survey Area	DBS West Survey Area
Harbour porpoise	668	805
Common dolphin	-	4
White-beaked dolphin	16	19
Dolphin / porpoise species	50	46
Dolphin species	-	1
Minke whale	3	7
Grey seal	62	80
Seal species	49	63
Marine mammal species	14	30

11.4.2.2 Other Available Sources

40. Other sources that have been used to inform the assessment are listed in **Table 11-9**.

Table 11-9 Other Available Data and Information Sources

Data Set	Spatial Coverage	Year	Notes
Small Cetaceans in the European Atlantic and North Sea (SCANS-III) data (Hammond *et al.* 2021)	North Sea and European Atlantic waters	Summer 2016	Provides information including abundance and density estimates of cetaceans in European Atlantic waters in summer 2016, including the offshore Project areas.
Management Units (MUs) for cetaceans in UK waters (IAMMWG 2022)	UK waters	2022	Provides information on MU for the Offshore Development Areas.

Data Set	Spatial Coverage	Year	Notes
Offshore Energy Strategic Environmental Assessment (OESEA) (including relevant appendices and technical reports) (OESEA 3 (DECC (2016); OESEA 4 (BEIS 2022a and 2022b)).	UK waters	2016 2022	Provides information on marine mammals in UK waters.
The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area (Heinänen and Skov 2015)	UK waters	1994-2011	Data was used to determine UK harbour porpoise SAC sites.
Revised Phase III data analysis of Joint Cetacean Protocol (JCP) data resources (Paxton *et al.*.2016)	UK EEZ	1994-2011	Provides information on cetaceans in UK waters.
Seasonal habitat-based density models for a marine top predator, the harbour porpoise, in a dynamic environment (Gilles *et al.*2016)	UK (SCANS II, Dogger Bank), Belgium, the Netherlands, Germany, and Denmark	2005-2013	Provides information for central and southern North Sea.
Distribution and abundance maps for cetacean species around Europe (Waggitt *et al.*2019).	North-east Atlantic	1980-2018	Provides information on cetacean species in the North Sea and UK waters.

Data Set	Spatial Coverage	Year	Notes
Distribution of marine mammals recorded from Digital Aerial survey (HiDef)	Dogger Bank Zone and Tranche C site	2013	Provides information on cetacean species in the Dogger Bank Project Areas.
Distribution of marine mammals recorded from Digital Aerial survey (HiDef)	Dogger Bank Zone 3	April 2010 to May 2012	Provides information on cetacean species in the Dogger Bank Zone 3 area.
Marine mammal surveys	Forewind Dogger bank OWF	January 2012 to June 2012	Provides information on cetacean species in the Forewind Dogger Bank project area.
Distribution of Cetaceans, Seals, Turtles, Sharks and Ocean Sunfish recorded from Aerial Surveys 2001-2008 (The Wildfowl and Wetlands Trust 2009)	UK areas of the North Sea	2001-2008	Provides information on species in the North Sea.
MARINElife surveys from ferry routes across the southern North Sea area (MARINElife 2022)	Southern North Sea	2017-2019	Provides information on species in the southern North Sea.
Sea Watch Foundation volunteer sightings off eastern England (Sea Watch Foundation 2023)	East coast of England	2019-2020	Provides information on species sighted along east coast of England.

Data Set	Spatial Coverage	Year	Notes
Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles (Carter *et al.*2020 and 2022)	North Sea	1991-2019	Provides information on abundance and absolute density estimates (i.e. number of seals) for seal species.
Seal telemetry data (e.g. Russell and McConnell, 2014; Russell 2016a; Carter *et al.*.2020)	North Sea	1988-2010; 2015	Provides information on movements and distribution of seal species.
Special Committee on Seals (SCOS) annual reporting of scientific advice on matters related to the management of seal populations (SCOS 2020; SCOS 2021).	North Sea	2019 & 2020	Habitat-based predictions of at-sea distribution for grey and harbour seals in the British Isles

11.4.3 Impact Assessment Methodology

41. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** provides a summary of the general impact assessment methodology applied. The following sections describe the methods used to assess the likely significant effects on marine mammals.

42. A matrix approach is used to guide the assessment of impacts following best practice, EIA guidance and the approach outlined in the Projects Scoping Report. An explanation of how this is applied within the marine mammal assessment is set out below.

43. In order to enable and facilitate a consistency of approach a matrix of definitions will be employed to structure the expertise and evidence led assessment of impacts. Receptor sensitivity for each marine mammal species have been defined within the ES, following the definitions set out in section 11.4.3.1.

11.4.3.1 Definitions

44. For each potential impact, the assessment identifies receptors sensitive to that impact and implements a systematic approach to understanding the impact pathways and the level of impacts (i.e. magnitude) on given receptors. The definitions of sensitivity and magnitude for the purpose of the marine mammal assessment are provided in **Table 11-10** and **Table 11-11**.

11.4.3.1.1 Sensitivity

45. The sensitivity of a receptor is determined through its ability to accommodate change and on its ability to recover if it is affected (**Table 11-10**). The sensitivity level of marine mammals to each type of impact is justified within the impact assessment and is dependent on the following factors:

- Adaptability – The degree to which a receptor can avoid or adapt to an impact;
- Tolerance – The ability of a receptor to accommodate temporary or permanent change without a significant adverse effect;
- Recoverability – The temporal scale over and extent to which a receptor will recover following an impact; and
- Value – A measure of the receptor importance, rarity and worth.

Table 11-10 Definition of Sensitivity for A Marine Mammal Receptor

Sensitivity	Definition
High	Individual receptor has very limited capacity to avoid, adapt to, tolerate or recover from the anticipated impact.
Medium	Individual receptor has limited capacity to avoid, adapt to, tolerate or recover from the anticipated impact.
Low	Individual receptor has some tolerance to avoid, adapt to, tolerate or recover from the anticipated impact.
Negligible	Individual receptor is generally tolerant to and can tolerate or recover from the anticipated impact.

11.4.3.1.2 Value

46. In addition, for some assessments the 'value' of a receptor may also be an element to add to the assessment where relevant – for instance if the receptor is designated or has an economic value.

47. The 'value' of the receptor forms an important element within the assessment, for instance, if the receptor is a protected species or habitat it is considered to be of higher value than a habitat or species that is not protected. It is important to understand that high value and high sensitivity are not necessarily linked within a particular effect. A receptor could be of high value but have a low or negligible physical/ecological sensitivity to an effect. Similarly, low value does not equate to low sensitivity and is judged on a receptor by receptor basis.

48. Most species of marine mammals are protected by a number of international legislations, as well as European and UK law and policy. All cetaceans in UK waters are EPS and, therefore, are internationally important. Harbour porpoise, bottlenose dolphin, grey seal and harbour seals are also afforded international protection through the designation of protected sites. As such, all species of marine mammal can be considered to be of high value.

49. **Table 11-11** provides definitions for the value afforded to a receptor based on its legislative importance. The value will be considered, where relevant, as a modifier for the sensitivity assigned to the receptor, based on expert judgement.

Table 11-11 Definition of Value for A Marine Mammal Receptor

Value	Definition
High	Internationally or nationally important Internationally protected species that are listed as a qualifying interest feature of an internationally protected site (i.e. Annex II protected species designated feature of a designated site) and protected species (including EPS) that are not qualifying features of a designated site.
Medium	Regionally important or internationally rare Protected species that are not qualifying features of a designated site but are recognised as a Biodiversity Action Plan (BAP) priority species either alone or under a grouped action plan, and are listed on the local action plan relating to the marine mammal study area.

Value	Definition
Low	Locally important or nationally rare Protected species that are not qualifying features of a designated site and are occasionally recorded within the study area in low numbers compared to other regions.
Negligible	Not considered to be particularly important or rare Species that are not qualifying features of a designated site and are never or infrequently recorded within the study area in very low numbers compared to other regions.

11.4.3.1.3 Magnitude

50. The thresholds for defining the potential magnitude of impact that could occur from a particular impact will be determined using expert judgement, current scientific understanding of marine mammal population biology, and JNCC *et al.* (2010) draft guidance on disturbance to EPS species. The JNCC *et al.* (2010) EPS draft guidance suggests definitions for a 'significant group' of individuals or proportion of the population for EPS species. As such this guidance has been considered in defining the thresholds for magnitude of impact (**Table 11-12**).

51. 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. The JNCC *et al.* (2010) draft guidance also provides limited consideration of temporary effects, with guidance reflecting consideration of permanent displacement.

52. Temporary effects are considered to be of medium magnitude at greater than 5% of the reference population. 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 impact in this assessment, consideration is given to uncertainty of the individual consequences of temporary disturbance.

53. Permanent effects with greater than 1% of the reference population being affected within a single year are considered to be high in magnitude in this assessment. This is based on Agreement on the Conservation of Small Cetaceans of the Baltic and North Seas (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 <1% of the population (Defra 2003; ASCOBANS 2015).

Table 11-12 Definition of Magnitude of Impacts

Magnitude	Definition
High	Permanent irreversible change to exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 1% of the reference population are anticipated to be exposed to the effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the Projects). Assessment indicates that more than 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that more than 10% of the reference population are anticipated to be exposed to the effect.
Medium	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.01% and 1% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the Projects).

Magnitude	Definition
	Assessment indicates that between 1% and 5% of the reference population are anticipated to be exposed to the effect. OR Temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 5% and 10% of the reference population anticipated to be exposed to effect.
Low	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that between 0.001% and 0.01% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more, but not permanent (e.g. limited to operational phase of the Projects). Assessment indicates that between 0.01% and 1% of the reference population are anticipated to be exposed to the effect. OR Intermittent and temporary effect (e.g. limited to the construction phase of development) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that between 1% and 5% of the reference population anticipated to be exposed to effect.
Negligible	Permanent irreversible change to exposed receptors or feature(s) of the habitat of particular importance to the receptor. Assessment indicates that < 0.001% of the reference population anticipated to be exposed to effect. OR Long-term effect for 10 years or more (but not permanent, e.g. limited to lifetime of the Projects). Assessment indicates that < 0.01% of the reference population are anticipated to be exposed to the effect. OR

Magnitude	Definition
	Intermittent and temporary effect (limited to the construction phase of development or Project timeframe) to the exposed receptors or feature(s) of the habitat which are of particular importance to the receptor. Assessment indicates that < 1% of the reference population anticipated to be exposed to effect.

11.4.3.1.4 Significance of Effect

54. The assessment of significance of an effect is informed by the sensitivity of the receptor and the magnitude of the impact. The determination of significance is guided by the use of an impact significance matrix presented in **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)**. Definitions of each level of significance are provided in **Table 11-13**. For the purposes of this assessment, any effect that is of major or moderate significance is considered to be significant in EIA terms, whether this be adverse or beneficial. Any effect that has a significance of minor or negligible is not significant.

Table 11-13 Marine Mammal Significance of Effect Matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	**Medium**	**Low**	**Negligible**	**Negligible**	**Low**	**Medium**	**High**
Sensitivity	**High**	Major	Major	Moderate	Minor	Minor	Moderate	Major	Major
	Medium	Major	Moderate	Minor	Minor	Minor	Minor	Moderate	Major
	Low	Moderate	Minor	Minor	Negligible	Negligible	Minor	Minor	Moderate
	Negligible	Minor	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Minor

Table 11-14 Definition of Effect Significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore no change in receptor condition.

11.4.4 Cumulative Effects Assessment Methodology

55. The Cumulative Effects Assessment (CEA) considers other schemes, plans, projects and activities that may result in significant effects in cumulation with the Projects. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** (and accompanying **Volume 7, Appendix 6-2 Offshore Cumulative Assessment Methodology (application ref: 7.6.6.2)**) provides further details of the general framework and approach to the CEA.

56. Section 11.7 presents the following information:

- Screening for cumulative effects; and
- A short list of schemes considered for CEA, including a brief description as to how schemes have been screened in and the tier level they have been assigned.

57. The CEA presents relevant cumulative effects of projects based on their stage of development using the tiered approach as devised by Natural England and Defra (2022), as follows:

- Tier 1: built and operational schemes;
- Tier 2: schemes under construction;
- Tier 3: schemes that have been consented (but construction has not yet commenced);

- Tier 4: schemes that have an application submitted to the appropriate regulatory body that have not yet been determined;
- Tier 5: schemes that have produced a PEIR and have characterisation data within the public domain;
- Tier 6: schemes that the regulatory body are expecting to be submitted for determination (e.g. schemes listed under the Planning Inspectorate programme of schemes); and
- Tier 7: schemes that have been identified in relevant strategic schemes or programmes.

58. These tiers are used as they are considered more appropriate in comparison to the tiers in The Planning Inspectorate (2019) Advice Note 17 for the types of schemes considered in this assessment, in particular for the OWFs.

59. The types of schemes to be taken into consideration are:

- Other OWFs;
- Other marine renewables (wave and tidal) developments;
- Aggregate extraction and dredging;
- Licenced disposal sites;
- Construction of subsea cables and pipelines;
- Oil and gas development and decommissioning, including seismic surveys;
- Coastal developments;
- UXO clearance;
- Commercial fisheries; and
- Shipping.

60. The CEA is a two-part process in which an initial list of potential schemes is identified with the potential to interact with the proposed projects based on the mechanism of interaction and spatial extent of the reference population for each marine mammal species. Following a tiered approach, the list of schemes is then refined based on the level of information available for this list of schemes to enable further assessment.

61. The CEA considers projects, plans and activities which have sufficient information available to undertake the assessment. Insufficient information precludes a meaningful quantitative assessment, and it is not appropriate to make assumptions about the detail of future projects in such circumstances.

62. The project tiers considered in the CEA for marine mammals are outlined in **Table 11-15** and the appropriate CEA screening will be provided.

Table 11-15 Tiers in Relation to Project Category Which Have Been Screened Into the CEA

Project Category	UK	Other
Other OWFs	Tier 1, 2, 3, 4, 5	Tier 1, 2, 3, 4, 5
Other renewable developments (tidal and wave)	Tier 1, 2, 3, 4, 5	Tier 1, 2, 3
Aggregate extraction and dredging	Tier 1, 2, 3, 4	Screened out
Oil and gas installations and decommissioning	Tier 1, 2, 3, 4	Screened out
Shipping	Tier 1, 2, 3	Screened out
Planned construction of subsea cables and pipelines	Tier 1, 2, 3, 4, 5	Screened out
Gas storage, offshore mines, and carbon capture projects	Tier 1, 2, 3, 4, 5	Screened out
Coastal developments	Tier 1, 2, 3, 4, 5	Screened out
Commercial fisheries	Tier 1, 2, 3	Screened out
Seismic and geophysical surveys	Tier 1, 2, 3, 4	Screened out

11.4.5 Transboundary Effect Assessment Methodology

63. The transboundary assessment considers the potential for transboundary effects to occur on marine mammal receptors as a result of the Projects; either those that might arise within the UK EEZ of European Economic Area (EEA) states or arising on the interests of EEA states e.g. a non UK fishing vessel. **Volume 7, Chapter 6 EIA Methodology (application ref: 7.6)** provides further details of the general framework and approach to the assessment of the transboundary effects.

64. For marine mammals, the potential for transboundary impacts has been addressed by considering the reference MUs and potential linkages to other countries (for example, as identified through seal telemetry studies).

65. The assessment of effects on transboundary designated sites is presented in the **Volume 6, RIAA (application ref: 6.1)**.

11.4.6 Assumptions and Limitations

66. Due to the large amount of data that has been collected for this and other nearby OWFs, as well as other available data for marine mammals within the region, there is a good understanding of the existing environment. There are, however, some limitations to data collected by marine mammal surveys, primarily due to the highly mobile nature of marine mammals and therefore the potential variability in usage of the site; each survey provides only a snapshot. The majority of the surveys, such as SCANS, are typically carried out in summer months which can result in seasonal gaps. However, the site-specific surveys were conducted every month during the two-year survey period (**Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**). However, the surveys in the study area over the last decade show relatively consistent results and taking into account the site-specific survey and data from other surveys, such as nearby OWFs for different months, seasons and years, there is good coverage to provide information on the species likely to be present in the area.

67. There are also limitations in the detectability of marine mammals from aerial surveys, such as not being able to detect those individuals that are submerged. **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)** seeks to address these limitations by estimating a correction factor in order to determine estimated absolute density estimates from the site-specific aerial surveys.

68. From the aerial surveys, for some marine mammal species, there has been a low number of sightings, therefore the estimated densities from the site-specific surveys are not a true representation. However, as a precautionary approach, density estimates for each marine mammal species used in the assessments are based on the highest for the area, see section 11.5.8.

69. Where practicable, an overview of the confidence of the data and information underpinning the assessment will be presented. Confidence will be classed as High, Medium or Low depending on the type of data (quantitative, qualitative or lacking) as well as the source of information (e.g., peer reviewed publications, grey literature) and its applicability to the assessment.

11.5 Existing Environment

11.5.1 Harbour Porpoise

11.5.1.1 Desk-Based Review of Harbour Porpoise Presence

70. Within the North Sea area, harbour porpoise are the most common marine mammal species. Heinänen and Skov (2015) identified one area of high harbour porpoise density in the summer period; from the western slopes of Dogger Bank south along a 30m depth contour towards an area off the Norfolk coast. High densities in winter were also identified in the southern North Sea, within an area between Flamborough Head and the outer Thames Estuary.

71. Distribution and abundance maps were developed by Waggitt *et al.* (2019) for cetacean species around Europe. For harbour porpoise, the distribution maps show a clear pattern of high harbour porpoise density in the southern North Sea, and the coasts of south-east England, for both January and July (See **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**; Waggitt *et al.* 2019). Interrogation of these data[1], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

- 0.59 individuals per km^2 for the DBS East Survey Area;
- 0.58 individuals per km^2 for the DBS West Survey Area;
- 0.56 individuals per km^2 for the Offshore Export Cable Corridor; and
- 0.415 individuals per km^2 for the total Offshore Development Area.

72. The SCANS-IV survey (Gilles *et al.* 2023) indicates that the occurrence of harbour porpoise is greater in the central and southern areas of the North Sea compared to the northern North Sea. The DBS sites are both in SCANS-IV survey blocks NS-C (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**), with the following abundance and density estimates:

- Abundance = 36,286 harbour porpoise (95% confidence limit (CL) = 23,346-56,118).
- Density = 0.6027 harbour porpoise/km^2 (coefficient of variation (CV=0228).

[1] Available from: https:// doi.org/10.5061/dryad.mw6m905sz

11.5.1.2 Results from the Site-Specific Surveys for Harbour Porpoise

73. Harbour porpoise was the most commonly sighted marine mammal species during the surveys, with a total of 668 individuals recorded through the 24 survey dates within the DBS East Survey Area, and 805 individuals recorded through the 24 survey dates within the DBS West Survey Area; totalling 1,473 individuals at the DBS East and West Survey Areas including the 4km buffer.

74. The distribution of harbour porpoise within DBS East and DBS West Survey Areas varied, with no evident pattern of harbour porpoise distribution within the Survey Areas, and no indication of a particular area of importance.

11.5.1.2.1 Site-Specific Density estimates for Harbour Porpoise

75. Density estimates of animals/km^2 have been calculated from the raw data counts for harbour porpoise and are set out in **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**. These abundance and densities are for the entire Survey Areas, plus 4km buffer. A correction factor has been used to count for diving individuals from Voet *et al*. (2017).

76. The average of the winter months, summer months, and annual density has then been calculated based on the maximum calculated for each month during the survey. **Table 11-16** shows the densities for harbour porpoise (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)** for more information on how these density estimates were derived). The density estimates are higher in the summer months.

Table 11-16 Seasonal Density Estimates for Harbour Porpoise Form APEM Ltd Survey

Season	DBS East absolute density estimates (of individuals/km^2)	DBS West absolute density estimates (of individuals/km^2)
Summer average	0.600	0.662
Winter average	0.442	0.625
Yearly average	0.521	0.643

11.5.1.3 Summary of Abundance and Density Estimates for Harbour Porpoise

77. Within the impact assessments for harbour porpoise, and in addition to the site specific density estimates for harbour porpoise, density estimates from the SCANS-IV surveys (Gilles *et al.* 2023) are used to provide context for the wider area.

78. For conservation and management purposes, it is necessary to consider this population within smaller MUs. MUs provide an indication of the spatial scales at which effects of plans and projects alone, and in-combination, need to be assessed for the key cetacean species in UK waters, with consistency across the UK (IAMMWG 2023).

79. The estimate of harbour porpoise abundance in the North Sea MU is 346,601 (CV = 0.09; 95%; confidence interval (CI) = 289,498 – 419,967 IAMMWG 2023). This is the reference population for harbour porpoise, of which any potential impacts will be assessed against.

11.5.2 Bottlenose Dolphin

11.5.2.1 Desk-Based Review of Bottlenose Dolphin Presence

80. There are distinct ecotypes of bottlenose dolphin in UK waters; the offshore ecotype and an inshore or coastal type.

81. For bottlenose dolphin, the distribution maps (developed by Waggitt *et al.* 2019) show a clear pattern of higher density to the western coastal areas of the UK, extending south to the Bay of Biscay (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**) for further information). Densities of bottlenose dolphin in the North Sea are very low in comparison.

82. A resident population of bottlenose dolphin is present in the Moray Firth, with an estimated 224 individuals (95% CI 214–234; Arso Civil *et al*. 2021; IAMMWG 2023). 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 (Aynsley 2017; Hacket 2022). They have been recorded approximately 300 miles outside of what would be considered their 'normal' home range (Cheney *et al*. 2018), with one individual from the Moray Firth population being recorded as far south and east as the Netherlands (Aynsley 2017).

83. Whilst bottlenose dolphin presence has been increasing in north-east England in recent years, they appear to be a coastal population at present (Hacket 2022). Re-sighted individuals from the Moray Firth have given indication to the assumption that there could be a southerly expansion of their range (Arso Civil *et al.* 2018). The most recent aerial surveys (Gilles *et al.* 2023) have detected sightings of bottlenose dolphin south of the Moray Firth, providing more evidence to support that the coastal ecotype is ranging further south than during the 2016 surveys (Hammond *et al*. 2021). Previous studies into the bottlenose dolphin on the east coast of Scotland found that the individuals associated with the Moray Firth population were generally recorded within 2km of the coastline, except within St Andrews Bay (Quick *et al*. 2014).

84. As sightings of bottlenose dolphin have been increasingly reported along the north-east coast of England, they have been included in the assessment.

85. Bottlenose density estimates derived from the Waggitt *et al.* (2019) are:

- 0.00014 individuals per km^2 for the DBS East Survey Area;
- 0.00025 individuals per km^2 for the DBS West Survey Area;
- 0.0013 individuals per km^2 for the Offshore Export Cable Corridor; and
- 0.0014 individuals per km^2 for the total Offshore Development Area.

86. During the SCANS-IV survey in the summer 2022 (Gilles *et al.* 2023), the density and abundance estimates for bottlenose dolphin in the NS-C block are (see **Volume 7**, **Appendix 11-2**):

- Abundance = 2,520 bottlenose dolphin (CL=57-6,616).
- Density = 0.0419 bottlenose dolphin per km^2 (CV=0.683).

11.5.2.2 Results from the Site-Specific Surveys for Bottlenose Dolphin

87. During the site specific digital aerial surveys of both DBS East and DBS West, no bottlenose dolphin were recorded. However, one sighting was recorded as unidentified dolphin, which could be attributed to being a bottlenose dolphin.

11.5.2.3 Summary of Abundance and Density Estimates for Bottlenose Dolphins

97. To assess the impact assessments for bottlenose dolphin, the worst-case density estimates relative to the Projects from the SCANS-IV NS-C survey block (Gilles *et al*. 2023) data are used in the assessment:

- 0.0419 individuals per km^2 for the Projects.

98. The estimate of bottlenose abundance in the GNS MU is 2,022 (95% CI = 548 – 7,453; IAMMWG 2023) and in the CES MU is 224 (95% CI = 214 – 234; IAMMWG 2023). Both of the MUs are used as the reference population for bottlenose dolphin for which any potential impacts are assessed against.

99. There are two ecotypes of bottlenose dolphin that may be present within the Offshore Development Area. Therefore, the potential effects taking place in the inshore region (i.e. associated with the export cable corridor and landfall) will be assessed against both the GNS and CES MUs, as individuals in these areas could be associated with either population. All offshore impacts will only be assessed against the offshore ecotype bottlenose dolphin within the GNS MU.

11.5.3 Common Dolphin

11.5.3.1 Desk-Based Review of Common Dolphin Presence

100. Throughout its range, the common dolphin *Delphinus delphis* is primarily distributed in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland (BEIS 2022b; Hammond *et al.*.2021; Waggitt *et al.* 2019) and is recorded as rare in the North Sea (Reid *et al.* 2003; Camphuysen & Peet, 2006; Evans, *et al*. 2003; Kinze, *et al*. 2010; Murphy *et al*. 2013; Murphy *et al*. 2021). There is very little literature on common dolphins in the North Sea, however it is documented that they have a seasonal occurrence in the North Sea in the summer months (Waggitt *et al.* 2019).

101. For the SCANS-IV surveys, common dolphin were recorded in survey block NS-C which is the first-time common dolphin has been recorded in the North Sea via a SCANS survey, with the following abundance and density estimates (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**, Gilles *et al.* 2023);

- Abundance = 192 common dolphin (CL=6-724).
- Density = 0.0032 common dolphin per km^2 (CV=0.966).

102. Waggitt *et al.* (2019) summer densities across the area of the SCANS-IV block NS-C have been calculated to show the density across a wider area in comparison, and results in a density of 0.017 common dolphin per km^2 for the Projects.

11.5.3.2 Results from the Site-Specific Surveys for Common Dolphin

103. During the site specific digital aerial surveys of the Projects, two sightings of two individuals were recorded in the DBS West site in March 2021 and May 2022, resulting in a relative density estimate of 0.02 individuals per km^2 for those months. None were recorded in the DBS East site. Adding a correction factor of 0.675 (De Boer *et al*. 2008) to account for availability bias gives a density estimate of 0.03 per km^2 for those months, and using that to generate an annual density estimate results in an average annual density of 0.002 common dolphin per km^2 within DBS West.

11.5.3.3 Summary of Abundance and Density estimates for Common Dolphin

104. Within the impact assessments for common dolphin, the site-specific annual density estimate will be used for DBS West, along with the SCANS density estimate, and the Waggit et al. (2019) summer densities across the area of the SCANS-IV block NS-C as these density estimates are more representative of the wider area, and represent a worst-case.

105. As for the density estimate, the CGNS MU (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**), in which sits the Projects, has a population estimate for the common dolphin of 102,656 (95% CI = 58,932 – 178,822; IAMMWG 2023).

11.5.4 White-Beaked Dolphin

11.5.4.1 Desk-Based Review of White-Beaked Dolphin Presence

106. White-beaked dolphin are widely distributed within the central North Sea, however, very few sightings are recorded along the east coast of England, with a small number of sightings in offshore waters within the shallow waters near the North Norfolk Sandbanks and Dogger Bank areas (Gilles *et al.* 2012; DECC 2016). The occurrence of white-beaked dolphin in the southern North Sea is relatively low (Reid *et al.* 2003; Hammond *et al.* 2013; 2021).

107. SCANS-V identified that for white-beaked dolphin, densities are low across much of UK waters, with higher densities shown to be in the Hebrides and the northern North Sea, with no white-beaked dolphin identified within the southern North Sea, and low but increasing densities with the more northerly North Sea survey blocks (blocks NS-C) (Gilles *et al.* 2023).

108. For the entire SCANS-IV aerial Survey Area (Gilles *et al.* 2023), white-beaked dolphin abundance in the summer of 2022 was estimated to be 67,138 with an overall estimated density of 0.0458/km^2 (CV = 0.325; 95% CL = 33,978-119,349); which is higher than previous SCANS surveys (Gilles *et al.* 2023). DBS is located in SCANS-IV survey block NS-C, with the following abundance and density estimate:

- Abundance = 894 white-beaked dolphin (95% CL= 12-2,387).
- Density = 0.0149 white-beaked dolphin per km^2 (CV=0.758).

109. For white-beaked dolphin, the distribution maps developed by Waggitt *et al.* (2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, with decreasing densities southwards of Scotland along the east coast of England. There is also a clear seasonal difference in the densities of white-beaked dolphin, with higher densities in July, particularly to the north of their range (**Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**; Waggitt *et al.* 2019). DBS East and DBS West are located to the southern end of the area with relatively higher densities, where there appears an increase in densities during the summer months.

110. For white-beaked dolphin, the density estimate from these distribution maps result in a Project density estimate of 0.006 individuals per km^2. In addition, the Waggitt *et al.* (2019) summer densities across the area of the SCANS-IV block NS-C have been calculated to show the density across a wider area in comparison, and results in a density of 0.032 white-beaked dolphin per km^2 for the Projects.

11.5.4.2 Results from the Site-Specific Surveys for White-Beaked Dolphin

111. During the site-specific aerial surveys of both DBS East and DBS West, there were three detections of white-beaked dolphins in the DBS East Survey Area during December 2021, December 2022 and January 2023; totalling 16 individuals, with a peak relative density estimate of 0.07 individuals per km^2.

112. In the DBS West Survey Area, white-beaked dolphins were recorded on four occasions; in April and June 2021, November 2022 and February 2023, totalling 19 individuals, with a peak relative density estimate of 0.07 individuals per km^2.

113. A correction factor was used for white-beaked dolphin of 0.18 (Rasmussen *et al*. 2013; Mate *et al*. 1994; 1995), which results in an average density estimate of 0.034 white-beaked dolphin per km^2 at DBS East, and an average density of 0.041 white-beaked dolphin per km^2 at DBS West for the survey period.

114. These site-specific densities are higher than the SCANS-IV density estimate for the relevant survey block (of 0.0149 per km^2), and similar to the density estimate for the SCANS-IV survey block when calculated from the Waggitt *et al*. (2019) data (of 0.032 per km^2), and are therefore considered to be proportionately worst-case in comparison to the desk-based data sources.

11.5.4.3 Summary of Abundance and Density estimates for White-Beaked Dolphin

116. Within the impact assessments for white-beaked dolphin, the worse-case density estimates for the offshore sites will be used. Therefore, within the impact assessments the density estimates from the site specific surveys:

- 0.034 individuals per km^{2}for the DBS East Array Area; and
- 0.041 individuals per km^2 for the DBS West Array Area.

117. The single MU for white-beaked dolphin, the CGNS MU, comprises all UK waters. The reference population for white-beaked dolphin in the CGNS MU is 43,951 animals (CV=0.22; 95% CI= 28,439 – 67,924; IAMMWG 2023).

11.5.5 Minke Whale

11.5.5.1 Desk-Based Review of Minke Whale Presence

118. Minke whales are widely distributed along the Atlantic seaboard of Britain and Ireland and throughout the North Sea. The JNCC Cetacean Atlas (Reid *et al.* 2003) indicates that minke whale occur regularly in the North Sea to the north of Humberside, but are comparatively scarce in the southern North Sea. Animals are present throughout the year, but most sightings are between May and September (Reid *et al.* 2003). DECC (2016) support this, stating that sightings rarely extend past Dogger Bank, but that occasional sightings of minke whale are made as far south as Flamborough Head and the north Humberside coastlines between July and October (DECC 2016).

119. For minke whale, the distribution maps developed by Waggitt *et al.* (2019) show a clear pattern of higher density in the northern North Sea, and around the coasts of Scotland, Ireland and within the CIS, with decreasing densities southwards of Scotland along the east coast of England. There is a clear seasonal difference in the densities of minke whale, with higher densities in July, which is particularly evident in the north of their range (**Volume 7, Appendix 11-2 (application ref: 7.11.11.2);** Waggitt *et al.* 2019). The Projects are located to the very southern end of the area with relatively higher densities, and there appears to be a slight difference in their seasonal distributions with higher densities in this area during the summer months. Interrogation of this data[2], including all 10km 'grids' that overlap with the specified area, reveals an average annual density estimate of:

- 0.0025 individuals per km^2 for the DBS East Survey Area;
- 0.0034 individuals per km^2 for the DBS West Survey Area;
- 0.0073 individuals per km^2 for the Offshore Export Cable Corridor; and
- 0.0075 individuals per km^2 for the total Offshore Development Area.

120. For the entire SCANS-IV aerial Survey Area (Gilles *et al*. 2023), minke whale abundance in the summer of 2022 was estimated to be 12,417 with an overall estimated density of 0.0085 per km^2 (CV = 0.361; 95% CL = 7,038-26,943). For the survey block NS-C, minke whale abundance and density estimates are;

- Abundance = 412 minke whale (% CL=4-1,392).
- Density = 0.0068 minke whale per km^2 (CV=0.881).

11.5.5.2 Results from the Site-Specific Surveys for Minke Whale

121. During the DBS site specific digital aerial surveys, three individual minke whale were recorded at the DBS East Survey Area and resulted in a peak relative density estimate of 0.02 individuals per km^2. Using an availability correction factor of 0.12 (CV = 0.28), (Heide-Jorgensen *et al.* 2010), resulted in a peak corrected density of 0.16 minke whale per km^2. Generating an average density from the corrected density results in a density estimate of 0.01 minke whale per km^2 over DBS East.

[2] Available from: https:// doi.org/10.5061/dryad.mw6m905sz

122. At DBS West, the four minke whale detections (with a total of seven individuals) resulted in a peak relative density estimate of 0.03 individuals per km^2. Using an availability correction factor of 0.12 (CV = 0.28; Heide-Jorgensen *et al*. 2010), the peak corrected density estimate is 0.25 minke whale per km^2. Generating an average density from the corrected density results in a density estimate of 0.02 minke whale per km^2 over DBS West.

123. These site-specific densities are higher than the SCANS-IV density estimate for the relevant survey block (of 0.0085 per km^2), and higher than Waggitt *et al*. (2019) density calculations (of 0.0025-0.0075 per km^2) and are therefore considered to be proportionately worst-case in comparison to the desk-based data sources.

11.5.5.3 Summary of Abundance and Density Estimates for Minke Whale

124. Within the impact assessments for minke whale, the worst case density estimates from the site specific surveys will be used:

- 0.01 minke whale per km^2 for DBS East; and
- 0.02 minke whale per km^2 for DBS West.

125. The single MU for minke whale is the CGNS covering all UK waters (IAMMWG 2023; see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**). The reference population for minke whales in the CGNS MU is 20,118 animals (CV = 0.18; 95% CI = 14,061 – 28,786; IAMMWG 2023).

11.5.6 Grey Seal

11.5.6.1 Desk-Based Review of Grey Seal Presence

126. Grey seal only occur in the North Atlantic, Barents and Baltic Sea with their main concentrations on the east coast of Canada and United States of America and in north-west Europe (SCOS 2020).

127. Approximately 36% of the world's grey seals breed in the UK, and 81% of these breeds at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland, on the north and east coasts of mainland Britain and in south-west England and Wales (SCOS 2021).

128. The relative seals at-sea density maps have been used to calculate grey seal density estimates for DBS East and DBS West. The Carter *et al.* (2022) density maps include updated tagging studies (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**). These density maps only include tagging studies from the UK.

129. The grey seal density estimates for DBS East and DBS West have been calculated from the seal at sea usage maps (Carter *et al.* 2022) based on the 5km x 5km grids that overlap with the Projects. The total grey seal at-sea population in the British Isles, at sea, is approximately 159,175, corrected from the latest haul-out count data provided in SCOS (2021). This is the population estimate used with the Carter *et al*. (2022) data to calculate density estimates for DBS East and DBS West array sites.

130. The mean at sea relative density estimates for these areas have been calculated from Carter *et al.* (2022);

- 0.181 individuals per km^2 for the DBS East Survey Area;
- 0.260 individuals per km^2 for the DBS West Survey Area;
- 0.531 individuals per km^2 for the Offshore Export Cable Corridor; and
- 0.386 individuals per km^2 for the total Offshore Development Area.

11.5.6.2 Results from the Site-Specific Surveys for Grey Seal

131. From March 2021 to February 2023, 62 grey seals were recorded in DBS East on 19 surveys with a relative annual density estimate of 0.030 individuals per km^2. Grey seal were recorded on 18 surveys in DBS West, with 88 individuals recorded, with a relative annual density estimate of 0.035 individuals per km^2.

132. However, a number of sightings were recorded as 'seal species', at DBS East (n=49), DBS West (n=34) and 'marine mammal species' DBS West (n=63), some of which could have been grey seals.

133. Seasonal calculation of grey seal relative density estimates has been calculated from the data from the site-specific surveys, and corrected for availability bias, and are presented in **Table 11-17**.

Table 11-17 Seasonal Densities for Grey Seal From The Site Specific Surveys.

Season	DBS absolute density estimates for grey seal	
	DBS East (individuals per km^2)	DBS West individuals per km^2)
Summer average	0.070	0.132
Winter average	0.080	0.123
Yearly average	0.091	0.128

11.5.6.3 Summary of Abundance and Density Estimates for Grey Seal

134. Within the impact assessments for grey seal, density estimates for DBS East and DBS West calculated from the seal at sea usage maps (Carter *et al.*, 2022) will be used (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

135. In accordance with the agreed approach for other OWFs, the reference population extent for grey seal incorporates the SE England MU and the NE England MU (IAMMWG, 2013; SCOS, 2020) to take into account the wide-ranging movement of grey seal as indicated by tagging studies.

136. These have also been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.2515 grey seals are available to count within the August surveys (i.e. are hauled-out), and therefore this has been used as a correction factor, to derive total grey seal numbers within each MU, rather than the number counted within each MU.

137. The reference population for grey seal is therefore currently based on the most recent estimates as shown in **Table 11-18**.

Table 11-18 Grey Seal Count 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 total population
SE England MU	7,694	SCOS 2022	0.2515	30,592
NE England MU	6,517	SCOS 2022	0.2515	25,913
Total wider reference population	14,211	-	0.2515	56,505

138. The total reference population for the assessment is 56,505 grey seal. Assessments are undertaken in the context of the nearest MU (of 30,592) as well as the wider reference population (of 56,505). As a worst case, it is assumed that all seals are from the nearest MU, the south-east England MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

11.5.7 Harbour seal

11.5.7.1 Desk-Based Review of Harbour Seal Presence

139. Harbour seals have a circumpolar distribution in the Northern Hemisphere and are divided into five sub-species. The population in European waters represents one subspecies *Phoca vitulina* (SCOS, 2022).

140. On the east coast of Britain harbour seal distribution is generally restricted, with concentrations in the major estuaries of the Thames, The Wash and the Moray Firth (SCOS, 2022).

141. Harbour seal come ashore in sheltered waters, typically on sandbanks and in estuaries, but also in rocky areas. Harbour seal regularly haul-out on land in a pattern that is often related to the tidal cycle (SCOS, 2022). Harbour seal give birth to their pups in June and July and pups can swim almost immediately after birth (SCOS, 2022). Harbour seals moult in August and spend a higher proportion of their time on land during the moult than at other times (SCOS, 2022).

142. The Carter *et al.* (2022) density maps include updated tagging studies (see **Volume 7, Appendix 11-1 (application ref: 7.11.11.1)**). These density maps only include tagging studies from the UK.

143. The harbour seal density estimates for DBS East and DBS West have been calculated from the seal at sea usage maps (Carter *et al.* 2022) based on the 5km x 5km grids that overlap with the Projects. The total harbour seal population in the British Isles, at sea, is approximately 40,600 individuals, based on the latest haul-out counts (SCOS 2021) and corrected for those available to count, and for those that would be at-sea at any one time. This is the population estimate used with the Carter *et al.* (2022) data to calculate density estimates for DBS East and DBS West array sites.

144. The mean at sea density estimates for these areas have been used in the assessment:

- 0.0017 individuals per km^2 for the DBS East Survey Area;
- 0.0010 individuals per km^2 for the DBS West Survey Area;
- 0.0017 individuals per km^2 for the Offshore Export Cable Corridor; and
- 0.0015 individuals per km^2 for the total Offshore Development Area.

11.5.7.2 Results from the Site-Specific Surveys for Harbour Seals

145. During the site specific digital aerial surveys of both DBS East and DBS West, no harbour seals were recorded. However, several sightings were recorded as unidentified seals, some of which could be attributed to harbour seals as well as grey seals (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

11.5.7.3 Summary of Abundance and Density Estimates for Harbour Seal

146. The relative seals at-sea density maps (Carter *et al.* 2022; **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**) have been used to calculate harbour seal density estimates for the Array Areas. These density estimates will be used within the impact assessments.

147. In accordance with the agreed approach for other OWFs, the reference population extent for harbour seal will incorporate the SE England MU (IAMMWG, 2013; SCOS, 2022).

148. These have also been corrected to take account of the number of seals not available to count during the surveys. Approximately 0.72 harbour seals (Lonergan *et al.* 2013) are available to count within the August surveys (i.e. are hauled-out), and therefore this has been used as a correction factor, to derive total harbour seal numbers within each MU, rather than the number counted within each MU. The reference population for harbour seal is therefore currently based on the most recent estimates of 4,868.

149. As a worst case it is assumed that all seals are from the nearest MU, the south-east England MU, although the more realistic assessment is based on wider reference population which takes into account movement of seals.

11.5.8 Summary of Marine Mammal Densities and Reference Populations for Assessments

150. **Table 11-19** and **Table 11-20** provide a summary of the reference populations and the density estimates for the marine mammal species used in the impact assessment.

151. To determine the magnitude of an impact the number of individuals that could be impacted is put into the context of the relevant reference population (see **Table 11-12** for definitions of magnitude).

Table 11-19 Summary of Marine Mammal Reference Populations Used in the Impact Assessments

Species	Reference population extent	Population	Source
Harbour porpoise	NS MU	346,601	IAMMWG (2023)
Bottlenose dolphin	GNS MU (for all potential effects)	2,022	IAMMWG (2023)
	CES MU (for potential effects in the export cable corridor and at landfall only)	224	IAMMWG (2023)
Common dolphin	CGNS MU	102,656	IAMMWG (2023)
White-beaked dolphin	CGNS MU	43,951	IAMMWG (2023)
Minke whale	CGNS MU	20,118	IAMMWG (2023)
Grey seal	SE England MU	30,592	Corrected from haul-out count in SCOS (2022)
	Wider reference population = (SE England MU; NE England MU)	56,505 (30,592; 25,913)	Corrected from haul-out counts in SCOS (2021)
Harbour seal	SE England MU	4,868	Corrected from haul-out counts in SCOS (2022)

Table 11-20 Summary of Marine Mammal Density Estimates Used in the Impact Assessments

Species	Area of density estimate	Density estimate (individuals per km²)	Source
Harbour porpoise	DBS East Array Area (summer season as worst case)	0.60	Site specific surveys
Harbour porpoise	DBS West Array Area (summer season as worst case)	0.66	Site specific surveys
Bottlenose dolphin	SCANS IV Block NS-C	0.0419	Gilles *et al.* (2023)
Common dolphin	Waggit densities over SCANS block NS-C	0.017	Waggitt *et al.* (2019)
White-beaked dolphin	DBS East Array Area	0.034	Site specific surveys
	DBS West Array Area	0.041	Site specific surveys
Minke whale	DBS East Array Area	0.01	Site specific surveys
	DBS West Array Area	0.02	Site specific surveys
Grey seal	DBS East Array Area	0.181	Carter *et al.* (2022)
	DBS West Array Area	0.260	
	Offshore Export Cable Corridor	0.531	

Species	Area of density estimate	Density estimate (individuals per km²)	Source
	Offshore Development Area	0.386	
Harbour seal	DBS East Array Area	0.0017	
	DBS West Array Area	0.001	
	Offshore Export Cable Corridor	0.0017	
	Offshore Development Area	0.0015	

11.5.9 Future Trends

152. In the event that the Projects are not developed, an assessment of future conditions for marine mammals has been carried out and is described within this section.

153. The existing baseline conditions for marine mammals are considered to be relatively stable for most species. The baseline environment of the southern North Sea has been influenced by the oil and gas industry since the 1960s, fishing by various methods for hundreds of years and the construction and operation of OWFs for over ten years (Kentish Flats in 2005; Lynn and Inner Dowsing in 2009). The baseline will continue to evolve as a result of global trends which include the effects of climate change.

154. The potential impacts of climate change on marine mammals can be direct, such as the effects of rising sea levels on seal haul-out sites, or species tracking a specific range of water temperatures in which they can physically survive. Indirect effects of climate change include changes in prey resources affecting distribution, abundance and migration patterns, community structure, susceptibility to disease and contaminants. Ultimately, these can impact on the reproductive success and survival of marine mammals and, hence, have consequences for populations (Learmonth *et al.*, 2006; Evans and Waggitt, 2020).

155. As reviewed in BEIS (2022b), significant change has been documented in many aspects of the UK marine environment, likely due to an array of factors including climatic influences, nutrient inputs and anthropogenic factors, such as fishing. These changes include rising sea temperatures, biogeographical shifts in many zooplankton assemblages, with a northward extension of warm-water species, changes in the distribution and abundance of fish species, with southern species becoming more prominent.

11.5.9.1 Harbour Porpoise

156. For harbour porpoise in the North Sea, the latest SCANS-IV survey results show no evidence for trends in abundance since the mid-1990s (Gilles *et al.* 2023).

157. Despite no overall change in population size, large scale changes in the distribution of harbour porpoise were observed between SCANS-I in 1994 and SCANS-II in 2005, with the main concentration shifting from north-eastern UK and Denmark to the southern North Sea. Such large-scale changes in the distribution of harbour porpoise are likely the result of changes to the resources of their principal prey species, such as sandeel, within the North Sea (SCANS-II, 2008).

158. The observed distribution of harbour porpoises from the SCANS-III survey in summer 2016 was similar to that observed in SCANS-II in 2005 (Hammond *et al.*, 2013). Although, one notable difference is that more sightings were made throughout the English Channel (block C) in 2016 than previous surveys (Hammond *et al.*, 2021) and again in block NS-A in 2022 (Gilles *et al.*, 2023). The progressive spread of sightings into most of the Channel over the past three decades indicates that harbour porpoise distribution has expanded, probably from the North Sea and the Celtic Sea, and now encompasses the entire Channel, at least in summer (Gilles *et al.*, 2023).

159. The effects of climate change on harbour porpoise populations are still relatively unknown, however, it is expected that there will be impacts to the population through prey depletion and range shifts. Harbour porpoise habitat and population range is determined from their preferred prey resources, and therefore a change in prey range has the potential to cause a change in the distribution of harbour porpoise (Evans and Bjorge, 2013; Ransijn *et al.*, 2019). As outlined above, a shift southward of harbour porpoise has been noted within the North Sea (Hammond *et al.*, 2021), and it is possible that this was due to a loss of sandeel resources in the northern parts of the North Sea (Evans and Bjorge, 2013).

160. National monitoring in the southern North Sea showed that the seasonal pattern of occurrence has changed. For example, harbour porpoise in the southern part of the North Sea shows a higher abundance in winter and spring and lower abundances in summer (Camphuysen, 2011; Scheidat *et al*., 2012). Recently, this pattern has changed (2012–2017); harbour porpoise abundance increased in summer and abundance and density are now comparable to spring (Geelhoed and Scheidat, 2018, Nachtsheim *et al*., 2021).

161. In the German sector of the North Sea, harbour porpoise abundance has been in decline in summer between 2002 and 2019, as well as local and seasonal differences in trends. (Nachtsheim *et al*., 2021). The underlying causes for the observed trends are unknown but it is suggested that cumulative effects of a number of stressors could be the cause. However, it is acknowledged that there is a lack of data on population trends that could be driven by anthropogenic activities (Nachtsheim *et al*., 2021). Therefore, more research is required to look at harbour porpoise population trends in the wider North Sea as there is little documented on porpoise population trends in the area of interest.

11.5.9.2 Bottlenose Dolphins

162. The observed distribution of bottlenose dolphins in SCANS-III in 2016 was similar to that observed in SCANS-II and Cetacean Offshore Distribution and Abundance in the European Atlantic (CODA) in 2005/07 (Hammond *et al.* 2013, 2021; CODA 2009). The total abundance estimate for SCANS-III in 2016 of 120,500 (CV = 0.165) is considerably greater than that from 2005/07 of 35,900 (CV = 0.21) (Hammond *et al.* 2021; WGMME, 2017). The difference in abundance estimates between 2005/07 and 2016 may reflect bottlenose dolphins responding to spatial variation in prey availability across the wider range (Hammond *et al.* 2021).

163. In SCANS-III there was an increase in predicted densities of bottlenose dolphin off the southwest coast of Britain and northwest coast of Spain since 2005, indicating that the species may be increasing its range northwards over time in response to climate change, warming seas and prey availability. There has been an increasing range expansion of the bottlenose dolphin from the Moray Firth. With an increase in the number of dolphins using areas along the east coast of Scotland, such as St Andrews Bay and the Tay estuary, 300km south of the Moray Firth SAC (Arso Civil *et al.* 2019). There has also been a recent increase in bottlenose dolphins in the north-east of England (Aynsley, 2017), with one individual from the Moray Firth population being recorded as far south as The Netherlands.

164. In the SCANS-IV summer survey in 2022, the population in the East coast Scotland are continuing to show signs of an increase and range expansion (Geelhoed *et al*., 2022, Gilles *et al*., 2023).

165. The Moray Firth population is a regular visitor to the east coast of England during the summer months; and potentially could be evidence of a new population becoming residents in the area, perhaps an expansion of the Moray Firth dolphins ranges (Hackett, 2022). This shift in bottlenose dolphin distribution is most likely due to a change a prey distribution (Hackett, 2022).

11.5.9.3 Common Dolphin

166. SCANS III predicted high densities of common dolphin in the Celtic Sea in 2016, focused on shelf waters off the southwest of England and northwest coast of Spain, and this species is regularly seen around coastal regions of Cornwall. The estimated density areas have shifted northwards over time, with high numbers expected within the Offshore Development Area in 2016 compared to 2005 (Hammond *et al.* 2013, 2021).

167. Between 1994 and 2010 the population in the UK has remained relatively stable. However, there are noted fluctuations on approximately decadal time scales (Paxton *et al.* 2016).

168. Common dolphins prefer a warm temperate or tropical environment (thermophilic) and are noted as having a flexible diet (Marcalo *et al.* 2018). Therefore, it may be expected that this species will move into more northerly regions as sea temperatures rise and prey availability changes at the same time (Williamson *et al.* 2021).

169. In the SCANS IV survey in the summer of 2022, common dolphin were encountered in the North Sea, therefore showing a more northly distribution compared to previous SCANS surveys (Gilles *et al*., 2023).

11.5.9.4 White-Beaked Dolphin

170. The observed distribution of white-beaked dolphin in 2022 (SCANS-IV) is similar to that observed in SCANS-III in 2016, SCANS-II in 2005 and in SCANS-I in 1994 (Hammond *et al.* 2002, 2013, 2021, Gilles *et al.* 2023). The estimate of abundance of white-beaked dolphin in 2022 is very similar to previous surveys, but higher than the revised estimate from SCANS-I in 1994 (Hammond *et al.* 2021).

171. SCANS-IV found no evidence of a trend in abundance of white-beaked dolphin in the North Sea since the mid-1990s (Hammond *et al.* 2021, Gilles *et al*. 2023). A review of the strandings data of white-beaked dolphin in the North Sea were collated and assessed by ASCOBANS (IJsseldijk *et al.*, 2018) in order to determine temporal and spatial trends in the distributions of white-beaked dolphin in the south-western North Sea. Strandings data used within the review were from Belgium, Germany, the Netherlands and the UK, from 1991 to 2017. This review indicates that there has been a reduction in the abundance of white-beaked dolphin in the south-east coasts of the UK, with an increase in the north-east area (IJsseldijk *et al.*, 2018). These changes probably reflect changes in prey distribution as a result of climate change.

172. Around north-west Scotland in the period 1992 to 2003, the relative frequency of stranding of white-beaked dolphin, a colder water species, declined while strandings of common dolphin, a warmer water species, increased. Similarly, sightings surveys in the area also show that the relative occurrence and abundance of white-beaked dolphins have declined, and common dolphins increased in comparison to previous studies. These observations are consistent with changes in the local cetacean community being driven by increases in local water temperature (MacLeod *et al.*, 2005).

11.5.9.5 Minke Whale

173. The abundance estimate of minke whale from SCANS-IV is slightly lower compared to SCANS-III survey, however a trend analysis has shown no support for change in abundance in the North Sea since 1989 (Gilles *et al.*, 2023). However, a decade of acoustic observations in the western North Atlantic have shown important distributional changes over the range of baleen whales, mirroring known climatic shifts (Davies *et al.*, 2020).

11.5.9.6 Grey Seal

174. There has been a continual increase in the total UK grey seal pup production since regular surveys began in the 1960s (SCOS, 2022). Grey seal pup production at colonies in the North Sea increased rapidly with an average 7% annual increase (SCOS, 2022). The majority of the increase in the North Sea has been due to the continued rapid expansion of newer colonies on the mainland coasts in Berwickshire, Lincolnshire, Norfolk and Suffolk. Interestingly, these colonies are all at easily accessible sites on the mainland, where grey seals have probably not bred in significant numbers since before the last ice age (SCOS, 2020).

175. The southern North Sea, the rates of increase in pup production from 2010 to 2014 by an average 22% per year suggests that there must be some immigration from colonies further north (SCOS, 2019). The colonies in the southern North Sea are still increasing in population size, but the rate has been much lower in the last three years, giving an early indication that they may be reaching carrying capacity (SCOS, 2022) as recorded with grey seal populations in other areas such as Orkney (SCOS, 2022).

11.5.9.7 Harbour Seal

176. Overall, the UK population of harbour seal has increased since the late 2000s and is close to the previous high observed during the 1990s (SCOS, 2021). However, there are significant differences in the population dynamics between seal management units, with general declines in counts of harbour seals in several regions around Scotland and more recently in the south-east. Recent trends, i.e. those that incorporate the last 10 years show significant growth in both MUs on the east coast of England up to 2018, but the 2019 count was approximately 27.6% lower than the mean of the previous five years in the SE England MU (SCOS, 2021).

177. The 2019 decrease follows a period when growth rates had decreased to zero, possibly indicating that the population in SE England MU was approaching it carrying capacity, meaning that it may be the first indication of a population decline. Additional surveys in 2020, 2021 and 2022 confirmed the decreased (SCOS, 2022).

178. In The Wash between 2006 and 2012 the counts of harbour seal approximately doubled and increased by 50% for East Anglia as a whole. Since 2012 the counts in these areas have been almost constant. The 2018 count was the second highest ever recorded in The Wash and was consistent with the pattern of relatively stable population since 2010. However, the 2019 count was 27% lower than the 2012 to 2018 mean count (SCOS, 2021). Along the East Anglian coast, the 2018 count was 17% higher than the 2017 count and similar to the average for the preceding five years.

179. This continues the pattern of high inter annual variability (SCOS, 2021). As outlined in SCOS (2021), these wide fluctuations are not unusual in the long-term time series and despite the apparently wide inter-annual variation, the pup production has increased at around 5.6% per year since surveys began in 2001, although the rate of increase may have slowed and may be reaching an asymptote (SCOS, 2021). The count for The Wash and North Norfolk SAC has decreased by approximately 19% over the same time periods, while Donna Nook and Scroby Sands showed a 38% decrease (SCOS, 2022). The harbour seal decline is evident at all sites and appears to have affected all sub-sections of The Wash & North Norfolk SAC (SCOS, 2022).

180. Harbour seal counts in 2019 to 2022 that were carried out during the harbour seal moult, when the highest numbers are hauled out, over all were much lower, indicating a decline of 20 to 30%.

181. It is unsure what factors is driving the decline, but the most likely main drivers could be increased competition with grey seal, anthropogenic activities, disease or toxins or interactions therein (SCOS, 2022). This decline is a clear cause for concern and emergency funding for additional surveys has been provided by Defra. A proposed programme of research to investigate the causes of this decline is being developed (SCOS, 2022).

11.5.9.8 Summary of Future Trends

182. For marine mammals, there are some changes evident as a result of climate change and it is reasonable to expect further such changes in the future and over the lifetime of the Projects. However, the latest changes in population distribution and abundance have been taken into account in the assessments that have been undertaken.

11.6 Assessment of Significance

11.6.1 Potential Effects During Construction

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

- Impact 1: Permanent and temporary auditory injury from underwater noise during piling;
- Impact 2: Disturbance or behavioural effects from underwater noise during piling;
- Impact 3: TTS and disturbance from underwater noise during other construction activities, including seabed preparations, cable installation and rock placement;
- Impact 4: TTS and disturbance from underwater noise and presence of vessels;
- Impact 5: Barrier effects as a result of underwater noise during construction;
- Impact 6: Increased collision risk with vessels during construction;
- Impact 7: Changes to prey resources;
- Impact 8: Changes to water quality; and
- Impact 9: Disturbance of seals at haul-out sites.

184. The realistic worst-case scenarios on which the assessments are based are outlined in **Table 11-1**.

185. UXO clearance is not secured under the DCO application, and a separate Marine Licence would be submitted following a detailed UXO survey prior to construction, and a detailed assessment based on that latest available information (including potential UXO locations, size, type, and number) has been undertaken. An indicative assessment has been provided in **Volume 7, Appendix 11-6 UXO Marine Mammal Impact Assessment (application ref: 7.11.11.6)** to illustrate the potential effects and mitigation measures have been considered in the **Volume 8, Outline MMMP (application ref: 8.25)**.

11.6.1.1 Impact 1: Permanent and Temporary Auditory Injury from Underwater Noise During Piling

186. A range of foundation options are being considered for the DBS Projects, including monopiles and, jackets (with pin piles) for foundations within the Array Areas, and additionally gravity bases for the potential platform foundation within the Offshore Export Cable Corridor (see section 11.3.2 and **Volume 7, Chapter 5 Project Description (application ref: 7.5)**). Of these, monopiles and jackets (with pin piles) may require piling. As a worst-case scenario for underwater noise, it has been assumed that all foundations would be piled which is considered precautionary as lower impact drive-drill-drive or alternative installation may be used, which would result in less potential impacts to marine mammals due to the noise source being continuous rather than impulsive and being significantly quieter compared to impact piling.

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

188. Should a marine mammal be very close to the source, the high peak pressure sound levels have the potential to cause death or 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). 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.

189. 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.

11.6.1.1.1 Underwater Noise Modelling

190. Underwater noise modelling was undertaken by Subacoustech Environmental Ltd to estimate the noise levels likely to arise during noisy activities (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) and determine the potential effects on marine mammals.

191. Underwater noise modelling was undertaken against the currently recommended marine mammal injury thresholds presented in Southall *et al.* (2019).

192. The worst-case locations for piling (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3**)) representing the maximum spatial extent were used for the impact assessment, these are;

- DBS East – south location;
- DBS West – west location; and
- Offshore Export Cable Corridor - northeast location.

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

193. PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SPL_{peak}) of the maximum hammer energy applied during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as for the duration of pile installation (SEL_{cum}).

11.6.1.1.2.1 Magnitude of Impact – DBS East or DBS West In Isolation

11.6.1.1.2.1.1 PTS from a single strike

194. The modelling results for the potential for PTS due to a single strike at the maximum hammer energy are provided in **Volume 7**, **Appendix 11-3 (application ref: 7.11.11.3)**.

195. The potential for PTS due to a single strike at the starting hammer energy (of 450kJ and 900kJ for monopiles and jacket pin piles respectively), as well as at the maximum hammer energy, will inform the final MMMP for piling; of which an **Volume 8, Outline MMMP (application ref: 8.25)** has been submitted with the DCO application.

196. **Table 11-21** present 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 at each Project. The potential effect range for PTS from a single strike is highest for harbour porpoise for both monopiles and jacket pin piles, with a maximum potential PTS range of 830m and 670m respectively, for the Offshore Export Cable Corridor.

Table 11-21 The Predicted Effect Ranges for PTS in all Marine Mammal Species, at the Worst Case Modelling Location, from a single strike of the Maximum Hammer Energies of both Monopiles and Pin Piles

Marine mammal species	Location	Potential effect ranges (and areas) for PTS from a single strike at the maximum hammer energy	
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
Harbour porpoise	DBS East	740m (1.7km^2)	600m (1.1km^2)
	DBS West	720m 1.6km^2)	580m (1.0km^2)
	Offshore Export Cable Corridor	830m (2.1km^2)	670m (1.4km^2)
Dolphin species	DBS East	<50m (<0.01km^2)	<50m (<0.01km^2)
	DBS West		
	Offshore Export Cable Corridor		
Minke whale	DBS East	<50m (<0.01km^2)	<50m (<0.01km^2)
	DBS West		
	Offshore Export Cable Corridor		
Seal species	DBS East	60m (<0.01km^2)	<50m (<0.01km^2)
	DBS West		
	Offshore Export Cable Corridor		

197. 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 11-22**. Densities used in **Table 11-22** are based on the worst case for each species from across the Array Areas and the Offshore Export Cable Corridor. The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

198. The magnitude of the potential impact is assessed as negligible adverse for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, for a single strike of both monopiles and jacket pin piles (**Table 11-22**).

Table 11-22 Assessment of the Potential for Instantaneous PTS Due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (permanent)
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	1.0 (0.0003% of the NS MU)	Negligible
	DBS West	1.1 (0.0003% of the NS MU)	
	Offshore Export Cable Corridor	1.4 (0.0004% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0004 (0.00002% of the GNS MU)	Negligible
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0002 (0.0000002% of the CGNS MU)	Negligible
White-beaked Dolphin	DBS East	0.0003 (0.0000008% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	0.0004 (0.0000009% of the CGNS MU)	
Minke whale	DBS East	0.0001 (0.0000005% of the CGNS MU)	Negligible

Marine mammal species	**Location**	**Assessment of impact (number of individuals and % of reference population)**	**Magnitude of impact* (permanent)**
	DBS West or Offshore Export Cable Corridor	0.0002 (0.000001% of the CGNS MU)	
Grey seal	DBS East	0.002 (0.000006% of the SE England MU &0.000003% of the wider MU)	Negligible (negligible)
	DBS West	0.003 (0.000009% of the SE England MU & 0.000005% of the wider MU)	
	Offshore Export Cable Corridor	0.005 (0.00002% of the SE England MU & 0.000009% of the wider MU)	
Harbour seal	DBS East	0.00002 (0.0000003% of the SE England MU)	Negligible
	DBS West	0.00001 (0.0000002% of the SE England MU)	
	Offshore Export Cable Corridor	0.00002 (0.0000003% of the SE England 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)	Negligible
	DBS West	0.7 (0.0002% of the NS MU)	
	Offshore Export Cable Corridor	0.7 (0.0002% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0004 (0.00002% of the GNS MU)	Negligible
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0002 (0.0000002% of the CGNS MU)	Negligible
White-beaked	DBS East	0.0003 (0.0000008% of the CGNS MU)	Negligible

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (permanent)
Dolphin	DBS West or Offshore Export Cable Corridor	0.0004 (0.0000009% of the CGNS MU)	
Minke whale	DBS East	0.0001 (0.0000005% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	0.0002 (0.000001% of the CGNS MU	
Grey seal	DBS East	0.002 (0.000006% of the SE England MU & 0.000003% of the wider MU)	Negligible (negligible)
	DBS West	0.003 (0.000009% of the SE England MU & 0.000005% of the wider MU)	
	Offshore Export Cable Corridor	0.005 (0.00002% of the SE England MU & 0.000009% of the wider MU)	
Harbour seal	DBS East	0.00002 (0.0000003% of the SE England MU)	Negligible
	DBS West	0.00001 (0.0000002% of the SE England MU)	
	Offshore Export Cable Corridor	0.00002 (0.0000003% of the SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.2.1.2 PTS from Cumulative Exposure from a Single Piling Location

199. 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).

200. **Table 11-23** 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.

201. The potential effect range for cumulative PTS exposure is highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative PTS range of 26km and 19km respectively for the DBS West Array Area, for a single pile in a 24-hour period. The potential effect range for cumulative PTS exposure, for multiple piles in a 24-hour period (i.e. sequential piling), is also highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative PTS range of 26km and 20km respectively for the DBS West Array Area.

202. 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, than has been assumed in the modelling.

Table 11-23 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 Jacket Pin Piles for the Projects in isolation

Marine mammal species	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**
Harbour porpoise	DBS East	10km (240km^2)	7.2km (130km^2)
	DBS West	9.0km (200km^2)	6.3km (100km^2)
	Offshore Export Cable Corridor	13km (510km^2)	9.5km (260km^2)
Dolphin species	DBS East, DBS West or Offshore Export Cable Corridor	0.1km (0.01km^2)	< 0.1km (0.1km^2)
Minke whale	DBS East	18km (560km^2)	13km (290km^2)
	DBS West	16km (460km^2)	11km (220km^2)
	Offshore Export Cable Corridor	26km (1500km^2)	19km (850km^2)

Marine mammal species	Location	Potential effect ranges (and areas) for PTS due to cumulative exposure	
		Monopile (6,000kJ)	**Jacket pin pile (3,000kJ)**
Seal species	DBS East	1.6km (6.2km^2)	0.75km (1.3km^2)
	DBS West	1.3km (4.3km^2)	0.58km (0.8km^2)
	Offshore Export Cable Corridor	2.7km (20km^2)	1.5km (6.6km^2)
Cumulative exposure from multiple sequential pile installations in 24 hours		**Two sequential monopiles in the Array Areas**	**Four sequential jacket pin piles**
Harbour porpoise	DBS East	11km (250km^2)	7.9km (140km^2)
	DBS West	9.3km (200km^2)	6.9km (110km^2)
	Offshore Export Cable Corridor	-	11km (320km^2)
Dolphin species	DBS East, DBS West or Offshore Export Cable Corridor	< 0.1km (0.1km^2)	< 0.1km (0.1km^2)
Minke whale	DBS East	18km (570km^2)	13km (300km^2)
	DBS West	16km (470km^2)	11km (240km^2)
	Offshore Export Cable Corridor	-	20km (920km^2)
Seal species	DBS East	1.6km (6.4km^2)	0.88km (1.7km^2)
	DBS West	1.3km (4.5km^2)	0.63km (1.0km^2)
	Offshore Export Cable Corridor	-	1.9km (9.6km^2)

203. An assessment of the maximum number of individuals that could be at risk of cumulative PTS, for both sequential monopiles and jacket pin piles, is presented in **Table 11-24**, based on the effect areas as presented in **Table 11-23**. Only the worst-case ranges have been fully assessed in **Table 11-24** below, and therefore the assessments for cumulative exposure are based on multiple sequential pile installations. The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

204. The magnitude of the potential impact (without any mitigation) is assessed, for either DBS East or DBS West, as negligible for bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal, and as medium for minke whale and harbour porpoise for both sequential monopiles and jacket pin piles (**Table 11-24**). For grey seal, the magnitude for sequential monopiles has been assessed as low to medium, and for sequential jacket pin piles is negligible to medium.

Table 11-24 Assessment of the Potential for PTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period

Marine mammal species	**Location**	**Assessment of impact (number of individuals and % of reference population)**	**Magnitude of impact* (permanent)**
PTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum}) in the Array Areas and one in the Offshore Export Cable Corridor			
Harbour porpoise	DBS East	144.0 (0.04% of the NS MU)	Medium
	DBS West	132.0 (0.04% of the NS MU)	
	Offshore Export Cable Corridor	336.6 (0.097% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.004 (0.00002% of the GNS MU)	Negligible
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.002 (0.000002% of the CGNS MU	Negligible
White-beaked dolphin	DBS East	0.003 (0.000008% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	0.004 (0.000009% of the CGNS MU)	
Minke whale	DBS East	5.6 (0.03% of the CGNS MU)	Medium
	DBS West	9.4 (0.05% of the CGNS MU)	

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (permanent)
	Offshore Export Cable Corridor	30.0 (0.149% of the CGNS MU)	
Grey seal	DBS East	1.1 (0.004% of the SE England MU & 0.002% of the wider MU)	Low (Low)
	DBS West	1.2 (0.004% of the SE England MU & 0.002% of the wider MU)	
	Offshore Export Cable Corridor	10.6 (0.034% of the SE England MU & 0.018% of the wider MU)	Medium (Medium)
Harbour seal	DBS East	0.01 (0.0002% of the SE England MU)	Negligible
	DBS West	0.005 (0.00009% of the SE England MU)	
	Offshore Export Cable Corridor	0.03 (0.0007% of the SE England MU)	
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})			
Harbour porpoise	DBS East	84.0 (0.02% of the NS MU)	Medium
	DBS West	72.6 (0.02% of the NS MU)	
	Offshore Export Cable Corridor	211.2 (0.06% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.004 (0.0002% of the GNS)	Negligible
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.002 (0.000002% of the CGNS MU	Negligible
White-beaked dolphin	DBS East	0.003 (0.000008% of the CGNS MU)	Negligible

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (permanent)
	DBS West or Offshore Export Cable Corridor	0.004 (0.000009% of the CGNS MU)	
Minke whale	DBS East	3.0 (0.015% of the CGNS MU)	Medium
	DBS West	4.8 (0.02% of the CGNS)	
	Offshore Export Cable Corridor	18.4 (0.09% of the CGNS MU)	
Grey seal	DBS East	0.3 (0.001% of the SE England MU & 0.0005% of the wider MU)	Low (Negligible)
	DBS West	0.3 (0.0008% of the SE England MU & 0.0004% of the wider MU)	Negligible (Negligible)
	Offshore Export Cable Corridor	5.1 (0.02% of the SE England MU & 0.009% of the wider MU)	Medium (Low)
Harbour seal	DBS East	0.003 (0.00006% of the SE England MU)	Negligible
	DBS West	0.001 (0.00002% of the SE England MU)	
	Offshore Export Cable Corridor	0.02 (0.0003% of the SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.2.2 Magnitude of Impact – DBS East and DBS West Together

205. As outlined in section 11.3.2, there is the potential that the Projects could be constructed sequentially or concurrently. As such, piling may occur at both Array Areas concurrently during either Development Scenario. Therefore, the worst-case for the Projects being developed concurrently has been assessed, based on piling at the two sites at the same time for the longest duration.

11.6.1.1.2.2.1 PTS from a Single Strike

206. The maximum predicted impact range for instantaneous PTS from a single strike of monopile or pin pile, with maximum hammer energy without any mitigation, is up to 830m for harbour porpoise for the monopile worst-case with a maximum hammer energy of 6,000kJ (**Table 11-21**). Therefore, there would be no overlap in PTS ranges between the two Projects due to distance between the Projects, and the assessments presented for the DBS Projects in isolation are appropriate.

207. The magnitude of the potential impact for instantaneous PTS from single strike of the maximum hammer energy without any mitigation, at DBS East and West together, is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 0.001% or less of the relevant reference populations anticipated to be exposed to any permanent effect (**Table 11-25**).

Table 11-25 Assessment of the Potential for Instantaneous PTS due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile at DBS East and DBS West Together

Marine mammal species	Scenario	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (permanent)
PTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East and DBS West concurrently	2.1 (0.0006% of the NS MU)	Negligible
Bottlenose dolphin	DBS East and DBS West concurrently	0.0008 (0.00004% of the GNS MU)	Negligible
Common dolphin	DBS East and DBS West concurrently	0.0004 (0.0000004% of the CGNS MU)	Negligible
White-beaked Dolphin	DBS East and DBS West concurrently	0.0007 (0.000002% of the CGNS MU)	Negligible
Minke whale	DBS East and DBS West concurrently	0.0003 (0.000001% of the CGNS MU)	Negligible
Grey seal	DBS East and DBS West concurrently	0.005 (0.00002% of the SE England MU & 0.000009% of the wider MU)	Negligible (negligible)
Harbour seal	DBS East and DBS West concurrently	0.00003 (0.0000006% of the SE England MU)	Negligible

Marine mammal species	Scenario	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (permanent)
PTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East, DBS West and Offshore Export Cable Corridor concurrently	2.1 (0.0006% of the NS MU)	Negligible
Bottlenose dolphin	DBS East, DBS West and Offshore Export Cable Corridor concurrently	0.001 (0.00005% of the GNS MU)	Negligible
Common dolphin	DBS East, DBS West and Offshore Export Cable Corridor concurrently	0.0006 (0.0000006% of the CGNS MU)	Negligible
White-beaked dolphin	DBS East, DBS West and Offshore Export Cable Corridor concurrently	0.001 (0.000002% of the CGNS MU)	Negligible
Minke whale	DBS East, DBS West and Offshore Export Cable Corridor concurrently	0.0005 (0.000002% of the CGNS MU)	Negligible
Grey seal	DBS East, DBS West and Offshore Export Cable Corridor concurrently	0.001 (0.000003% of the SE England MU & 0.000002% of the wider MU)	Negligible (Negligible)
Harbour seal	DBS East, DBS West and Offshore Export Cable Corridor concurrently	0.00005 (0.000001% of the SE England MU)	Negligible

* *Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.2.2.2 PTS from Cumulative Exposure from Multiple Piling Locations

208. 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 while piling is ongoing), and 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.

209. 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.

210. 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 (i.e. the results of the modelling for the DBS East, DBS West and the Offshore Export Cable Corridor locations are totalled to inform the assessment, to align with the modelling locations used for the concurrent modelling).

211. **Table 11-26** presents the underwater noise modelling results for the predicted effect ranges and areas for PTS due to the cumulative exposure of concurrent monopiles and jacket pin piles at the DBS East, DBS West and the Offshore Export Cable Corridor. Within the modelling, the worst-case locations were chosen as they have the potential for the largest 'spread' in terms of underwater noise propagation, and therefore the results presented in this assessment are for an absolute worst-case scenario. The modelling includes:

- Two x two simultaneous monopile installations totalling a maximum of four in 24 hours; and
- Four x three simultaneous jacket pin pile installations totalling a maximum of twelve in 24 hours.

212. Underwater noise modelling has been carried out for concurrent and sequential piling, as described above, which is based on a worst-case of:

- DBS East: S location and DBS West: W location for two concurrent monopile foundations (two installed sequentially at each location, for a total of four monopiles in a 24-hour period); and

- DBS East: S location, DBS West: W location, and Offshore Export Cable Corridor search area: NE location for three concurrent multi-leg foundations (four installed sequentially at each location, for a total of 12 jacket pin piles in a 24-hour period).

213. The potential effect range for PTS is highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative PTS effect area of 6,500km^2 for multiple concurrent jacket pin piles (**Table 11-26**).

214. For harbour porpoise, seal species, and minke whale, the cumulative PTS is significantly higher for concurrent piling that it is for a single piling location at any one time, however, for dolphin species, the potential PTS ranges are significantly smaller, and do not interact with each other where there are concurrent piling events at the same time (**Table 11-26**).

215. The results of the modelling for concurrent and sequential piling, for both monopiles and jacket pin piles, are used for the assessments for all marine mammal species (**Table 11-26**).

Table 11-26 Summary of the Impact Areas for the Concurrent Installation of Monopile and 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.

Monopile foundation [two sequential at each location] **Southall *et al.* (2019)** **Weighted SEL_{cum}**		**Area of PTS onset for sequential and concurrent pile installations (km^2)**	
		PTS from two concurrent monopile installations (two sequential at DBS East at the same time as two sequential at DBS West)	**PTS from two concurrent jacket 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)**
PTS (Impulsive)	LF (183 dB)	2,400km^2	6,500km^2
	HF (185 dB)*	0.2km^2	0.3km^2
	VHF (155 dB)	1,400km^2	3,700km^2
	PCW (185 dB)	230km^2	240km^2

** For the HF species group (bottlenose dolphins), PTS onset ranges do not overlap for concurrent piling, and therefore the assessment is based on the sum of PTS onset at each location separately*

216. An assessment of the maximum number of individuals that could be at risk of cumulative PTS, for concurrent monopiles and jacket pin piles is presented in **Table 11-27**, based on the effect areas as presented in **Table 11-26**. The assessment for the worst case density for each species from DBS East Array Area, DBS West Array Area or the Offshore Export Cable Corridor has been used.

217. The magnitude of the potential impact (without any mitigation) is assessed as medium for harbour porpoise, minke whale and grey seal, as negligible for bottlenose dolphin, common dolphin and white-beaked dolphin, and as low for harbour seal for both concurrent monopile and jacket pin pile installations at DBS East and DBS West together (**Table 11-27**).

Table 11-27 Assessment of the Potential for PTS due to the Cumulative Exposure of two concurrent Monopiles or four concurrent Jacket Pin Piles at DBS East and DBS West

Marine mammal species	Potential effect areas for PTS due to cumulative exposure of concurrent pile installations			
	Monopile (6,000kJ)		Jacket pin pile (3,000kJ)	
	Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)	Magnitude* (permanent)	Three concurrent jacket pin piles at DBS East, DBS West, and Offshore Export Cable Corridor, with four sequential jacket pin piles at each location (total of 12 jacket pin piles installed in one day)	Magnitude* (permanent)
Harbour porpoise	942.0 (0.27% of the NS MU)	Medium	2,442.0 (0.70% of the NS MU)	Medium
Bottlenose dolphin	0.008 (0.0004% of the GNS MU)	Negligible	0.01 (0.0006% of the GNS MU)	Negligible
Common dolphin	0.003 (0.000003% of the CGNS MU)	Negligible	0.005 (0.000005% of the CGNS MU)	Negligible
White-beaked dolphin	0.008 (0.00002% of the CGNS MU)	Negligible	0.01 (0.00003% of the CGNS MU)	Negligible
Minke whale	48.0 (0.24% of the CGNS MU)	Medium	130 (0.65% of the CGNS MU)	Medium

Marine mammal species	Potential effect areas for PTS due to cumulative exposure of concurrent pile installations			
	Monopile (6,000kJ)		Jacket pin pile (3,000kJ)	
	Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)	Magnitude* (permanent)	Three concurrent jacket pin piles at DBS East, DBS West, and Offshore Export Cable Corridor, with four sequential jacket pin piles at each location (total of 12 jacket pin piles installed in one day)	Magnitude* (permanent)
Grey Seal	59.8 (0.20% of the SE England MU & 0.11 of the wider MU)	Medium (Medium)	127.4 (0.42% of the SE England MU & 0.23% of the wider MU)	Medium (Medium)
Harbour seal	0.4 (0.008% of the SE England MU)	Low	0.4 (0.008% of the SE England MU)	Low

* *Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.3 Impact 1b: Temporary Auditory Injury (TTS) due to Impact Piling

218. TTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SPL_{peak}) of the maximum hammer energy applied during piling. TTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

11.6.1.1.3.1 Magnitude of Impact – DBS East or DBS West In Isolation

11.6.1.1.3.1.1 TTS from a Single Strike

219. **Table 11-28** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS from a single strike of the maximum hammer energy, for the worst case location of DBS East, DBS West and the Offshore Export Cable Corridor, for both monopiles and jacket pin piles.

220. The potential effect range for TTS is highest for harbour porpoise for both monopiles and jacket pin piles, with a potential TTS range of 2.1km and 1.8km for the Offshore Export Cable Corridor and 1.9km and 1.5km respectively for DBS East.

Table 11-28 Predicted Effect Ranges for TTS in All Marine Mammal Species, at the Worst Case Modelling Location, for a Single Strike from the Maximum Hammer Energies of Both Monopiles and Pin Piles

Marine mammal species	Location	Potential effect ranges (and areas) for TTS from a single strike at the maximum hammer energy	
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
Harbour porpoise	DBS East	1.9km (11km^2)	1.5km (7.1km^2)
	DBS West	1.8km (9.8km^2)	1.5km (6.5km^2)
	Offshore Export Cable Corridor	2.1km (14 km^2)	1.8km (9.6km^2)
Dolphin species	DBS East, DBS West and Offshore Export Cable Corridor	<0.05km (0.01km^2)	<0.05km (<0.01km^2)

Marine mammal species	Location	Potential effect ranges (and areas) for TTS from a single strike at the maximum hammer energy	
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
Minke whale	DBS East or DBS West	0.13km (0.05km^2)	0.1km (0.03km^2)
	Offshore Export Cable Corridor	0.14km (0.06km^2)	0.11km (0.04km^2)
Seal species	DBS East or DBS West	0.15km (0.07km^2)	0.12km (0.05km^2)
	Offshore Export Cable Corridor	0.16km (0.08km^2)	0.13km (0.05km^2)

221. An assessment of the maximum number of individuals that could be at risk of instantaneous TTS, due to a single strike at the maximum hammer energy, for both monopiles and jacket pin piles, is presented in **Table 11-29**, based on the effect areas as presented in **Table 11-28**.

222. Densities used in **Table 11-29** are based on the worst case for each species from across the Array Areas, and the Offshore Export Cable Corridor. The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

223. The magnitude of the potential impact (without any mitigation) is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal for either monopile or jacket pin piles (**Table 11-29**).

Table 11-29 Assessment of the Potential for Instantaneous TTS Due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
TTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	6.6 (0.002% of the NS MU	Negligible
	DBS West	6.5 (0.002% of the NS MU)	
	Offshore Export Cable Corridor	9.1 (0.003% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0004 (0.00002% of the GNS MU)	Negligible
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0002 (0.0000002% of the CGNS MU)	Negligible
White-beaked dolphin	DBS East	0.0003 (0.0000008% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	0.0004 (0.0000009% of the CGNS MU)	
Minke whale	DBS East	0.0005 (0.000003% of the CGNS MU)	Negligible
	DBS West	0.001 (0.000005% of the CGNS MU)	
	Offshore Export Cable Corridor	0.0012 (0.000006% of the CGNS MU)	Negligible
Grey seal	DBS East	0.01 (0.00004% of the SE England MU & 0.00002% of the wider MU)	Negligible (negligible)
	DBS West	0.2 (0.0006% of the SE England MU & 0.0003% of the wider MU)	
	Offshore Export Cable Corridor	0.04 (0.0001% of the SE England MU & 0.00008% of the wider MU)	

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
Harbour seal	DBS East	0.0001 (0.000002% of the SE England MU)	Negligible
	DBS West	0.0007 (0.00001% of the SE England MU)	
	Offshore Export Cable Corridor	0.0001 (0.000003% of the SE England MU)	
TTS due to a single strike of a jacket pin pile at maximum hammer energy (SPL_{peak})			
Harbour porpoise	DBS East	4.3 (0.001% of the NS MU)	Negligible
	DBS West	4.3 (0.001% of the NS MU)	
	Offshore Export Cable Corridor	6.3 (0.002% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0004 (0.00002% of the GNS MU)	Negligible
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.0002 (0.0000002% of the CGNS MU)	Negligible
White-beaked Dolphin	DBS East	0.0003 (0.0000008% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	0.0004 (0.0000009% of the CGNS MU)	
Minke whale	DBS East	0.0003 (0.000002% of the CGNS MU)	Negligible
	DBS West	0.0006 (0.000003% of the CGNS MU)	
	Offshore Export Cable Corridor	0.0008 (0.000005% of the CGNS MU)	
Grey seal	DBS East	0.009 (0.00003% of the SE England MU & 0.00002% of the wider MU)	Negligible (negligible)

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
	DBS West	0.01 (0.00003% of the SE England MU & 0.00002% of the wider MU)	
	Offshore Export Cable Corridor	0.03 (0.00009% of the SE England MU & 0.00005% of the wider MU)	
Harbour seal	DBS East	0.00009 (0.000002% of the SE England MU)	Negligible
	DBS West	0.00004 (0.0000008% of the SE England MU)	
	Offshore Export Cable Corridor	0.00009 (0.000002% of the SE England MU	

* *Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.3.1.2 TTS from Cumulative Exposure from a Single Piling Location

224. As outlined for PTS from cumulative exposure, the cumulative exposure ranges indicate the distance that an individual would need to be from the noise source at the start of the piling sequence to prevent a cumulative noise exposure which could lead to TTS. This is highly conservative as the assessment assumes the worst case exposure levels for an animal in the water column, and does not take account of periods where exposure will be reduced, for example in seals when their heads are out of the water; or that the cumulative noise dose received by the marine mammal will be largely dependent on the swimming speed, and whether the animal moves away from the noise source rapidly as a flee response. The cumulative SEL dose does not take account of these factors and therefore is likely to overestimate the received noise levels.

225. **Table 11-30** presents the underwater noise modelling results for the predicted effect ranges, and areas for TTS due to the cumulative exposure of monopiles and jacket pin piles at the worst case location of DBS East, DBS West and the Offshore Export Cable Corridor. The potential effect range for TTS is highest for minke whale at the Offshore Export Cable Corridor, with a potential cumulative range of 93km for monopiles and 79km for pin piles for single pile installations. For sequential piles, the highest TTS ranges are also for minke whale at the Offshore Export Cable Corridor location, with potential cumulative TTS range of 94km and 85km both sequential monopiles and jacket pin piles respectively.

226. The assessment for TTS from cumulative exposure is highly precautionary, and 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)**). For example, for harbour porpoise, the TTS effect range for two sequential monopile installations is 65km at the northeast location of the Offshore Export Cable Corridor (worst case) 52km at DBS West location, and 49km at DBS East. 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.

Table 11-30 Predicted Effect Ranges for TTS in All Marine Mammal Species, at the Worst Case Modelling Location, for the Cumulative Exposure of both Monopiles and Pin Piles

Marine mammal species	Location	Potential effect ranges (and areas) for TTS due to cumulative exposure	
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
Cumulative exposure from a single pile installation in 24 hours		**One monopile**	**One jacket pin pile**
Harbour porpoise	DBS East	47km (3,700km^2)	39km (2,700km^2)
	DBS West	48km (3,800km^2)	39km (2,700km^2)
	Offshore Export Cable Corridor	61km (8,100km^2)	51km (6,000km^2)
Dolphin species	DBS East	1.1km (3.2km^2)	0.28km (0.2km^2)
	DBS West	0.95 km (2.3km^2)	0.2km (0.1km^2)
	Offshore Export Cable Corridor	1.9 km (10km^2)	0.7km (1.4km^2)
Minke whale	DBS East	67km (6,500km^2)	58km (5,000km^2)

Marine mammal species	Location	Potential effect ranges (and areas) for TTS due to cumulative exposure	
		Monopile (6,000kJ)	Jacket pin pile (3,000kJ)
	DBS West	74km (8,000km²)	63km (5,800km²)
	Offshore Export Cable Corridor	93km (14,000km²)	79km (12,000km²)
Seal species	DBS East	28km (1,400km²)	24km (1,000km²)
	DBS West	25km (1,200km²)	21km (870km²)
	Offshore Export Cable Corridor	38km (3,500km²)	32km (2,500km²)
Cumulative exposure from multiple sequential pile installations in 24 hours		**Two sequential monopiles in the Array Area**	**Four sequential jacket pin piles**
Harbour porpoise	DBS East	49km (3,800km²)	44km (3,100km²)
	DBS West	52km (4,200km²)	46km (3,300km²)
	Offshore Export Cable Corridor	-	59km (7,200km²)
Dolphin species	DBS East	1.2km (3.3km²)	0.33km (0.2km²)
	DBS West	0.95km (2.4km²)	0.23km (0.1km²)
	Offshore Export Cable Corridor	-	0.8km (1.8km²)
Minke whale	DBS East	68km (6,500km²)	60km (5,200km²)
	DBS West	75km (8,100km²)	67km (6,200km²)
	Offshore Export Cable Corridor	-	85km (12,000km²)
Seal species	DBS East	30km (1,500km²)	28km (1,300km²)
	DBS West	28km (1,400km²)	26km (1,200km²)
	Offshore Export Cable Corridor	-	40km (3,500 km²)

227. The assessments for TTS from cumulative exposure is based on two sequential monopiles and four sequential pin piles in a 24-hour period, as the worst case.

228. An assessment of the maximum number of individuals that could be at risk of cumulative TTS, for both sequential monopiles and jacket pin piles, is presented in **Table 11-31**, based on the effect areas as presented in **Table 11-30**. The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

229. The magnitude of the potential impact (without any mitigation) is assessed as negligible for bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal for both monopiles and jacket pin piles for both Projects. For harbour porpoise and minke whale, the magnitude of impact due to sequential monopile installations or sequential jacket pin pile installations is negligible at both DBS East and DBS West, and low for the Offshore Export Cable Corridor (**Table 11-31**).

230. The magnitude of the potential impact (without any mitigation) for grey seal is assessed as negligible to low for DBS East and DBS West, and as low to medium for the Offshore Export Cable Corridor, for both sequential monopiles and jacket pin piles (**Table 11-31**).

Table 11-31 Assessment of the Potential for TTS due to the Cumulative Exposure of Sequential Monopiles or Jacket Pin Piles in a 24 Hour Period

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
TTS due to the cumulative exposure of two sequential monopiles in a 24 hour period (SEL_{cum}) in the Array Areas and one monopile in the Offshore Export Cable Corridor			
Harbour porpoise	DBS East	2,280.0 (0.66 % of the NS MU)	Negligible
	DBS West	2,772.0 (0.80% of the NS)	
	Offshore Export Cable Corridor	5,346.0 (1.542% of the NS MU)	Low
Bottlenose dolphin	DBS East	0.14 (0.007% of the GNS MU)	Negligible
	DBS West	0.1 (0.005% of the GNS MU)	
	Offshore Export Cable Corridor	0.4 (0.02% of the GNS MU)	

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
Common dolphin	DBS East	0.06 (0.00005% of the CGNS MU)	Negligible
	DBS West	0.04 (0.00004% of the CGNS MU)	
	Offshore Export Cable Corridor	0.2 (0.0002% of the CGNS MU)	
White-beaked dolphin	DBS East	0.1 (0.0003% of the CGNS MU)	Negligible
	DBS West	0.1 (0.0002% of the CGNS MU)	
	Offshore Export Cable Corridor	0.4 (0.0009% of the CGNS MU)	
Minke whale	DBS East	65.0 (0.32% of the CGNS MU)	Negligible
	DBS West	162 (0.81% of the CGNS MU)	
	Offshore Export Cable Corridor	280.0 (1.39% of the CGNS MU)	Low
Grey seal	DBS East	271.5 (0.89% of the SE England MU & 0.48% of the wider MU)	Negligible (Negligible)
	DBS West	364.0 (1.19% of the SE England & 0.64% of the wider reference MU)	Low (negligible)
	Offshore Export Cable Corridor	1,858.5 (6.07% of the SE England MU & 3.28% of the wider MU)	Medium (Low)
Harbour seal	DBS East	2.6 (0.05% of the SE England MU)	Negligible
	DBS West	1.4 (0.03% of the SE England MU)	
	Offshore Export Cable Corridor	6.0 (0.12% of the SE England MU)	

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
TTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period (SEL_{cum})			
Harbour porpoise	DBS East	2,046.0 (0.59% of the NS MU)	Negligible
	DBS West	2,178.0 (0.63% of the NS MU)	
	Offshore Export Cable Corridor	4,752.0 (1.25 % of the NS MU)	Low
Bottlenose dolphin	DBS East	0.008 (0.0004% of the GNS MU)	Negligible
	DBS West	0.004 (0.0002% of the GNS)	
	Offshore Export Cable Corridor	0.08 (0.004% of the GNS MU)	
Common dolphin	DBS East	0.003 (0.000003% of the CGNS MU)	Negligible
	DBS West	0.002 (0.000003% of the CGNS MU)	
	Offshore Export Cable Corridor	0.03 (0.0000293% of the CGNS MU)	
White-beaked dolphin	DBS East	0.007 (0.00002% of the CGNS MU)	Negligible
	DBS West	0.004 (0.00009% of the CGNS MU)	
	Offshore Export Cable Corridor	0.07 (0.0002% of the CGNS MU)	
Minke whale	DBS East	52.0 (0.26% of the CGNS MU)	Negligible
	DBS West	124.0 (0.62% of the CGNS MU)	
	Offshore Export Cable Corridor	240.0 (1.19% of the CGNS MU)	Low

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
Grey seal	DBS East	235.3 (0.77% of the SE England MU & 0.42% of the wider MU).	Negligible (Negligible)
	DBS West	312.0 (1.02% of the SE England MU & 0.55% of the wider MU)	Low (Negligible)
	Offshore Export Cable Corridor	1,858.5 (6.08% of the SE England MU & 3.29% of the wider MU)	Medium (Low)
Harbour seal	DBS East	2.2 (0.05% of the SE England MU)	Negligible
	DBS West	1.2 (0.02% of the SE England MU)	
	Offshore Export Cable Corridor	6.0 (0.12% of the SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.3.2 Magnitude of Impact – DBS East and DBS West Together

11.6.1.1.3.2.1 TTS From a Single Strike

231. The maximum predicted impact range for TTS from a single strike of monopile or pin pile, with the maximum hammer energy and without any mitigation, is up to 1.9km for harbour porpoise for the monopile worst-case with a maximum hammer energy of 6,000kJ (**Table 11-28**). Therefore, there would be no overlap between the TTS ranges across the two Projects due to the distance between DBS East and DBS West.

232. As a worst-case, the maximum number of marine mammals from each Project have been combined to indicate the maximum number of marine mammals that could be impacted from DBS East and DBS West together, if they are developed concurrently (**Table 11-32**).

233. The magnitude of the potential impact for instantaneous TTS from a single strike of monopile or jacket pin pile with maximum hammer energy without any mitigation at DBS East and West together is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 1% or less of the relevant reference populations anticipated to be exposed to any temporary effect (**Table 11-32**).

Table 11-32 Assessment of the Potential for Instantaneous TTS due to a Single Strike of the Maximum Hammer Energy for a Monopile and Jacket Pin Pile at DBS East and DBS West Together, at the worst location across the Array Areas

Marine mammal species	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
TTS due to a single strike of a monopile at maximum hammer energy (SPL_{peak})		
Harbour porpoise	13.2 (0.004% of the NS MU)	Negligible
Bottlenose dolphin	0.0008 (0.00004% of the GNS MU)	Negligible
Common dolphin	0.0004 (0.0000004% of the CGNS MU)	Negligible
White-beaked dolphin	0.0007 (0.000002% of the CGNS MU)	Negligible
Minke whale	0.002 (0.00001% of the CGNS MU)	Negligible
Grey seal	0.2 (0.0006% of the SE England MU & 0.0004% of the wider MU)	Negligible (negligible)
Harbour seal	0.0008 (0.00002% of the SE England MU)	Negligible
TTS due to a single strike of a pin pile at maximum hammer energy (SPL_{peak})		
Harbour porpoise	8.6 (0.002% of the NS MU)	Negligible
Bottlenose dolphin	0.0008 (0.00004% of the GNS MU)	Negligible
Common dolphin	0.0004 (0.0000004% of the CGNS MU)	Negligible
White-beaked Dolphin	0.0007 (0.000002% of the CGNS MU)	Negligible

Marine mammal species	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
Minke whale	0.001 (0.000005% of the CGNS MU)	Negligible
Grey seal	0.02 (0.0006% of the SE England MU & 0.0004% of the wider MU)	Negligible (Negligible)
Harbour seal	0.0001 (0.000002% of the SE England MU)	Negligible

* *Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.3.2.2 TTS from Cumulative Exposure from Concurrent Piling

234. As described above for PTS, 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 when piling is ongoing), and 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.

235. The full underwater noise modelling results are provided in **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)** for the potential for TTS due to the cumulative exposure of multiple monopile and jacket pin pile installations at the same time. The modelling includes concurrent piling for both monopiles and jacket pin piles at DBS East and DBS west, which are used for the assessments for all marine mammal species (**Table 11-33**).

236. Underwater noise modelling has been carried out for concurrent piling, which represents the worst-case of:

- DBS East: S location and DBS West: W location for two concurrent monopile foundations (two installed sequentially at each location, for a total of four monopiles in a 24-hour period); and
- DBS East: S location, DBS West: W location, and Offshore Export Cable Corridor search area: NE location for three concurrent multi-leg foundations (four installed sequentially at each location, for a total of 12 jacket pin piles in a 24-hour period).

237. **Table 11-33** presents the underwater noise modelling results for the predicted effect ranges and areas for TTS due to the cumulative exposure of concurrent monopiles and jacket pin piles at DBS East, DBS West and the Offshore Export Cable Corridor from the worst case modelling locations (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

238. The potential effect range for TTS is highest for minke whale for both monopiles and jacket pin piles, with a potential cumulative TTS effect area of 15,000km² and 22,000km² respectively. For dolphin species, the potential TTS range for jacket pin-pile installations are significantly smaller, and do not interact with each other where there are concurrent piling events at the same time. Therefore, for dolphin species, the assessments are based on the results for DBS East, DBS West, and the Offshore Export Cable Corridor, combined together. **Table 11-33** provides the TTS ranges for the installation of monopile foundations at the worst-case location for DBS East and DBS West array.

Table 11-33 Summary of the Impact Areas for the Concurrent Installation of Monopile and 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

Monopile foundation Southall *et al.* (2019) Weighted SEL_{cum}		**Area of TTS onset for sequential and concurrent pile installations (km²)**	
		TTS from two concurrent monopile installations (two sequential at DBS East at the same time as two sequential at DBS West)	**TTS from three concurrent jacket pin pile installations (four sequential at DBS East at the same time as four sequential at DBS West and at the Offshore Export Cable Corridor)**
TTS (Impulsive)	LF (183 dB)	15,000km²	22,000km²
	HF (185 dB)	200km²	2.1km²
	VHF (155 dB)	9,100km²	16,000km²
	PCW (185 dB)	4,400km²	11,000km²

239. An assessment of the maximum number of individuals that could be at risk of cumulative TTS, for concurrent monopiles and jacket pin piles, is presented in **Table 11-34**, based on the effect areas as presented in **Table 11-33**.

240. The magnitude of the potential impact (without any mitigation) is assessed as low for harbour porpoise and minke whale, and low (low) for grey seal, for concurrent monopile installations. The magnitude of the potential impact (without any mitigation) is assessed as low for harbour porpoise and minke whale and high (high) for grey seal for jacket pin piles. The magnitude is negligible for bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal for both monopiles and jacket pin piles, due to concurrent monopiles and jacket pin pile installations at DBS East and DBS West together (**Table 11-34**).

Table 11-34 Assessment of the Potential for TTS due to the Cumulative Exposure of Concurrent Monopiles or Jacket Pin Piles at the Same Time at DBS East and DBS West

Marine mammal species	Potential effect areas for TTS due to cumulative exposure of concurrent pile installations			
	Monopile (6,000kJ)		Jacket pin pile (3,000kJ)	
	Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)	Magnitude* (temporary)	Three concurrent jacket pin piles at the DSB East, DBS West, and Offshore Export Cable Corridor, with four sequential piles at each location (total of 12 jacket pin piles installed in one day)	Magnitude* (temporary)
Harbour porpoise	6,006.0 (1.73% of the NS MU)	Low	10,560.0 (3.05% of the NS MU)	Low
Bottlenose dolphin	8.4 (0.41% of the GNS MU)	Negligible	0.09 (0.004% of the GNS MU)	Negligible
Common dolphin	3.4 (0.003% of the CGNS MU)	Negligible	0.04 (0.00003% of the CGNS MU)	Negligible
White-beaked dolphin	8.2 (0.02% of the CGNS MU)	Negligible	0.07 (0.0002% of the CGNS MU)	Negligible
Minke whale	300.0 (1.49% of the CGNS MU)	Low	440.0 (2.19% of the CGNS MU)	Low

Marine mammal species	Potential effect areas for TTS due to cumulative exposure of concurrent pile installations			
	Monopile (6,000kJ)		Jacket pin pile (3,000kJ)	
	Two concurrent monopiles at DBS East and DBS West, with two sequential monopiles at each location (total of four monopiles installed in one day)	Magnitude* (temporary)	Three concurrent jacket pin piles at the DSB East, DBS West, and Offshore Export Cable Corridor, with four sequential piles at each location (total of 12 jacket pin piles installed in one day)	Magnitude* (temporary)
Grey Seal	1,144.0 (3.74% of the SE England MU & 2.02% of the wider MU)	Low (Low)	5,841.0 (19.09% of the SE England MU & 10.34% of the wider MU)	High (High)
Harbour seal	7.5 (0.15% of the SE England MU)	Negligible	18.7 (0.38% of the SE England MU)	Negligible

* *Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.4 Sensitivity of Receptor

241. All species of cetaceans rely on sonar for navigation, finding prey and communication; they are therefore highly sensitive to permanent hearing damage (Southall *et al.* 2007). As such, sensitivity to PTS from pile driving noise is assessed as high for all cetacean species. However, when considering the impact that any auditory injury has on an individual, the frequency range over which the auditory injury occurs must be considered. PTS would normally only be expected in the critical hearing bands in and around the critical band of the fatiguing sound (Kastelein *et al.* 2012). Auditory injury resulting from sound sources like piling (where most of the energy occurs at lower frequencies) is unlikely to negatively affect the ability of high-frequency cetaceans to communicate or echo-locate. PTS would not result in an individual being unable to hear but could result in some permanent change to hearing sensitivity.

242. Pinnipeds use sound both in air and water for social and reproductive interactions (Southall *et al.* 2007), but not for finding prey. Therefore, Thompson *et al.* (2012) suggest damage to hearing in pinnipeds may not be as sensitive as it could be in cetaceans. Pinnipeds also have the ability to hold their heads out of the water during exposure to loud noise, and potentially avoid PTS during piling. As such, sensitivity to PTS in harbour and grey seal is expected to be lower than cetacean species such as harbour porpoise, with the individual showing some tolerance to avoid, adapt to or accommodate or recover from the impact (for example, Russell, 2016b), but as a precautionary approach they are also considered as having high sensitivity in this assessment.

243. Any PTS would be permanent, and marine mammals within the potential impact area are considered to have very limited capacity to avoid such effects, and therefore unable to recover from the effects.

244. PTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SPL_{peak}) of the maximum hammer energy applied during piling. PTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}). All marine mammal species are assessed as having high sensitivity to PTS.

245. TTS can occur instantaneously from acute exposure to high noise levels, such as single strike (SEL_{ss}) of the maximum hammer energy applied during piling. TTS can also occur as a result of prolonged exposure to increased noise levels, such as during the duration of pile installation (SEL_{cum}).

246. All marine mammal species are assessed as having medium sensitivity to TTS. A fleeing response is assumed to occur at the same noise levels as TTS. The response of individuals to a noise stimulus will vary and not all individuals will respond, however, for the purpose of this assessment, it is assumed that 100% of the individuals exposed to the noise stimulus will respond and flee the area.

247. Any TTS would be temporary, and individuals would recover from any temporary changes in hearing sensitivity after the noise source has ceased. However, as a precautionary approach, medium sensitivity to TTS assumes an individual has limited capacity to avoid, adapt to, tolerate or recover from the anticipated impact.

11.6.1.1.5 Significance of Effect – DBS East or DBS West In Isolation

248. The assessment for the effect of PTS from monopile installation and jacket pin piles in marine mammals is provided in **Table 11-35**, taking into account the high marine mammal sensitivity and the potential magnitude of the impact (i.e. number of individuals as a percentage of the reference population; **Table 11-22** and **Table 11-24**).

249. The significance of effect for permanent changes in hearing sensitivity (PTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without mitigation) has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-35**).

250. For the potential PTS from cumulative exposure for sequential monopile installations in 24 hours (without mitigation), the significance of effect has been assessed as **major adverse** (significant in EIA terms) for harbour porpoise, minke whale and for grey seal at the Offshore Export Cable Corridor location, **moderate adverse** (significant in EIA terms) for grey seal at DBS East and DBS West, and **minor adverse** (not significant in EIA terms) for bottlenose dolphin, common dolphin, white-beaked dolphin, and harbour seal (**Table 11-35**).

251. For the potential PTS from cumulative exposure for sequential jacket pin piles installations in 24 hours (without mitigation), the significance of effect has been assessed as **major adverse** (significant in EIA terms) for harbour porpoise and minke whale, **minor adverse** (not significant in EIA terms) for bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal at DBS West, and harbour seal, as **minor to moderate adverse** (significant in EIA terms) for grey seal at DBS East, and **moderate to major adverse** (significance in EIA terms) at the Offshore Export Cable Corridor (**Table 11-35**)

Table 11-35 Assessment of Significance of Effect for the Potential for PTS for DBS East and DBS West In Isolation due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
PTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All marine mammals	High	Negligible	Minor adverse
PTS due to the cumulative exposure of two sequential monopiles in a 24 hour period			
Harbour porpoise, minke whale, and grey seal (Offshore Export Cable Corridor)	High	Medium	Major adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin, and harbour seal		Negligible	Minor adverse
Grey seal (DBS East and DBS West)		Low	Moderate adverse
PTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period			
Harbour porpoise and minke whale	High	Medium	Major adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse
Grey seal (DBS East)		Negligible to low	Minor to moderate adverse
Grey seal (DBS West)		Negligible	Minor adverse
Grey seal (Offshore Export Cable Corridor)		Low to medium	Moderate to major adverse

252. The assessment for the effect of TTS from monopile installation in marine mammals is provided in **Table 11-36**, taking into account high marine mammal sensitivity and the potential magnitude of the impact (i.e. number of individuals as a percentage of the reference population; **Table 11-29** and **Table 11-31**).

253. The significance of effect for temporary changes in hearing sensitivity (TTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without any mitigation) has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-36**).

254. For the potential TTS from cumulative exposure for sequential monopile and jacket pin pile installations (without mitigation), the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal (at DBS East and DBS West), and harbour seal (**Table 11-36**). For grey seal at the Offshore Export Cable Corridor, the effect significance has been assessed as **minor to moderate adverse** (significant in EIA terms).

Table 11-36 Assessment of Significance of Effect for the Potential for TTS for DBS East or DBS West In Isolation due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species	Sensitivity	Magnitude of impact*	Potential significance of effect
TTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All marine mammals	Medium	Negligible	Minor adverse
TTS due to the cumulative exposure of sequential monopiles in a 24 hour period			
DBS East and DBS West			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal (DBS East) and harbour seal	Medium	Negligible	Minor adverse
Grey seal (DBS West)		Low (Negligible)	

Marine mammal species	Sensitivity	Magnitude of impact*	Potential significance of effect
Offshore Export Cable Corridor (one pile)			
Harbour porpoise, minke whale	Medium	Low	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin, and harbour seal		Negligible	Minor adverse
Grey seal		Medium (low)	Moderate to minor adverse
TTS due to the cumulative exposure of four sequential jacket pin piles in a 24 hour period			
DBS East			
All marine mammals	Medium	Negligible (Negligible)	Minor adverse
DBS West			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, and harbour seal	Medium	Negligible	Minor adverse
Grey seal		Low (Negligible)	Minor adverse
Offshore Export Cable Corridor			
Harbour porpoise and minke whale	Medium	Low	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse
Grey seal		Medium (Low)	Moderate to minor adverse

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.1.6 Significance of Effect – DBS East and DBS West Together

255. The significance of effect for PTS and TTS based on maximum number of marine mammals that could be impacted as a result of underwater noise during concurrent piling for DBS East and DBS West is summarised in **Table 11-37** and **Table 11-38**.

256. The significance of effect for permanent changes in hearing sensitivity (PTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without mitigation) at DBS East and DBS West together has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-37**).

257. For the potential PTS from cumulative exposure for concurrent monopile or jacket pin pile installations (without mitigation), the significance of effect has been assessed as **major adverse** for harbour porpoise, minke whale and grey seal, **minor adverse** (not significant in EIA terms) for bottlenose dolphin, common dolphin, white-beaked dolphin, and **moderate adverse** (significant in EIA terms) for harbour seal (**Table 11-37**).

Table 11-37 Assessment of Significance of Effect for the Potential for PTS for DBS East and DBS West Together due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species species	Sensitivity	Magnitude of impact	Potential significance of effect
PTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All marine mammals	High	Negligible	Minor adverse
PTS due to the cumulative exposure of concurrent monopile installations			
Harbour porpoise, minke whale and grey seal	High	Medium	Major adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin		Negligible	Minor adverse
Harbour seal		Low	Moderate adverse
PTS due to the cumulative exposure of concurrent jacket pin pile installations			
Harbour porpoise, minke whale and grey seal	High	Medium	Major adverse

Marine mammal species species	Sensitivity	Magnitude of impact	Potential significance of effect
Bottlenose dolphin, common dolphin, white-beaked dolphin		Negligible	Minor adverse
Harbour seal		Low	Moderate adverse

258. The significance of effect for temporary changes in hearing sensitivity (TTS) from a single strike of the maximum hammer energy for monopiles and jacket pin piles (without any mitigation) at DBS East and DBS West together has been assessed as **minor adverse** (not significant in EIA terms) for all species (**Table 11-38**).

259. For the potential TTS from cumulative exposure for concurrent monopile installations (without mitigation) the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammals (**Table 11-38**).

260. For the potential TTS from cumulative exposure for concurrent jacket pin pile installations (without mitigation), the significance of effect has been assessed as **major adverse** (significant in EIA terms) for grey seals, and **minor adverse** (not significant in EIA terms) for harbour porpoise, minke whale, bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal (**Table 11-38**).

Table 11-38 Assessment of Significance of Effect for the Potential for TTS for DBS East or DBS West together due to Piling of Monopiles and Jacket Pin Piles

Marine mammal species species	Sensitivity	Magnitude of impact	Potential significance of effect
TTS due to a single strike of a at maximum hammer energy for monopiles and jacket pin piles			
All marine mammals	Medium	Negligible	Minor adverse
TTS due to the cumulative exposure of concurrent monopile installations			
Harbour porpoise, minke whale and grey seal	Medium	Low	Minor adverse

Marine mammal species species	Sensitivity	Magnitude of impact	Potential significance of effect
Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse
TTS due to the cumulative exposure of concurrent jacket pin pile installations			
Harbour porpoise and minke whale	Medium	Low	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse
Grey seal		High (High)	Major adverse

11.6.1.1.7 Mitigation and Residual Significance of Effect – DBS East or DBS West In Isolation

261. A MMMP for piling (section 11.3.3) would reduce the risk of PTS from a single strike of both monopiles and jacket pin piles, at the maximum hammer energy, and from the cumulative exposure of one monopile and one jacket pin pile. Mitigation will be undertaken for each pile, and therefore would be designed to ensure it addresses the potential effect of the installation of either one monopile or one jacket pin pile, as required.

262. The final MMMP for piling would be developed post-consent in consultation with the MMO and other relevant stakeholders (including Natural England), and would be based on the latest information, scientific understanding and guidance and detailed project design at the time. The final MMMP is expected to be based on the standard JNCC guidance (JNCC, 2010), and include:

263. A monitoring zone of at least 500m (or higher if required to cover the PTS range for a single strike of the hammer), where soft-start cannot commence until the monitoring zone is clear of marine mammals;

264. Soft-start piling (comprised of a period of low-energy blows at the starting hammer energy, followed by a gradual ramp-up to full hammer energy); and

265. ADDs to deter marine mammals from the piling location, to a distance that is greater than the PTS range for the installation of one pile.

266. ADDs have been widely used as mitigation to deter marine mammals during OWF piling and are proven to be effective mitigation for harbour porpoise, minke whale, grey and harbour seal (Sparling *et al.* 2015; McGarry *et al.* 2017, 2020).

267. In addition, the presence of construction vessels themselves could act as an effective deterrent to harbour porpoise. Brandt *et al.* (2018) found that at seven German OWFs in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice OWF, indicate higher vessel activity within 1km was associated with an increased probability of response in harbour porpoise (Graham *et al.*, 2019). This disturbance of marine mammals from the area around the construction site prior to piling would also reduce the risk of PTS.

268. The mitigation in the final MMMP will be designed to reduce the number of marine mammals within PTS ranges; both from a single strike and cumulative exposure. **Volume 8, Outline MMMP (application ref: 8.25)** has been provided with the DCO Application. These measures will reduce the worst case magnitude of impact for harbour porpoise, minke whale, and grey seal from medium to negligible, and therefore the residual effect is **minor adverse** (not significant in EIA terms) and ensure a negligible magnitude of impact for all marine mammal species, which is deemed to be not significant in EIA terms.

269. The mitigation in the final MMMP to reduce the risk of PTS would also reduce the number of marine mammals at risk of TTS. The piling scenarios that have been identified to have the potential for a significant effect for TTS are for grey seal, due to the installation of a single monopile in the Offshore Export Cable Corridor, or for sequential jacket pin piles in the Offshore Export Cable Corridor. As noted in the **Volume 8, Outline MMMP (application ref: 8.25)** the final mitigation requirements for the Projects will be based on the final project design, which will include consideration of alternative foundation options and noise abatement systems if required. With the implementation of such a method, the magnitude of impact effect for TTS would be reduced, and therefore the residual effect for grey seal would be **minor adverse** (not significant in EIA terms).

11.6.1.1.8 Mitigation and Residual Significance of Effect – DBS East and DBS West Together

270. For DBS East and DBS West together, there is the potential for a significant effect due to PTS in harbour porpoise, minke whale, grey seal and harbour seal, for concurrent and sequential piling (both monopiles and jacket pin piles). There is also the potential for a significant effect for TTS in grey seal for the concurrent and sequential jacket pin piles for DBS East, DBS West, and the Offshore Export Cable Corridor. It should be noted that these assessments are based on the worst-case, and it is likely that these scenarios will be refined in the post-consent phase.

271. Further consideration will be given to the number of installation vessels and foundations to be installed in 24 hours at DBS East and DBS West together when the project requirements have been more refined.

272. Mitigation would be undertaken for each pile, and the measures should be designed to ensure they cover for the potential effect of the installation at DBS East and DBS West together. The final MMMP would be based on the latest information, scientific understanding and guidance and detailed project design at the time. The Site Integrity Plan for the Southern North Sea SAC would manage and reduce the potential for significant disturbance of harbour porpoise from cumulative underwater noise during OWF piling. This would also reduce the potential for disturbance for all other marine mammal species.

273. The use of noise abatement technology will also be considered if required when taking into account wider cumulative effects in the wider North Sea area.

274. These measures will reduce the magnitude of impact from high for all marine mammal species, therefore the residual effect is **minor adverse**, which is deemed to be not significant in EIA terms.

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

275. 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).

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

277. For marine mammals a fleeing response can be assumed to occur at the same noise levels as TTS. Therefore, the potential effect range and areas for TTS, as shown in **Table 11-28** with the estimated number of marine mammals and percentage of reference populations presented in **Table 11-29** providing an indication of the effect level of a possible fleeing response.

278. Disturbance from construction activities (including piling) may have behavioural consequences on marine mammals 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).

279. The potential disturbance of marine mammals from underwater noise during piling has been assessed based on:

- Known and reported behavioural responses of marine mammals (section 11.6.1.2.1);
- Effective Deterrence Radius (EDR) approach for harbour porpoise and reported disturbance ranges for seals and minke whales (section 11.6.1.2.2.1);
- Dose response curve assessment for harbour porpoise, grey seal and harbour seal (section 11.6.1.2.2.2);
- Population modelling (section 11.6.1.2.2.3);
- Disturbance during ADD activation (section 11.6.1.2.3.3); and
- Duration of piling (section 11.6.1.2.3.6).

280. The most realistic of these assessments methods is for dose response curves, and for population modelling, however, these approaches are not available for all species. Previously reported disturbance ranges will be used where these methods are not available, alongside a review of any relevant studies for each marine mammal species. Only where these methods are not available for a certain species, would TTS be used as a proxy for disturbance.

11.6.1.2.1 Desk-Based Review of Behavioural Responses

11.6.1.2.1.1 Behavioural Response of Harbour Porpoise to Piling

281. The Gescha 2 study (Rose *et al.* 2019) analysed the impact from the construction of 11 OWFs in Germany on harbour porpoise in the German North Sea and adjacent Dutch waters, from 2014 to 2016. This study also included analysis of previously surveys within the Gescha 1 study, which studied the impact from the construction of eight German OWFs from 2009 to 2013. The study involved the deployment of Cetacean Porpoise Detectors (CPODs) and digital aerial surveys in order to monitor harbour porpoise presence and abundance during the construction of these projects, alongside the measurement of noise levels associated with piling at both 750m and 1,500m from source. The piling activities monitored in this study were mostly undertaken with noise abatement systems in order to reduce disturbance impacts on harbour porpoise.

282. The Gescha 2 study (Rose *et al.* 2019) found that noise levels recorded during piling were predominantly below the limit of 160dB at 750m (the German Federal Maritime and Hydrographic Agency (BSH) mandatory noise limit for German waters). In addition, noise levels were 9dB lower than the noise levels recorded during the Gescha 1 study, due to advancement in noise abatement methods. Rose *et al.* (2019) also found that noise levels were 15dB less using noise abatement than for noise levels from unmitigated piling. It was expected that the improved efficiency of noise abatement for piling, and therefore the overall reduced noise levels, would lead to a reduction in disturbance impacts on harbour porpoise, however, this was not the case.

283. The range of disturbance impact of harbour porpoise to piling within the Gescha 2 study (Rose *et al.* 2019) based on CPOD data was 17km (Standard Deviation (SD) 15-19km), and the duration of disturbance (i.e. the time it took for harbour porpoise to return to baseline levels) was between 28 and 48 hours, and based on aerial data the impact range was found to be between 11.4 and 19.5km (at least 12 hours after piling) (Rose *et al.* 2019). These results are similar to those reported in the Gescha 1 study (with a disturbance range of 15km (SD 14-16km) and duration of disturbance of 25 to 30 hours), which showed higher piling noise levels (Rose *et al.* 2019). This suggests that the noise level of the piling is not the only determining factor when discussing the potential for disturbance.

284. Analysis of the CPOD data collected in the Gescha 2 study (Rose *et al.* 2019) indicated that there is no correlation between noise levels received and the range at which harbour porpoise become disturbed, for noise that is below 165dB at 750m from source. This could be due to individuals maintaining a certain distance from noisy activities, irrespective of the actual noise levels, provided that noise level is above a certain threshold for that individual (Rose *et al.* 2019). It should be noted however that this study recorded noise levels up to 20kHz only, and therefore there may be higher frequency noise associated with piling that these results do not take into account.

285. A reduction in harbour porpoise presence was seen for all wind farms, for both the Gescha 1 and 2 studies, up to 24 hours prior to any noisy activity occurring, which could be due to the increased vessel activity at the pile location prior to piling taking place (Rose *et al.* 2019). However, the displacement during pile driving was noted to be larger than for the period prior to piling. In Gescha 2, a decrease in detection rates was found in the three hours prior to piling activity at a distance up to 15km from the piling location, with no difference in detection rates observed at a distance of 25km (Rose *et al.* 2019).

286. A study of harbour porpoise at Horns Rev (Brandt *et al.* 2011), found that at closer distances (2.5 to 4.8km) there was 100% avoidance during piling. However, this proportion decreased significantly moving away from the pile driving activity, such that at distances of 10.1 to 17.8km, avoidance occurred in 32% to 49% of the population and at 21.2km, the abundance reduced by just 2%. This suggests that an assumption of behavioural displacement of all individuals is unrealistic and that in reality not all individuals would move out of the area.

287. During the piling campaign at Beatrice Offshore Wind Farm in 2017, an array of underwater noise recorders were deployed to determine noise levels associated with the piling campaign, alongside a separate array of acoustic recorders to monitor the presence of harbour porpoise during piling (Graham *et al.* 2019). Piling at Beatrice Offshore Wind Farm comprised of four pin piles at each turbine or sub-station structure, with a 2.2m diameter and a hammer energy of 2,400kJ. The sound levels recorded were then used to determine the sound level at each of the acoustic recorders.

288. This study assumed that a change in the number of harbour porpoise present at each location was based on the number of positive identifications of porpoise vocalisations (Graham *et al.* 2019). These two data sets (the harbour porpoise presence and the perceived sound level at each location) were then analysed in order to determine any disturbance impacts as a result of the piling activities and at what sound level impacts are observed. Harbour porpoise presence was measured over a period of 48 hours prior to piling, and continued following the cessation of piling to ensure that any change in porpoise detections could be observed (a total period of 96 hours was recorded for each included piling event, with a total of 17 piling events included within this analysis) (Graham *et al.,* 2019).

289. The results from Beatrice Offshore Wind Farm (Graham *et al.,* 2019) showed that at the start of the piling campaign, there was a 50% chance of a harbour porpoise responding to piling activity, within a distance of 7.4km, during the 24 hours following piling. In the middle of the piling campaign, this 50% response distance had reduced to 4.0km, and by the end of the piling had reduced further to 1.3km.

290. The response to audiogram-weighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 54.1dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 60.0dB re 1 1μPa^2s during the middle of the campaign, and to 70.9dB re 1 μPa^2s by the end of the piling activities. Similarly, the response to unweighted SEL noise levels reduced over time, with a 50% response being observed at sound levels of 144.3dB re 1 μPa^2s at the first location, during the first 24 hours following piling, increasing to 150.0dB re 1 1μPa^2s during the middle of the campaign, and to 160.4dB re 1 μPa^2s by the end of the piling activities (Graham *et al.* 2019).

291. Additional comparisons were made through this study (Graham *et al.,* 2019) to assess the difference in harbour porpoise presence where ADDs were used and where they were not, as well as relating to the number of vessels present within 1km of the piling site. A significant difference was observed in the presence of harbour porpoise where ADDs were used compared to where they were not, but only in the short-term (<12 hours following piling), and there was no significant difference when considering a longer time period from piling. With 50% response distances for pile locations with ADD use recorded as up to 5.3km (during 12 hours after piling), and without ADD use, responses due to piling were recorded up to 0.7km during 12 hours following piling. It should be noted however that only two locations used in the analysis had ADD use, and therefore the sample number in this analysis is small (Graham *et al.* 2019).

292. Overall, this study has shown that the response of harbour porpoise to piling activities reduces over time, suggesting a habituation effect occurred. In addition, there is some indication that the use of ADDs does reduce the presence of harbour porpoise in the short term. In addition, higher levels of vessel activity increased the potential for a response by harbour porpoise. Harbour porpoise response to piling activity was best explained by the distance from the piling location, or from the received noise levels (taking into account weighting for their hearing) (Graham *et al.*.2019).

293. During the construction of two Scottish wind farms (Beatrice Offshore Wind Farm and Moray East Offshore Wind Farm), a set of CPODs were deployed to monitor harbour porpoise presence during construction (Benhemma-Le Gall *et al.*.2021). In addition, the broadband noise levels were recorded and monitored, and vessel Automatic Identification System (AIS) data. The purpose of this study was to assess the response of harbour porpoise to both the changes in the baseline noise level due to piling at the two wind farms, and due to an increase in vessel activity. The result of this study was that there was an 8-17% decline in porpoise presence during impact piling and other construction activities, compared to baseline levels (Benhemma-Le Gall *et al.* 2021).

294. An increase in broadband noise levels due to piling led to a significant reduction in porpoise presence. When piling was not occurring, porpoise detections decreased by 17% as the noise levels increased (from 102dB re 1 μPa (SPL) to 159dB re 1 μPa (SPL)) (**Plate 11-1**; Benhemma-Le Gall *et al.*.2021). During piling, porpoise detections decreased by 9% as noise levels increased (from 102dB to 159dB). A similar reduction in buzz vocalisations was also evident; the presence of buzz vocalisations can be attributed to foraging behaviours. When piling was not taking place, buzz vocalisations decreased by 41.5% as the noise levels increased (from 104dB re 1 μPa (SPL) to 155dB re 1 μPa (SPL)). During piling, porpoise detections decreased by 61.8% as noise levels increased (from 104dB to 155dB re 1 μPa (SPL)) (Benhemma-Le Gall *et al.* 2021).

295. Harbour porpoise buzz vocalisations increased by 4.2% during Moray East piling compared to the baseline levels. At this point, Beatrice OWF foundations were constructed, and the introduction of hard substrates are likely to have improved the fine-scale habitat for key harbour porpoise prey species, with the potential of increasing prey resources (Benhemma-Le Gall *et al.* 2021).

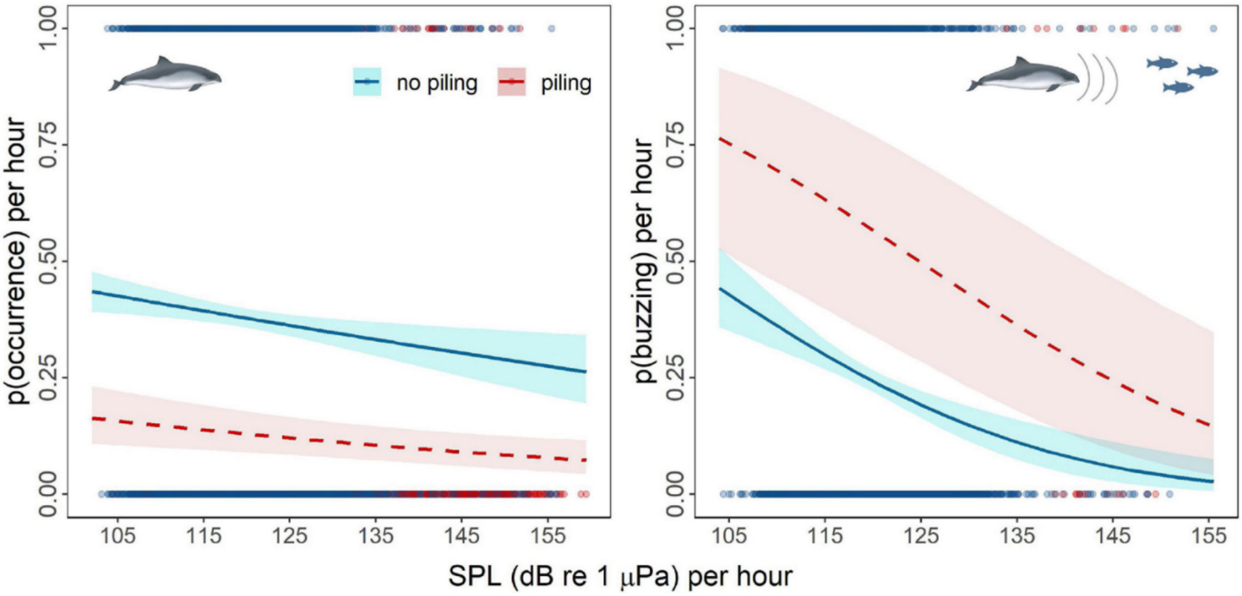

Plate 11-1 [Left] The probability of harbour porpoise presence in relation to the SPL (Red = during piling, Blue = outside of piling time, and [Right] the probability of buzzing activity per hour in relation to the SPL (Red = during piling, Blue = outside of piling time (Benhemma-Le Gall et al., 2021)

296. In summary, the research highlights that during piling operations, there is a reduction in harbour porpoise in the vicinity of the piling event, avoidance and displacement had been documented up to 17.8km (Brandt *et al.* 2011), shows evidence that harbour porpoise is responsive to sound. However, long-term monitoring has shown that harbour porpoise can become habituated to the noise from impact pile driving. Although the studies from Brandt et al. (2011) found deterrent ranges around 17km, Tougaard et al. (2013) estimated an EDR of 26km to reflect the overall temporary loss of habitat from piling due to larger deterrent ranges reported up to 34km for impact pile driving without noise abatement (Tougaard *et al.* 2009, Brandt *et al.* 2011, 2012, 2018, Dahne *et al.* 2013).

11.6.1.2.1.2 Behavioural Response of Delphinids to Piling

297. There is limited information on the behavioural response of any dolphin species to piling. Within the Southall *et al.* (2007) paper, a review of the data available for mid-frequency cetaceans (which include species other than dolphins, such as sperm whale *Physeter macrocephalus* and beluga *Delphinapterus leucas*) indicate that some significant response was observed at a SPL of 120 dB to 130 dB re 1μPa (rms), although the majority of individuals did not display significant behavioural response until exposed to a level of 170 dB to 180 dB re 1μPa (rms). Other mid-frequency species were observed to have no behavioural response even when exposed to a level of 170 dB to 180 dB re 1μPa (rms). It should be noted that few of the reviewed studies were based on dolphin species.

298. Graham *et al.* (2017) studied the responses of bottlenose dolphins due to both impact and vibration pile driving noise during harbour construction works in northeast Scotland. The study used passive acoustic monitoring devices to record cetacean activity, and noise recorders to measure and predict received noise levels. Local abundance and patterns of occurrence of bottlenose dolphins were also compared with a five-year baseline. The median peak-to-peak source level estimated for impact piling was 240 dB re 1 μPa (single-pulse sound exposure level [SEL] 198 dB re 1 $\mu Pa^2 s$), and the rms source level for vibration piling was 192 dB re 1 μPa (Graham *et al.* 2017).

299. The results of the study found that bottlenose dolphin were not excluded from sites in the vicinity of impact piling or vibration piling; nevertheless, some small effects were detected, where bottlenose dolphins spent a reduced period of time in the vicinity of construction works during both impact and vibration piling (Graham *et al.* 2017). Dolphins generally showed a weak behavioural response to impact piling, reducing the amount of time they spend around the construction activity during piling (Graham *et al.* 2017). Observed fine-scale behavioural responses by dolphins during this study to piling occurred at predicted received single-pulse SEL values of between 104 and 136.2 dB re 1 μPa^2 s for impact piling (Graham *et al.* 2017).

300. During the Beatrice Offshore Wind Farm piling campaign in 2017, dolphin detections decreased by 50% in the Impact Areas (minimum of 53km from the piling site), and decreased by 14% in the Reference Area (minimum of 80km from the piling site), compared to baseline years (Fernandez-Betelu *et al.* 2021). When impact piling was conducted at Moray East Offshore Wind Farm in 2019, no significant difference in dolphin detections between the study areas (Impact Area at a minimum of 45km from the piling site; Reference Area at a minimum of 78km from the piling site) was found in comparison to baseline years (Fernandez-Betelu *et al.* 2021).

301. The southern coast of the Moray Firth is the closest area to the offshore activities within this bottlenose dolphin population's range, with piling at Beatrice Offshore Wind Farm 50–70km from the studied population, and Moray East 40–70km from the population. The analyses showed that dolphins continued using the southern coast of the Moray Firth during the seismic survey and impact pile-driving (and therefore the species was not significantly affected at this distance of 40-70km) (Fernandez-Betelu *et al.* 2021).

302. In summary while displacement distances are available for other marine mammal species (such as harbour porpoise), there are no such studies conducted for bottlenose dolphins. However, as dolphins are generally less sensitive than harbour porpoises to underwater noise, shorter ranges of displacement would be expected (Fernandez-Betelu *et al.* 2021).

11.6.1.2.1.3 Behavioural Response of Minke Whale to Piling

303. There is limited information on the behavioural response of minke whale to piling, however behavioural studies have been conducted to look at the responses of other baleen whales, which can be assumed to represent minke whale.

304. Southall *et al.* (2007) recommended that the most appropriate way to assess the disturbance effect of a noise source on marine mammals is the use of empirical studies. The same paper presented a severity scale to apply to observed behavioural responses, and subsequent JNCC guidance indicates that a score of five or more on this behavioural response severity scale could be significant. A score of five relates to extensive changes in swim speed and direction, or dive pattern, but no avoidance of the noise source, or a moderate shift in distributions, a change in group size, aggregations and separation distances, and a prolonged cessation in vocal behaviours. The higher the behavioural response score, the more likely the associated noise source is to cause a significant disturbance effect.

305. Southall *et al.* (2007) includes a summary of the observed behavioural responses from noise sources, however, the majority of the studies included were based on the responses to seismic surveys. These studies contain some relevant information for whale species behavioural responses.

306. Whale species were typically observed to respond significantly at a received level of 150dB to 160dB re 1 µPa (rms) (Malme *et al.* 1983, 1984; Richardson *et al.* 1986; Ljungblad *et al.* 1988; Todd *et al.* 1996; McCauley *et al.* 1998), with behavioural changes including visible startle responses, extended cessation or modification of vocal behaviour, brief cessation of reproductive behaviour or brief and minor separation of females and dependent offspring.

307. During migration periods, avoidance behaviours of bowhead whales *Balaena mysticetus* were observed at distances of more than 20km from seismic sources (Koski and Johnson 1987; Richardson *et al.* 1999), however, during foraging periods, bowhead whales did not respond at greater than 6km from the source (Richardson *et al.* 1986; Miller *et al.* 2005). Richardson *et al.* (1986) concluded that due to a single airgun, avoidance and behavioural response was observed once noise levels reached more than 160dB re 1 µPa.

308. For a migrating bowhead whale study, most individuals avoided a seismic survey source at distances of up to 20km (the seismic surveys used airgun arrays of up to 16 guns, and total volume of 560 to 1,500 cu. In.), with significantly reduced bowhead whale presence between 20 and 30km from the source, with estimated received noise levels of 120 to 130dB re 1 µPa ($_{rms}$) at that distance (Richardson *et al.*.1999).

309. Observations of behavioural changes in baleen whale species have shown avoidance reactions of up to 10km for a seismic survey, with a noise source level of 143dB 1 µPa (peak to peak) (Macdonald *et al.* 1995).

310. Dose-response functions for avoidance responses of grey whales *Eschrichtius robustus* to both continuous and impulsive noises were developed for vessel noise and seismic air guns by Malme (1984). For continuous noise sources, avoidance of minke whale started at a received level of 110-119dB re 1 µPa ($L_{peak, rms}$), with more than 80% of individuals responding at 130dB re 1 µPa ($L_{peak, rms}$), and 50% at 120dB re 1 µPa ($L_{peak, rms}$).

311. Higher noise levels were required for an avoidance response due to the impulsive noise source (seismic airguns), with 10% of migrating grey whales responding at 164dB re 1 μPa (L_{peak}, rms), 50% at 170dB re 1 μPa (L_{peak}, rms), and 90% at 180dB re 1 μPa (L_{peak}, rms) (Malme 1984 cited in Tyack and Thomas 2019). A secondary study (Malme 1987) using 100 cu. In. air guns (with a source level of 226dB re 1μPa) for foraging grey whales found a response level (where individuals would cease foraging activities) of 50% at 173dB re 1 μPa (L_{peak}, rms), and 10% at 163dB re 1 μPa (L_{peak}, rms).

312. In summary, documented studies have shown that baleen whales show a behaviour response to impulsive noise and can show signs of avoidance or displacement up to 20km from seismic airguns. Due to the fact that the acoustic properties of both seismic airguns and impact pile driving are similar with both being a loud broadband impulsive sound and similar in frequency, the research described above can provide an insight to minke whale behaviour impacts to piling.

11.6.1.2.1.4 Behavioural Response of Seals to Piling

313. There is limited data on the behavioural response of seals to disturbance from underwater noise such as piling. A study undertaken on ringed seals *Pusa hispida*, bearded seals *Erignathus barbatus,* and spotted seals *Phoca largha* (Harris *et al.* 2001) found the onset of a significant behavioural response at a received noise level of 160 to 170dB re 1 μPa (rms), although a larger proportion of individuals showed no response at noise levels of up to 180dB re 1 μPa (rms). Only at much higher sound pressure levels (190 to 200dB re 1 μPa (rms)) did significant numbers of seals exhibit a significant disturbance response.

314. Data from tagged harbour seals in the Wash indicated that seals were not excluded from the vicinity of the Lincs Offshore Wind Farm during the construction phase but there was clear evidence of avoidance during pile driving events (Russell *et al.* 2016). Seal activity was significantly reduced at ranges of up to 25km from piling sites, although within two hours of cessation of piling, seal distribution returned to pre-piling levels (Russell *et al.* 2016, Whyte *et al.* 2020).

11.6.1.2.2 Magnitude of Impact – DBS East or DBS West In Isolation

11.6.1.2.2.1 Disturbance / Displacement of Marine Mammals Based on Known Disturbance Ranges for Piling

11.6.1.2.2.1.1 Harbour Porpoise

315. The current advice from the SNCBs is that for harbour porpoise, a potential disturbance range or EDR of 26km (2,123.7km^2) around piling locations for monopiles (without noise abatement), and 15km (706.9km^2) for jacket pin piles (with and without noise abatement) is used for disturbance in the relevant SAC (JNCC *et al.* 2020). DBS East and West are located wholly within the Southern North Sea SAC, and therefore this approach has been followed. Not all harbour porpoise within these potential disturbance areas will be disturbed, however as a worst case scenario 100% disturbance of harbour porpoise in the areas has been assumed.

316. The estimated number of harbour porpoise and percentage of the North Sea MU reference population that could be disturbed as a result of underwater noise during piling at DBS East or DBS West Array Area (**Table 11-39**). The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

317. For one piling event at a time, the magnitude of the potential impact is assessed as negligible for the 26km EDR for monopiles, with 0.40% (or less) of the reference population anticipated to be affected, and negligible for the 15km EDR for jacket pin piles with 0.13% or less of the reference population anticipated to be temporarily disturbed (**Table 11-39**). There is therefore the potential for a negligible magnitude of impact for harbour porpoise from the disturbance of piling at DBS East or DBS West.

Table 11-39 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles for Single Piling Events at DBS East or DBS West

Species	EDR	Location	Assessment of Impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
For a single piling event				
Harbour porpoise	Monopiles	DBS East	1,274.2 (0.37% of the NS MU	Negligible

Species	EDR	Location	Assessment of Impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
	(EDR – 26km, with a disturbance area of 2,123.7km^2)	DBS West or Offshore Export Cable Corridor	1401.6 (0.40% of the NS MU)	Negligible
	Jacket pin piles (EDR – 15km, with a disturbance area of 706.9km^2)	DBS East	424.1 (0.12% of the NS MU)	Negligible
		DBS West or Offshore Export Cable Corridor	466.6 (0.13% of the NS MU)	Negligible

11.6.1.2.2.1.2 Bottlenose Dolphin, Common Dolphin, and White-Beaked Dolphin

318. There is little information on behavioural response of dolphin species, therefore, there is not much documented on the potential disturbance ranges due to impact piling (or any impulsive noise source). However, research has concluded that dolphins are less sensitive than harbour porpoise to underwater noise and was clearly shown with the installation of Moray East OWF, with impacting piling having no impact on the presence of dolphins (Fernandez-Betelu *et al.* 2021). Although other research as stated in section 11.6.1.2.1.2 have shown dolphins to move away from impulsive noise sources (Graham *et al.* 2017; Fernandez-Betelu *et al.* 2021). Therefore, based on the literature referenced in section 11.6.1.2.1.2 , it is most likely for the potential impact of disturbance to result in a magnitude of negligible or low.

319. In the absence of any further information on potential disturbance ranges for dolphin species, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect for all dolphin species and represents the worst-case (**Table 11-30**). There is therefore the potential for a negligible magnitude of impact for all dolphin species, due to the potential disturbance effect of piling.

11.6.1.2.2.1.3 *Minke Whale*

320. There is very little information on the potential disturbance ranges of minke whale due to impact piling. The modelled TTS / fleeing response range for minke whale of the worst case modelling for DBS West of 75km for cumulative monopiles and 67km for jacket pin pile installation (**Table 11-30**). However, the TTS ranges are very large, and it is unknown when the kurtosis level (the level of impulsiveness) changes, so within the 75km, that impulsive sound from piling will change to a non-impulsive sound and the impact range doesn't account for that. If the assessment as undertaken for TTS / fleeing response is used to represent the potential disturbance range of minke whales (**Table 11-31**) there is the potential for a negligible to low magnitude of impact for minke whale from the disturbance of piling.

321. As noted above, baleen whale species (bowhead whale) have been recorded to have a deterrence distance of up to 30km from a seismic source (Richardson *et al.* 1999). While this was for a seismic survey rather than impact piling, it is an impulsive noise source with a high source level.

322. Consultation comments from the PEIR (**Volume 7, Appendix 11-1 Marine Mammal Consultation Responses (application ref: 7.11.11.1)**) stated that using TTS as a proxy for disturbance is not the best method to assess for potential disturbance, therefore an assessment using the 30km (2827.43km^2) impact range from Richardson *et al*. (1999) has also been assessed in **Table 11-40**. Based on this approach, there is the potential for a negligible magnitude of impact for minke whale from the disturbance of piling.

Table 11-40 Assessment of the Potential for Disturbance to Minke Whale Based on the Richardson et al (1999) 30km disturbance range for impulsive sounds, therefore used for Piling Events at DBS East or DBS West

Species	Potential disturbance range and area	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
For a single piling event				
Minke whale	Monopiles (EDR – 30km, with a disturbance area of 2,8273.43km^2)	DBS East	28.3 (0.14% of the CGNS MU)	Negligible
		DBS West or Offshore Export Cable Corridor	56.5 (0.28% of the CGNS MU)	Negligible

11.6.1.2.2.1.4 Grey Seal and Harbour Seal

323. Regarding both grey and harbour seal, as noted above, a study has shown 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) (Russell *et al.*, 2016). This range has been used to determine the number of grey seal and harbour seal that may be disturbed during piling at DBS East or DBS West (**Table 11-41**).

324. The magnitude of the potential impact is assessed as negligible to low for grey seal at DBS East and DBS West, and low for the Offshore Export Cable Corridor. For harbour seal, the magnitude is negligible for harbour seal for all three locations, for a single piling event at each (**Table 11-41**).

Table 11-41 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 or DBS West

Species	Potential disturbance range and area	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact (temporary)
Grey seal	25km, with a disturbance area of 1,963.5km^2	DBS East	355.4 (1.16% of the SE England MU or 0.63% of the wider MU)	Low (Negligible)
		DBS West	510.5 (1.67% of the SE England MU or 0.90% of the wider MU)	Low (Negligible)
		Offshore Export Cable Corridor	1,042.6 (3.41% of the SE England MU or 1.85% of the wider MU)	Low (Low)
Harbour seal	25km, with a disturbance area of 1,963.5km^2	DBS East or Offshore Export Cable Corridor	3.3 (0.07% of the SE England MU reference population)	Negligible
		DBS West	2.0 (0.040% of the SE England MU)	Negligible

** not taking into account any overlap between disturbance areas between the two locations*
 # Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species

11.6.1.2.2.2 Dose Response Curve Assessment for Piling (Harbour Porpoise and Seals Only)

325. 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 harbour porpoise, harbour seal, and grey seal.

326. 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).

327. 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 **11-9 (application ref: 7.11.1)**) and subsequently the number of animals likely to be disturbed based on the corresponding dose-response curve (**Plate 11-2**). This analysis was applied to monopiles only as a worst-case. For harbour porpoise, the SCANS IV density estimates were used for the analysis as a worst case (Gilles *et al.* 2023). For both seal species, the Carter *et al.* (2022) density estimates were used.

328. The dose-response relationship used for harbour porpoise was developed by Graham *et al.* (2017) using data collected during Phase 1 of piling at the Beatrice Offshore Wind Farm. This dose response relationship is displayed in **Plate 11-3**. 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.

329. In the absence of species-specific dose-response data for dolphins or whales, harbour porpoise is the only species of cetacean that this analysis is applied to. Due to differences in hearing of baleen whales, dolphins, and porpoise, as well as their behaviour, it would not be appropriate to extrapolate the findings of Graham *et al.* (2017) to dolphin species or minke whale.

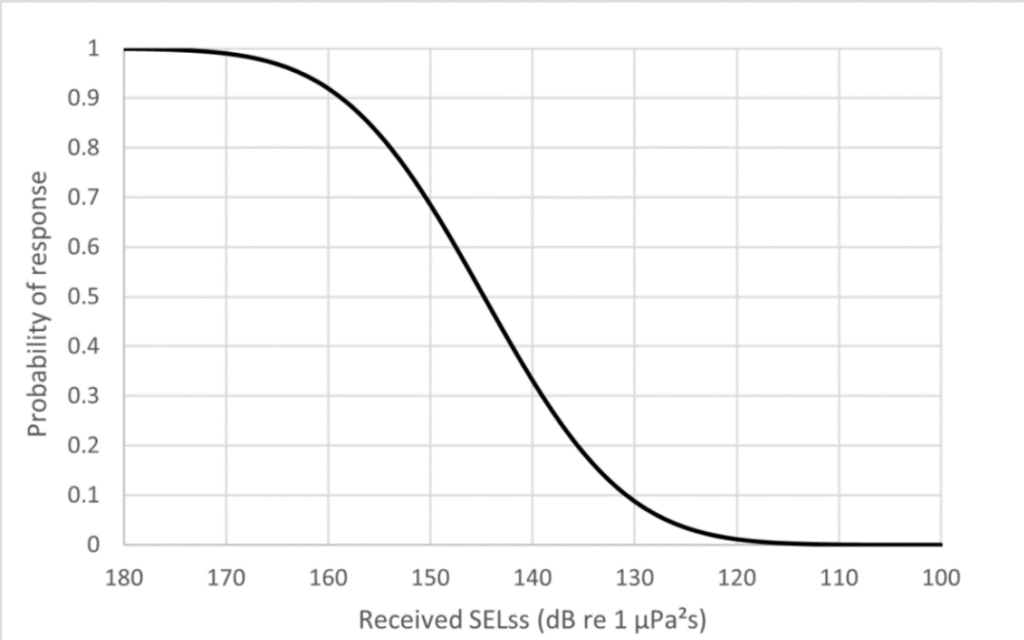

Plate 11-2 Dose-Response Relationship Developed by Graham et al. (2017) Used for Harbour Porpoise in this Assessment

330. For seals, a dose-response relationship derived from harbour seal telemetry data collected during several months of piling at the Lincs Offshore Wind Farm has been used (Whyte *et al.* 2020). As seen in **Plate 11-3**, the greatest SEL_{SS} considered in the Whyte *et al.* (2020) study was 180dB re 1 µPa²s, and no significant responses were observed at SEL_{ss} levels below 145dB re 1 µPa²s. 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 µPa²s all seals are assumed to be disturbed. At SEL_{SS} of less than 145dB re 1 µPa²s, no significant disturbance is expected. The dose-response curve for harbour seal is appropriate for grey seal, as both species have similar hearing audiograms.

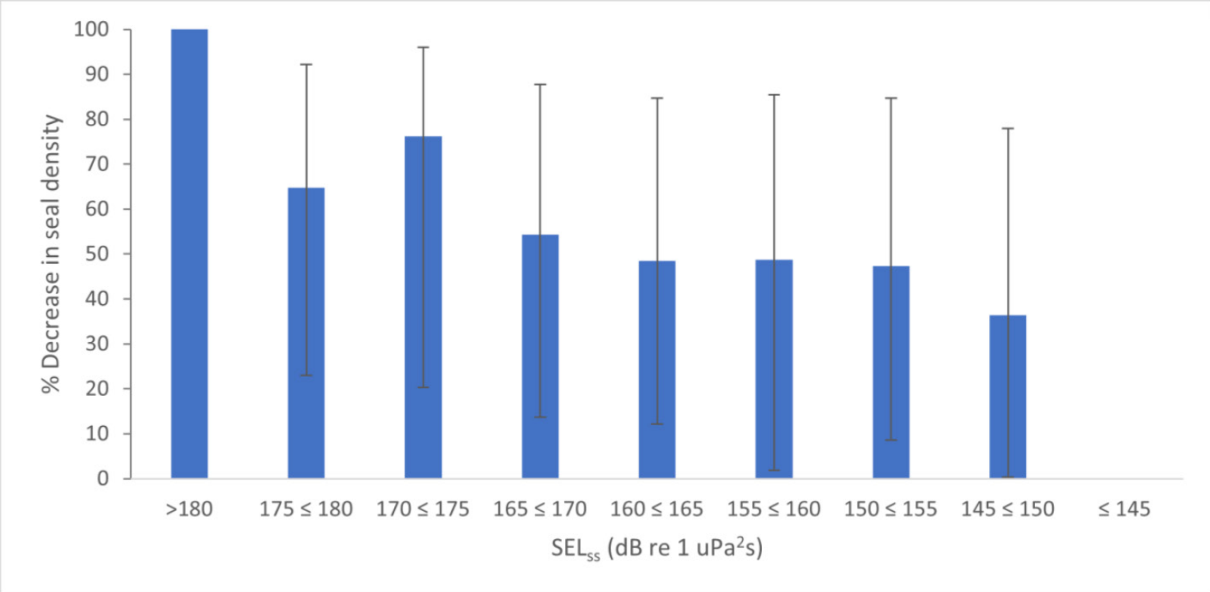

Plate 11-3 Dose-Response Behavioural Disturbance Data for Harbour Seal Derived from the Data Collected and Analysed by Whyte et al. (2020).

331. The estimated numbers (and percentage of the relevant reference populations) of harbour porpoise, grey seal, and harbour seal disturbed as a result of underwater noise during piling are presented in **Table 11-42**.

332. For harbour porpoise, the magnitude of the potential impact is assessed as low for all monopile locations, and for harbour seal it is assessed as negligible. For grey seal, the magnitude is moderate to high for DBS East, low to medium for DBS West, and high for the Offshore Export Cable Corridor (see **Table 11-42**). These results for grey seal are due to the noise levels associated with piling propagating close to the coastline; where there are significantly high numbers of grey seal at Donna Nook.

333. 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 11-42 Number of Individuals (and % of Reference Population) That Could Be Disturbed During Piling at DBS East, DBS West, or the Offshore Export Cable Corridor In Isolation Based on the Dose-Response Approach

Marine Mammal Species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
Instantaneous behavioural disturbance due to a single, maximum energy monopile strike (SEL_{SS})			
Harbour porpoise	DBS East	4,295.5 (1.24% of the NS MU reference population)	Low
	DBS West	5,097.7 (1.47% of the NS MU)	Low
	Offshore Export Cable Corridor	7,940.5 (2.29% of the NS MU)	Low
Grey seal	DBS East	3,124.2 (10.21% of the SE England MU or 5.53% of the wider MU population)	High (Medium)
	DBS West	2,378.7 (7.78% of the SE England MU or 4.21% of the wider MU population)	Medium (Low)
	Offshore Export Cable Corridor	9,102.6 (24.00% of the SE England MU or 13.00% of the wider MU population)	High
Harbour seal	DBS East	8.1 (0.17% of the SE England MU)	Negligible
	DBS West	7.0 (0.14% of the SE England MU)	Negligible
	Offshore Export Cable Corridor	23.1 (0.47% of the SE England MU)	Negligible

11.6.1.2.2.3 Population Modelling for Piling

334. Population modelling using the Interim Population Consequence of disturbance (iPCoD) has been undertaken to determine the population consequences of disturbance due to piling at DBS East and DBS West sequentially, as the worst-case with the most disturbance days in comparison to DBS East and DBS West being constructed together.

335. While an assessment under the dose response curve approach is considered to be most realistic for both seal species, population modelling has been undertaken to determine whether the number of animals disturbed cause a population level effect. The results of this modelling for harbour porpoise, bottlenose dolphin, minke whale, grey seal and harbour seal will be used to determine the requirement for any noise reduction measures to be put in place, and it is this assessment of which the overall impact significances for disturbance from piling is assessed. 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)**.

336. 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.

11.6.1.2.2.3.1 Harbour Porpoise

337. The population modelling for harbour porpoise is based on:

- A worst-case of potentially 17,334 harbour porpoise disturbed;
  - The worst case results for the potential number of harbour porpoise that could be disturbed from one monopile installation came from the assessment using dose response curves. The potential numbers are at DBS East (4,295.5), DBS West (5,097.7) and the Offshore Export Cable Corridor (with the potential for 7,940.5 to be disturbed (**Table 11-39**).
- A total of 601.5 individuals at risk of PTS;
  - Based on the assessment of PTS (Impact range and number of potential individuals at risk of PTS) at DBS East (740m, 144 individuals) DBS West (720m, 132 individuals) and the Offshore Export Cable Corridor (830m, 325.5 individuals).

338. Harbour porpoise to be disturbed and at risk of PTS for every piling day with a piling schedule of 4 years. By the end of 2032 (2 years after piling ends, and six years after the onset of the disturbance) the median population size for the impacted population is predicted to be 99.89% of the unimpacted population. Beyond 2032, the impacted population is expected to maintain the same stable trajectory as the un-impacted population as far as 2052 which is the end point of the modelling (**Table 11-43**). Therefore, piling has very little impact to the population of harbour porpoise in the North Sea (**Table 11-43**).

339. **Plate 11-4** shows the mean unimpacted and the mean impacted population of harbour porpoise and overlaid both together. As stated in **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)**, the simulation is run a thousand times and includes other elements that could impact the population as well as pile driving. The figure shows that with piling at DBS East, DBS West and the Offshore Export Cable Corridor, there is no significant impact on the population of harbour porpoise. Therefore, the impact on the population is assessed as a negligible magnitude.

Table 11-43 Results of the iPCoD modelling for DBS East, DBS West and Offshore Export Cable Corridor sequentially scenario, giving the mean population size of harbour porpoise population (NS MU) for years up to 2052 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	346,601	346,601	100.00%
End 2028	346,557	346,549	99.99%
End 2029	346,574	346,445	99.96%
End 2032	346,020	345,641	99.89%
End 2037	346,105	345,700	99.88%
End 2047	344,767	344,358	99.88%
End 2052	344,000	343,589	99.88%

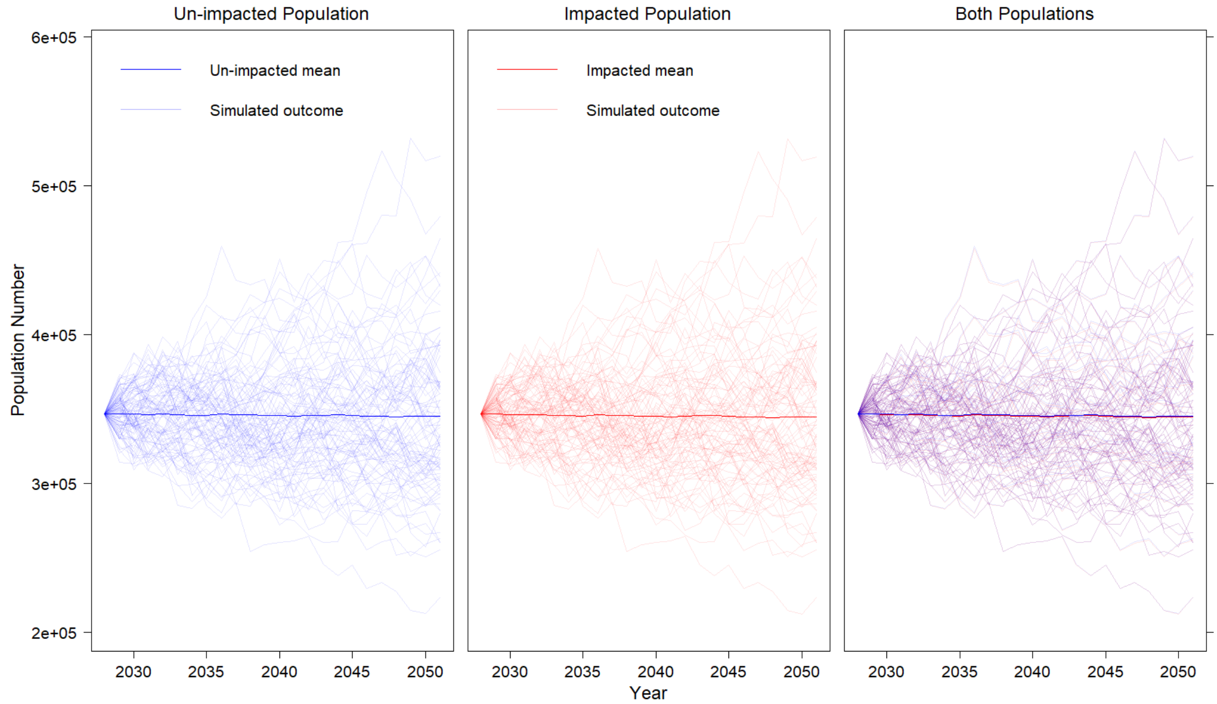

Plate 11-4 Simulated worst-case harbour porpoise population sizes for both the unimpacted and the impacted populations.

11.6.1.2.2.3.2 Bottlenose Dolphin

340. The population modelling for bottlenose dolphin is based on:

- A worst-case of a single bottlenose dolphin being disturbed;
- Based on using TTS impact ranges from disturbance (0.7 bottlenose dolphin combined from all three locations; **Table 11-31**);
- Less than one individual at risk of PTS at DBS East, DBS West and the Offshore Export Cable Corridor (combined from all three locations; **Table 11-24**); and
- The above number of bottlenose dolphin being impacted on each piling day with a piling schedule of 4 years.

341. 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 and remains stable at 100% until 2052, which is the end point of the modelling (**Table 11-44**).

342. Therefore the iPCoD model estimates there to be no change in between the impacted and unimpacted bottlenose dolphin population (**Table 11-44**) in the worst-case project scenario where both DBS East, DBS West and the Offshore Export Cable Corridor are constructed sequentially.

343. **Plate 11-5** shows the mean unimpacted and the mean impacted population of bottlenose dolphin and overlaid both together. The figure shows that with piling at DBS East, DBS West and the Offshore Export Cable Corridor, there is no impact on the population of bottlenose dolphin. Therefore, the impact on the population is assessed as having a negligible magnitude.

Table 11-44 Results of the iPCoD modelling for DBS East, DBS West and Offshore Export Cable Corridor sequentially scenario, giving the mean population size of bottlenose dolphin population (NS MU) for years up to 2052 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	2,022	2,022	100.00%
End 2028	2,011	2,011	100.00%
End 2029	1,997	1,997	100.00%
End 2032	1,957	1,957	100.00%
End 2037	1,9,05	1,9,05	100.00%
End 2047	1,803	1,803	100.00%
End 2052	1,750	1,750	100.00%

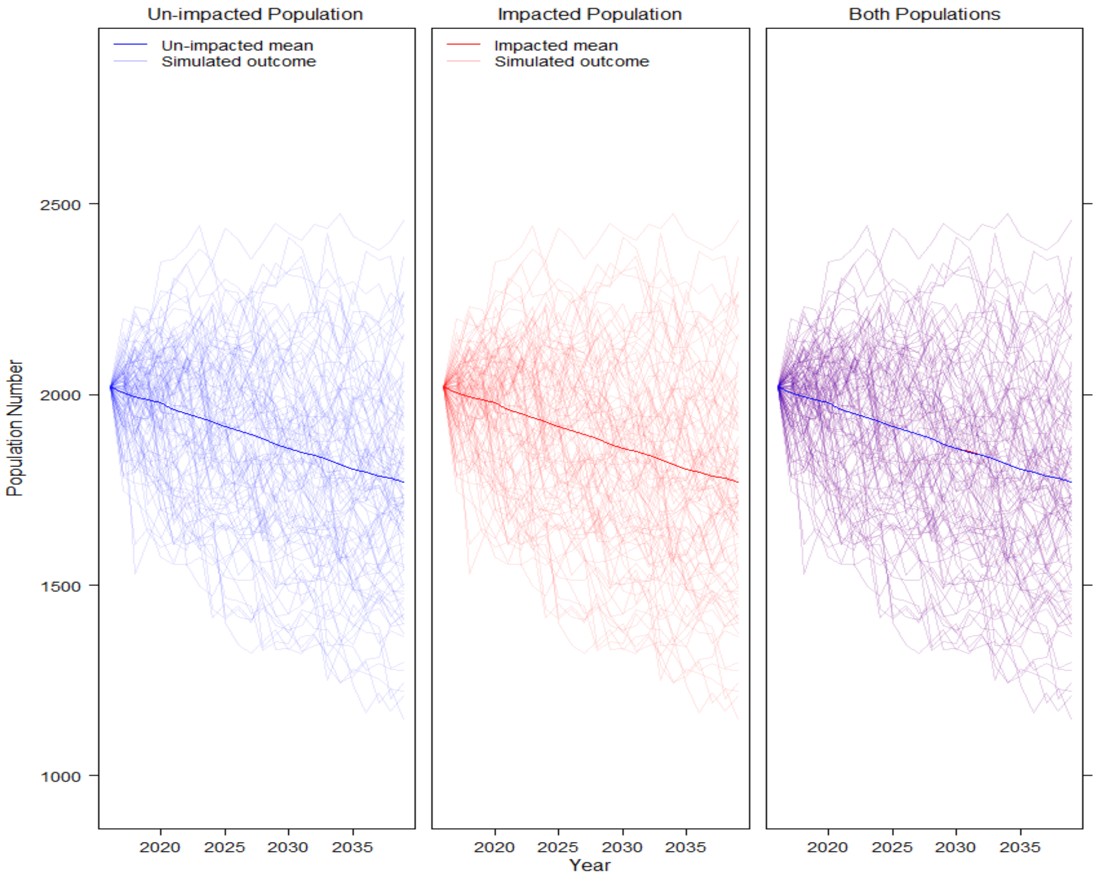

Plate 11-5 Simulated worst-case bottlenose dolphin population sizes for both the unimpacted and the impacted populations.

11.6.1.2.2.3.3 Minke Whale

344. The population modelling for minke whale is based on;

- A more realistic-case of up to 142 minke whale being disturbed (combined total for DBS East and DBS West Array Areas and the Offshore Export Cable Corridor; (based on the results of the 30km disturbance range assessment (**Table 11-40**), as reviewed based on the consultation comments from the PEIR);
- Up to 48 individuals could be impacted with PTS at DBS East, DBS West and the Offshore Export Cable Corridor (based on the combined total for all three locations; **Table 11-24**); and
- The above number of minke whale would be impacted on every piling day, with a piling schedule of 4 years.

345. By the end of 2032 (2 years after piling ends) the median population size for the impacted population is predicted to be 98.34% of the unimpacted population, and by 2052, which is the end point of the modelling) the median population size for the impacted population is predicted to be 96.31% the unimpacted population. Therefore the iPCoD model estimates there to be a small change between the impacted and unimpacted CGNS minke whale population (**Table 11-45**) in the worst-case project scenario where both DBS East, DBS West and the Offshore Export Cable Corridor are constructed sequentially. Within the first six years of the modelling, there has been a total change of 1.7%, which is not significant under the NRW (2023) guidance.

346. **Plate 11-6** shows the mean unimpacted and the mean impacted population of minke whale and overlaid both together. The figure shows that with piling at DBS East, DBS West and the Offshore Export Cable Corridor, there is a small but insignificant impact on the population of minke whale. Therefore, the impact on the population is assessed as a low magnitude.

Table 11-45 Results of the iPCoD modelling for DBS East, DBS West and Offshore Export Cable Corridor sequentially scenario, giving the mean population size of minke population (CGNS MU) for years up to 2052 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	20,118	20,118	100.00%
End 2028	20,101	20,099	99.99%
End 2029	20,101	20,018	99.58%
End 2032	20,065	19,732	98.34%
End 2037	19,959	19,369	97.04%
End 2047	19,851	19,119	96.31%
End 2052	19,861	19,109	96.21%

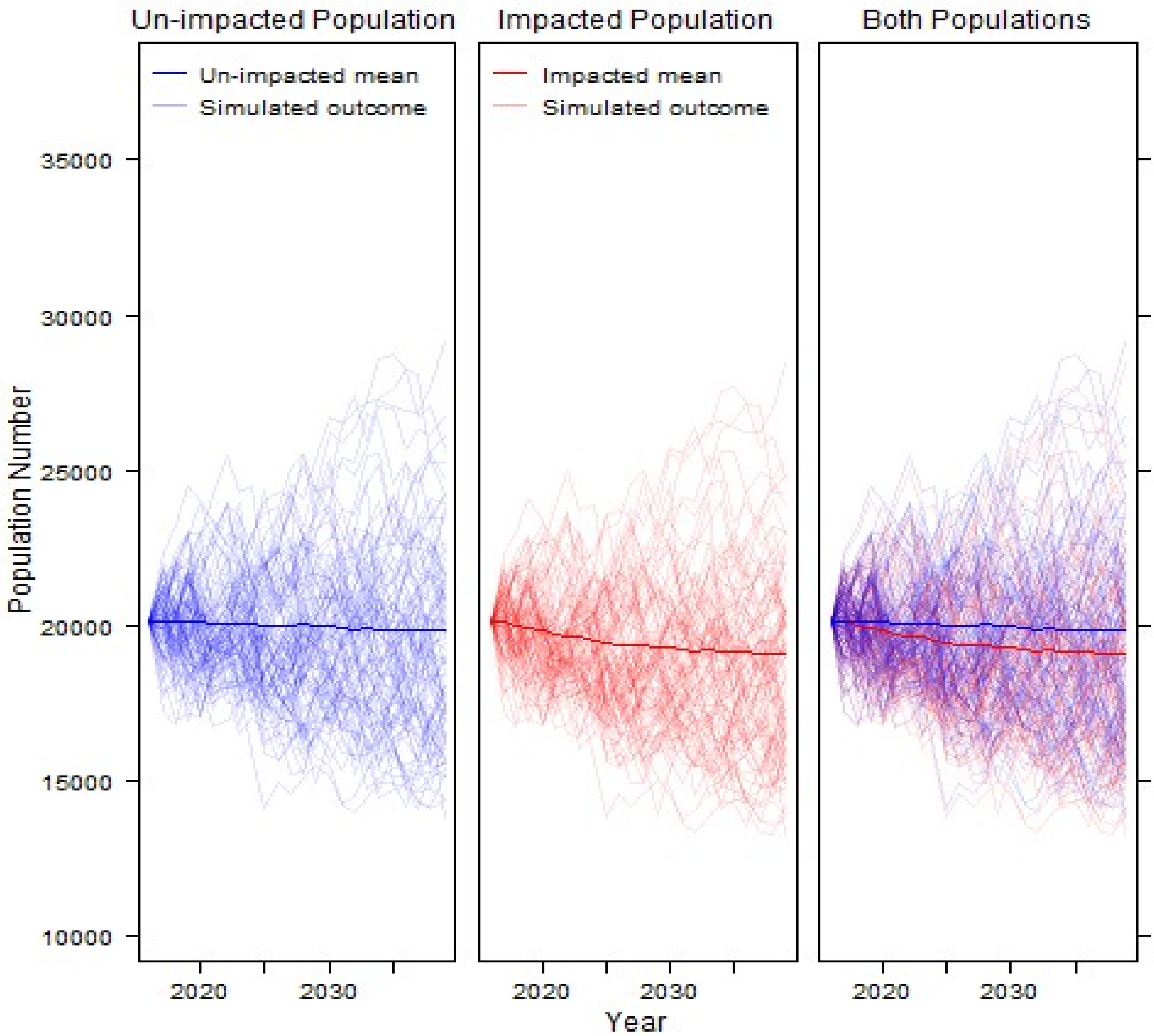

Plate 11-6 Simulated worst-case minke whale population sizes for both the unimpacted and the impacted populations.

11.6.1.2.2.3.4 Grey Seal

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

- A worst-case of up to 14,601 grey seal disturbed;
  - Based on the dose response curve assessments (3,124.2 at DBS East, 2,378.7 at DBS West and 9,102.6 individuals in the Offshore Export Cable Corridor; **Table 11-41**).

- Up to 15 individuals could at risk of PTS at DBS East, DBS West and the Offshore Export Cable Corridor (combined total from all three locations; **Table 11-24**); and
- The above number of grey seal being at risk of impact for every piling day with a piling schedule of 4 years.

348. For the SE England MU, by the end of 2032 (2 years after piling ends), the median population size for the impacted population is predicted to be 99.00% of the unimpacted population. Beyond 2032, the impacted population is expected to maintain relatively stable as the un-impacted population (99.00%) as far as 2052 which is the end point of the modelling (**Table 11-46**).

349. Looking at the wider MU, the median population size for the impacted population is predicted to be 100.00% of the unimpacted population (**Table 11-47**). Therefore, the iPCoD model estimate there no significant change between the impacted and unimpacted wider seal population (and the wider MU.

Table 11-46 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 (SE England MU) for years up to 2053 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	30,594	30,594	100.00%
End 2028	30,828	30,827	99.96%
End 2029	30,984	30,931	99.82%
End 2032	31,710	31,489	99.00%
End 2037	32,685	32,360	99.00%
End 2047	34,963	34,616	99.00%
End 2052	36,020	35,662	99.00%

Table 11-47 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 (Wider MU) for years up to 2052 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	56,502	56,502	100.00%
End 2028	56,793	56,793	100.00%
End 2029	57,236	57,237	100.00%
End 2032	58,162	58,164	100.00%
End 2037	59,823	60,638	100.00%
End 2047	63,742	63,318	100.00%
End 2052	66,147	66,150	100.00%

350. **Plate 11-7** shows the mean unimpacted and the mean impacted population of grey seal (SE England MU) and **Plate 11-8** (wider population) and overlaid both together. The figure 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 whale. Therefore, the impact on the population is assessed as having a negligible magnitude.

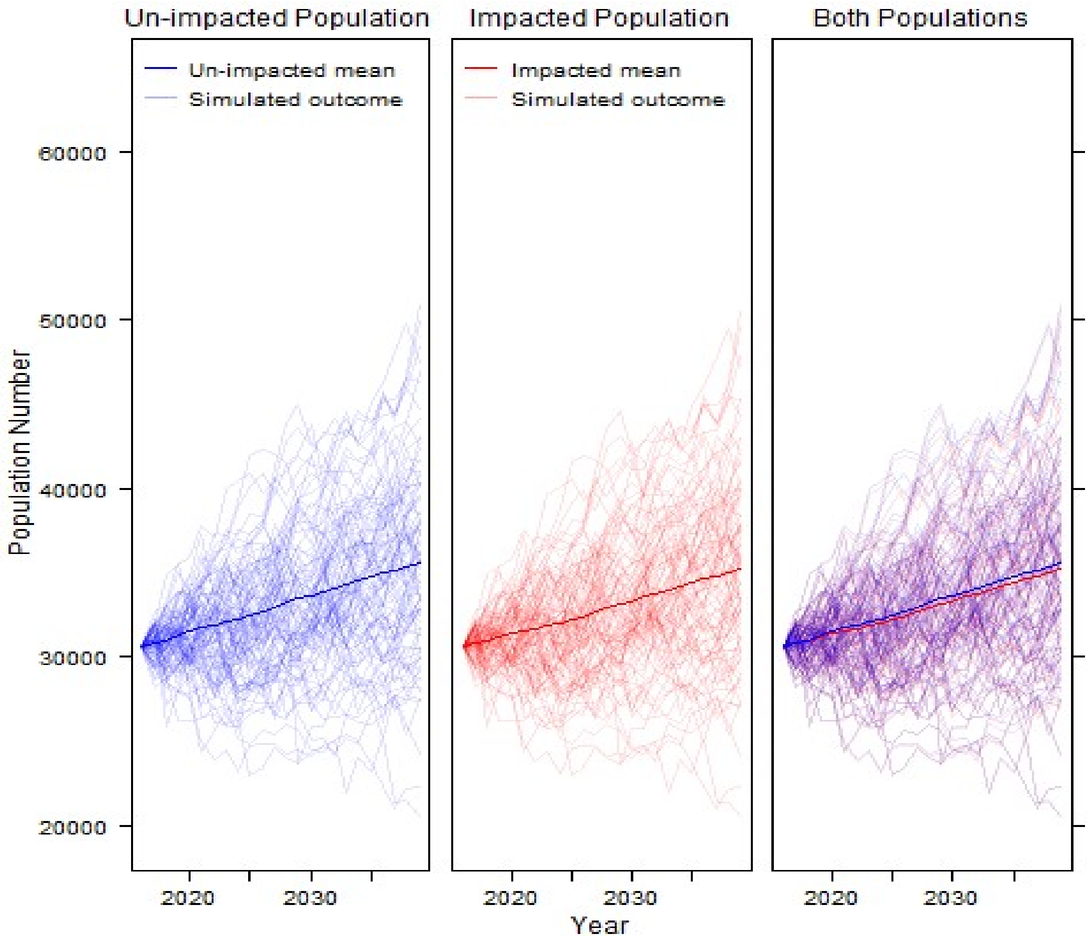

Plate 11-7 Simulated worst-case grey seal population sizes (SE England MU) for both the unimpacted and the impacted populations.

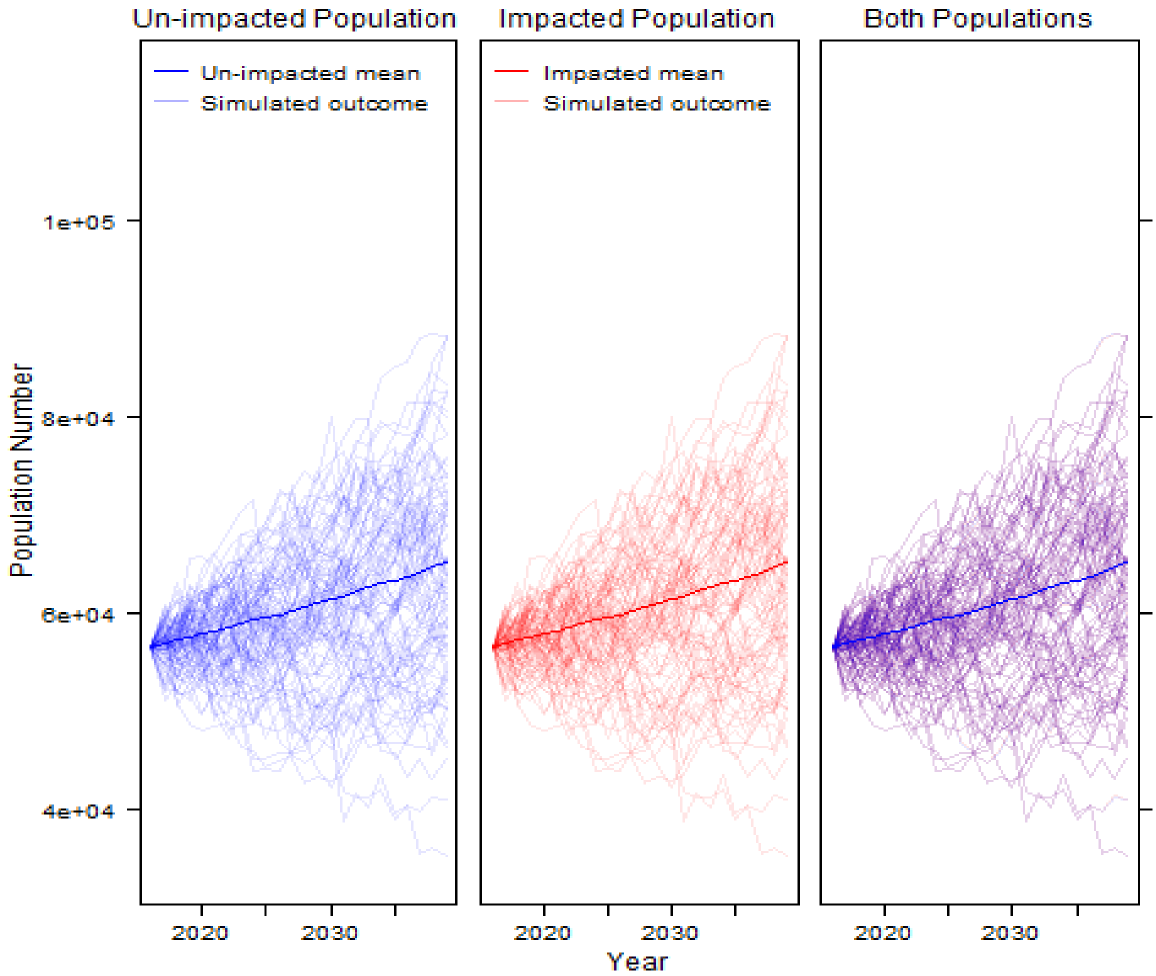

Plate 11-8 Simulated worst-case grey seal population sizes (SE & NE England (Wider) MU) for both the unimpacted and the impacted populations.

11.6.1.2.2.3.5 Harbour Seal

351. The harbour seal population modelling is based on:

- Assuming a worse case of potentially 39 harbour seal disturbed;
- Based on the assessments using the dose response curve assessment, (combined total for all three locations; **Table 11-41**).
- Up to one individual at risk of PTS at DBS East, DBS West and the Offshore Export Cable Corridor (**Table 11-24**); and
- The above harbour seal being impacted on every piling day with a piling schedule of 4 years.

352. 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 and remains stable at 100% until 2052, which is the end point of the modelling (**Table 11-56**). Therefore, the iPCoD model estimates there to be no change between the impacted and unimpacted SE England harbour seal population, for the worst-case project scenario where both DBS East, DBS West and the Offshore Export Cable Corridor are constructed sequentially.

353. **Plate 11-9** shows the mean unimpacted and the mean impacted population of harbour seal and overlaid both together. The figure shows that with piling at DBS East, DBS West and the Offshore Export Cable Corridor, there is no significant impact on the population of harbour seal in the SE England MU. Therefore, the impact on the population is assessed as have a negligible magnitude, considering a stable population of the SE England MU.

Table 11-48 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 (stable) population (SE England MU) for years up to 2052 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	4,870	4,870	100.00%
End 2028	5,073	5,073	100.00%
End 2029	5,266	5,266	100.00%
End 2032	5,941	5,941	100.00%
End 2037	7,214	7,214	100.00%
End 2047	10,725	10,752	100.00%
End 2052	13,090	13,091	100.00%

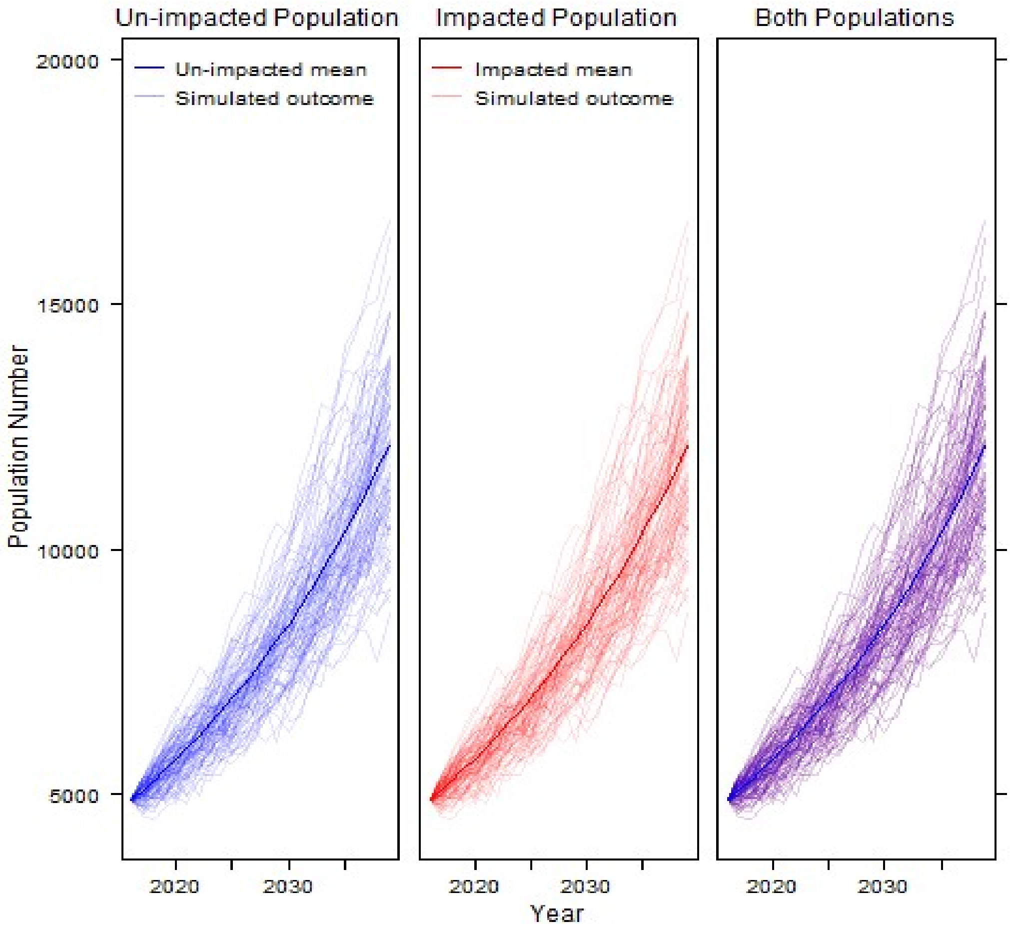

Plate 11-9 Simulated worst-case harbour seal (stable) population sizes for both the unimpacted and the impacted populations.

11.6.1.2.2.3.5.1 Harbour Seal (Declining Population)

354. Taking into consideration of the reports that the harbour seal SE England MU is in decline (SCOS, 2022), additional 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).

355. Using the same data for project related impacts as set our above, 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 and remains stable at 100% until 2052, which is the end point of the modelling (**Table 11-56**). Therefore the iPCoD model estimate there to no significant impact between the impacted and unimpacted SE England harbour seal population (**Table 11-49**), in the worst-case project scenario where both DBS East, DBS West and the Offshore Export Cable Corridor are constructed sequentially.

356. While there is a significant decline in the population, it is the same level of decline for either an impacted or un-impacted population, and therefore the Projects are not assessed as having any impact on that decline.

357. **Plate 11-10** shows the mean unimpacted and the mean impacted population of harbour seal and overlaid both together for a declining harbour seal population. The figure shows that with piling at DBS East, DBS West and the Offshore Export Cable Corridor, there is no significant impact on the declining population of harbour seal in the SE England MU. Therefore, the impact on the population is assessed as having a negligible magnitude.

Table 11-49 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 (declining) population (SE England MU) for years up to 2052 for both impacted and un-impacted populations as well as median ration between their populations

Year	Un-impacted pop. mean	Impacted pop. mean	Median impacted
Start	4,868	4,868	100.00%
End 2028	4,364	4,364	100.00%
End 2029	3,892	3,892	100.00%
End 2032	2,794	2,794	100.00%
End 2037	1,606	1,606	100.00%
End 2047	534	534	100.00%
End 2052	309	309	100.00%

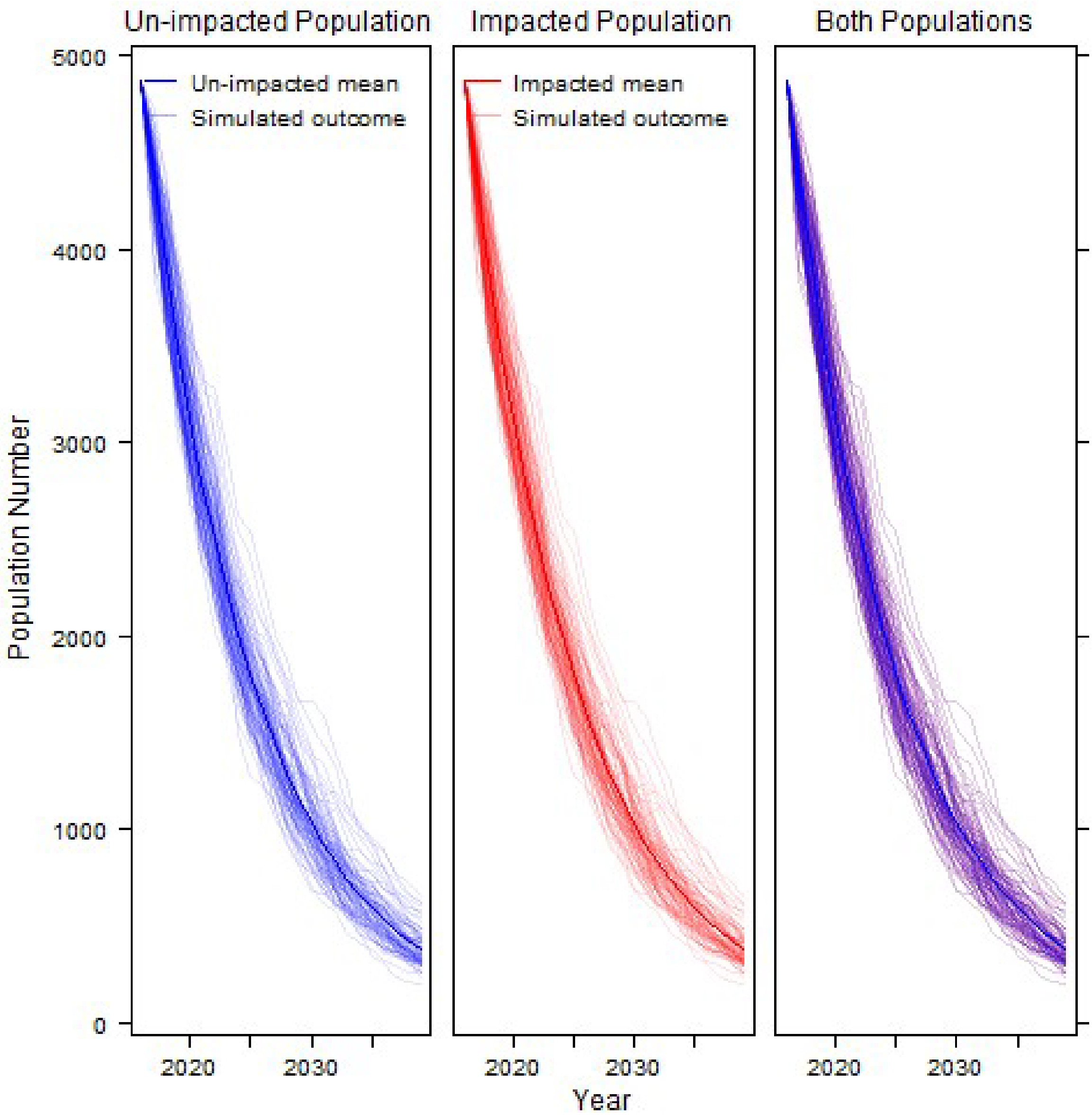

Plate 11-10 Simulated worst-case harbour seal (declining) population sizes for both the unimpacted and the impacted populations.

11.6.1.2.2.3.6 Summary of Population Level Consequences due to Disturbance

358. The results of population modelling for DBS East and DBS West piling as shown above show no significant difference in the population estimates at the end of the 25-year modelling period for the disturbed or un-disturbed populations.

359. There is the potential for a maximum of 0.05% reduction in the harbour porpoise population over the modelled period of 25 years (**Table 11-43**). For bottlenose dolphin the disturbance from piling at DBS East and DBS West would not cause a population level effect (**Table 11-44**).

360. There is a potential population decline of 3.69% in the minke whale population over the 25 years, and within the first six years of disturbance, there is a decline of 1.79%, which is not a significant decline under the NRW (2023) guidance (**Table 11-45**).

361. For the SE England population of grey seal, there is a potential decline of 0.005% (**Table 11-46**) and no population level effect for the wider MU (**Table** 11-47).

362. For harbour seal, carrying out the population modelling on either a stable or declining population results in the same overall assessment; that there is no population level effect on the SE England population (**Table 11-48**; **Table 11-49**).

11.6.1.2.2.4 Reduction in Foraging Due to Noise Disturbance

363. Whilst underwater noise has been shown to disturb cetaceans foraging at sea, it is expected that the main sources of disturbance will be short-term in nature. Construction activities such as piling will include measures to reduce the direct effects of noise on marine mammals, which will also help to mitigate disturbance to foraging behaviour and reduce the effect. In addition, the period of construction (approximately five years for each Project) is unlikely to increase this significantly. The magnitude of impact for harbour porpoise, dolphin species and minke whale is therefore low.

364. 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 (Hastie *et al.* 2021). This indicates that seals would choose to remain at a noisy environment, if there were good prey resources at the same location (Hastie *et al.* 2021).

365. The largest disturbance range for seal species for activities within the Offshore Export Cable Corridor would be 4km and for activities within the Array Areas would be 25km. Therefore, there is no potential for disturbance of seals from the identified key foraging areas of harbour seal. The magnitude of impact for grey seal and harbour seal is therefore low.

11.6.1.2.2.5 Disturbance During ADD Activation

366. The assessments of the potential disturbance during any ADD activation is indicative only, as the final requirements for mitigation in the MMMP will be determined prior to construction.

367. As outlined in section 11.3.3, additional mitigation to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing. The maximum predicted PTS impact ranges for a single pile installation are 13km for harbour porpoise, and 26km for minke whale, based on worst-case for cumulative exposure (SEL_{cum}) during installation of a monopile with a maximum of up to 6,000kJ (**Table 11-23**). The maximum predicted PTS SEL_{cum} impact ranges for the installation of a single jacket pin pile is 9.5km for harbour porpoise and 19km for minke whale. As mitigation will be undertaken before each pile is installed, it is appropriate to base the mitigation requirements (and therefore ADD activation times) on the installation of a single pile, rather than multiple sequential piles.

368. Based on a precautionary swim speed of 1.5m/s (Otani *et al.* 2000), prior to monopile installation, the ADD would need to be activated for a minimum of 145 minutes to ensure harbour porpoise were beyond the maximum 13km PTS impact range, or 134 minutes to ensure minke whale are beyond the 26km range.

369. Prior to jacket pin pile installation, the ADD would need to be activated for a minimum of 145 minutes to ensure harbour porpoise were beyond the maximum 9.5km PTS impact range, or 134 minutes to ensure minke whale are beyond the 19km range.

370. ADD devices such as the Lofitech seal scarer have been recorded to be effective out to–12 - 18km for harbour porpoise (Dähne *et al.* 2017) However, Tougaard *et al.* (2014) critically evaluated ADDs and the harbour porpoise noise criteria and found that avoidance of mostly 'mid-frequency' devices were at ranges between 1 and 7.5km. This indicates that even if the ADD is used for the 145 minutes a disturbance range of 13km might not be reached.

371. The use of ADDs for 145 minutes has the potential to cause disturbance and may be deemed as excessive. Therefore, the assessments for disturbance during ADD activation is based on 80 minutes for monopiles. Through consultation with regulators, the maximum an ADD can be operated will be confirmed in the final MMMP prior to construction, and will be based on the final pile design.

372. During an 80 minute ADD activation, harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal would move at least 7.2km from the ADD location, resulting in a potential disturbance area of 162.9km². Minke whale would move at least 15.6km from the ADD location during the 80 minute activation (based on a precautionary marine mammal swimming speed of 3.25m/s; Blix and Folkow 1995), resulting in a potential disturbance area of 764.5km² (**Table 11-50**).

Table 11-50 ADD Duration, Marine Mammal Swim Speed and Calculated Range

Species	Piling scenario	ADD duration required	Swim speed (m/s)	Range of deterrence	Area of deterrence
Harbour porpoise, Bottlenose dolphin, common dolphin, grey seal and harbour seal	Monopile at DBS East, DBS West, and Offshore Export Cable Corridor or jacket pin piles at DBS East and Offshore Export Cable Corridor	80 minutes	1.5	7.2km	162.86km²
Minke whale			3.25	15.6km	764.54km²
Harbour porpoise, Bottlenose dolphin, common dolphin, grey seal and harbour seal	Jacket pin pile at DBS West	70 minutes	1.5	6.3km	124.69km²
Minke whale			3.25	13.7km	585.35km²

373. The magnitude of the potential impact is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 1% or less of the relevant reference populations anticipated to be temporarily disturbed (**Table 11-51**).

Table 11-51 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.

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
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)	Negligible
	DBS West or Offshore Export Cable Corridor	107.5 (0.03% of the NS MU)	
Bottlenose dolphin	DBS East, DBS West or Offshore Export Cable Corridor	8.0 (0.40% of the GNS MU)	Negligible
Common dolphin	DBS East & DBS west or Offshore Export Cable Corridor	2.8 (0.003% of the CGNS MU)	Negligible
White-beaked dolphin	DBS East	5.5 (0.01% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	6.7 (0.02% of the CGNS MU)	
Minke whale	DBS East	7.7 (0.04% of the CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	15.3 (0.08% of the CGNS MU)	
Grey seal	DBS East	29.5 (0.10% of the SE E MU, or 0.05% of the wider MU)	Negligible (negligible)
	DBS West	42.3 (0.14% of the SE E MU, or 0.08% of the wider MU)	

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
	Offshore Export Cable Corridor	86.5 (0.28% of the SE E MU, or 0.15% of the wider MU)	
Harbour seal	DBS East or Offshore Export Cable Corridor	0.3 (0.006% of the SE England MU)	Negligible
	DBS West	0.2 (0.003% of the SE England MU)	
ADD duration of 70 minutes as required for jacket pin piles at DBS West			
Harbour porpoise	DBS West	82.3 (0.02% of the NS MU)	Negligible
Bottlenose dolphin	DBS West	6.1 (0.30% of the GNS MU)	Negligible
Common dolphin	DBS West	2.1 (0.002% of the CGNS MU)	Negligible
White-beaked dolphin	DBS West	5.1 (0.01% of the CGNS MU)	Negligible
Minke whale	DBS West	11.7 (0.06% of the CGNS MU)	Negligible
Grey seal	DBS West	32.4 (0.11% of the SE E MU, or 0.06% of the wider MU)	Negligible (negligible)
Harbour seal	DBS West	0.1 (0.003% of the SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.2.2.6 Duration of Piling and ADD Activation

374. The foundation installation period (for both monopiles and jacket pin piles) is currently expected to take place over approximately 18 months per project. This will include transit of the foundation components in batches to the Array Areas and foundation installation, including any piling.

375. 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. There is also the potential for up to two (for monopiles) or three (for jacket pin piles) vessels to be on site at the same time to install piles concurrently. This would potentially reduce the duration of the installation phase due to the potential overlap but not the duration of noise produced per pile.

376. **Table 11-52** summarises the worst case scenarios for the duration of piling based on the maximum number of wind turbines, number of piles and piling duration to install each pile, including soft-start and ADD activation. For monopiles, including ADD activation, there will be up to 30 days of active piling within the five-year offshore construction period (or for 1.6% of each Project's offshore construction period), and for jacket pin piles, including ADD activation, there will be up to 65 days of active piling within the offshore construction period (or for 3.6% of each Project's offshore construction period). Note that the actual active piling period will be less than this, as piling will not be required for the full 5.20 hours per pile for monopiles, or 3.10 hours per pile for jacket pin piles at all locations.

Table 11-52 Maximum Duration of Piling and ADD activation at each Array Area, Based on Worst Case Scenarios, Including Soft-Start, and ADD Activation

Parameter	Number of Piles	Maximum Active Piling Time per Pile	Total Piling Time	ADD Activation*	Total Duration
Up to 100 wind turbines	Up to 100 monopiles	320 minutes including soft-start and ramp-up	533 hours and 20 minutes for 100 monopiles	133 hours and 20 minutes for 80 min ADD activation per monopile	666 hours and 40 minutes with 80 min ADD activation for 100 monopiles

Parameter	Number of Piles	Maximum Active Piling Time per Pile	Total Piling Time	ADD Activation*	Total Duration
	Up to 400 jacket pin piles	190 minutes including soft-start and ramp-up	1,266 hours and 40 minutes for 400 jacket pin piles	133 hours and 20 minutes for 80 min ADD activation per jacket pin piles at DBS East Or 116 hours and 40 minutes for 70 min ADD activation per jacket pin piles at DBS West	1,400 hours with 80 min ADD activation for 400 jacket pin piles at DBS East Or 1,383 hours and 20 minutes with 70 min ADD activation for 400 jacket pin piles at DBS West
Up to four offshore platforms	Up to 4 monopiles	320 minutes including soft-start and ramp-up	22 hours for 4 monopiles	5.33 hours for 80 min ADD activation per monopile	Up to28 hours and with 80 min ADD activation for 4 monopiles
	Up to 32 jacket pin piles	190 minutes including soft-start and ramp-up	101.5 hours for 32 jacket pin piles	43 hours for 80 min ADD activation per jacket pin piles	Up to 145 hours minutes with 80 min ADD activation for 32 jacket pin piles
Piling of up to 104 monopiles and (including soft-start, ramp-up and ADD activation) = up to 694 hours (less than 30 days) or for 1.6% of the total piling programme days Or Piling of up to 432 jacket pin piles (including soft-start, ramp-up and ADD activation) = up to 1,544 hours (less than 65 days) or for 3.6% of the total piling programme days.					

**Where the ADD is used only once per foundation*

377. The duration of piling is based on a worst case scenario and a very precautionary approach. As has been shown at other OWFs, the duration used in the impact assessment can be overestimated. For example, for the installation of monopile foundations at Dudgeon Offshore Wind Farm, the impact assessment estimated a piling period of 93 days, time to install each monopile was estimated to be up to 4.5 hours and the estimated duration of active piling was 301.5 hours (approximately 13 days). However, the actual total duration of active piling was 65 hours (approximately 3 days) with the average time for installation per monopile of 71 minutes (Dudgeon Offshore Wind Farm Limited (DOWL), 2016). Therefore, the actual piling duration was approximately 21% of the predicted maximum piling duration.

378. The piling duration to install the individual monopiles at Dudgeon Offshore Wind Farm varied considerably for each location, and the worst case scenario of up to 4.5 hours to install a pile was an accurate assessment of the actual maximum duration (4.35 hours), however the majority of piles were installed in much shorter duration. At Dudgeon Offshore Wind Farm, the time intervals between the installations of individual monopiles (not including time to collect further piles for installation) was on average of approximately 23 hours. Monopiles were installed in groups of up to three, due to the capacity of the piling vessel, which meant that it could only carry three monopiles and three transition pieces before returning to port to collect the next three monopiles. The intervals between groups of monopiles being installed ranged from approximately 2.5 days to 11 days, with an average of approximately four days between the 22 groups of three monopiles (DOWL 2016).

379. Similar results were also observed for the Beatrice Offshore Wind Farm, where within the ES it was estimated that each pin pile would require 5 hours of active piling time. However, during construction, the total duration of piling ranged from 19 minutes to 2 hours and 45 minutes, with an average duration of 1 hour and 15 minutes per pile (Beatrice Offshore Wind Farm Ltd 2018).

380. Once the piling is completed, the duration of the exclusion could last up to three days following a single piling event if the animal is close to the source. Data presented by Brandt *et al.* (2009, 2011) indicated that harbour porpoise would completely leave the area (indicated by the duration of waiting time between porpoise detections after first piling) for a median time of 16.6 hours and a maximum of 74.2 hours within 0.5 to 6.0km of the noise source. Waiting times did not return to 'normal' until 22.7 hours after piling. At distances of greater than approximately 9.0km from the noise source there was a much shorter duration of effect; with waiting times returning to 'normal' between one and 2.6 hours after piling ceased. However, at 18 to 25km there was still a marked effect. Porpoise activity was significantly lower within approximately 3km of the noise source for 40 hours after piling.

381. A study on the effects of OWF construction on harbour porpoise within the German North Sea between 2009 and 2013 (Brandt *et al.* 2016), indicated that the duration of effect after piling was about 20-31 hours within close vicinity of the construction site (up to 2km) and decreased with increasing distance. The study also observed significant decreases in porpoise detections prior to piling at distances of up to 10km, which is thought to relate to increased vessel activity during preparation works. The study concluded that although there were adverse short-term effects (1-2 days in duration) of construction on acoustic porpoise detections, there was no indication that harbour porpoises within the German Bight were negatively affected by wind farm construction at the population level (Brandt *et al.* 2016). It is acknowledged that some of the projects included in this study used noise mitigation techniques.

382. The duration of any potential displacement effect will differ depending on the distance of the individual from the piling activity and the noise level the animal is exposed to. Furthermore, those individuals that are distant from the activity that do not respond, and therefore are not affected, will continue with their normal behaviour that may involve approaching the wind farm area.

383. Nabe-Nielsen *et al.* (2018) developed the DEPONS (Disturbance Effects of Noise on the Harbour Porpoise Population in the North Sea) model to simulate individual animal's movements, energetics and survival for assessing population consequences of sub-lethal behavioural effects. The model was used to assess the impact of OWF construction noise on the North Sea harbour porpoise population, based on the acoustic monitoring of harbour porpoise during construction of the Gemini OWF. Local population densities around the Gemini OWF recovered 2–6 hours after piling, similar recovery rates were obtained in the model. The model indicated that, assuming noise influenced porpoise movements as observed at the Gemini Offshore Wind Farm, the North Sea harbour porpoise population was not affected by construction of 65 OWFs, as required to meet the EU renewable energy target (Nabe-Nielsen *et al.* 2018).

384. The DEPONS model determined that at the North Sea scale, population dynamics were indistinguishable from those in the noise-free baseline scenario when porpoises reacted to noise up to 8.9km from the construction sites, as at the Gemini OWF. Underwater noise from OWF construction noise only influenced population dynamics in the North Sea when simulated animals were assumed to respond at distances exceeding 20–50km from the OWFs. Indicating that in these scenarios, the population effect of noise was more strongly related to the distance at which animals reacted to noise (Nabe-Nielsen *et al.* 2018). The duration of any potential displacement effect will differ depending on the distance of the individual from the piling activity and the noise level to which the animal is exposed.

11.6.1.2.3 Magnitude of Impact – DBS East and DBS West Together

11.6.1.2.3.1 Disturbance / Displacement of Marine Mammals Based on Known Disturbance Ranges for Piling

11.6.1.2.3.1.1 Harbour Porpoise

385. The estimated number of harbour porpoise and percentage of the North Sea 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 piling.

386. The estimated number of harbour porpoise and percentage of the North Sea 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 11-53**. Based on the worst case scenario of two concurrent piling events, the magnitude of the potential impact is assessed as low for the 26km EDR for monopiles, with 0.77% (or less) of the reference population anticipated to be affected, or negligible for the 15km EDR for jacket pin piles, with 0.39% or less of the reference population anticipated to be temporarily disturbed (**Table 11-53**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 11-53 Assessment of the Potential for Disturbance to Harbour Porpoise Based on the EDR Approach for Monopiles and Jacket Pin Piles, and for Concurrent Piling Events

Species	Potential disturbance range and area*	Location	Assessment of impact effect (number of individuals and % of reference population)	Magnitude of Impact (temporary)
Harbour porpoise	EDR of 26km for monopiles, at two concurrent locations	DBS East & DBS West	2,675.9 (0.77% of the NS MU)	Negligible
	EDR of 15km for jacket pin piles, at three concurrent locations	DBS East, DBS West, & Offshore Export Cable Corridor	1,357.2 (0.39% of the NS MU)	Negligible

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

11.6.1.2.3.1.2 Bottlenose Dolphin, Common Dolphin, and White-Beaked Dolphin

387. For dolphin species, there is very little information on the potential disturbance ranges due to impact piling (or any impulsive noise source). There have been some studies looking at the impacts of impulsive noise to dolphins, where some have shown some signs of avoidance (Graham *et al.* 2017) and in have shown no signs of impact (Fernandez-Betelu *et al.* 2021) (section 11.6.1.2.1.2). Therefore, in the absence of any further information, the assessment as undertaken for TTS / fleeing response is used to inform the potential for a disturbance effect for all dolphin species, and represents the worst-case for the cumulative exposure from the Concurrent Scenario (**Table 11-33**). There is therefore the potential for a negligible magnitude of impact for all dolphin species, due to the potential disturbance effect of piling of either monopiles or jacket pin piles at DBS East and DBS West together (**Table 11-34**).

11.6.1.2.3.1.3 Minke Whale

388. **Table 11-34** presents the assessment as undertaken for TTS / fleeing response can be used to inform the potential for a disturbance effect range of minke whales for DBS East and DBS West together. The magnitude of impact was assessed as low.

389. However, using a 30km disturbance range as stated in section 11.6.1.2.2.1 could be a more realistic approach to a potential EDR. For two concurrent pilling events the impact range would be 5,654.86km^2 (**Table 11-54**) for DBS East and DBS West together.

Table 11-54 Assessment of the Potential for Disturbance to minke whale Based on an EDR Approach for Monopiles and Jacket Pin Piles, and for Concurrent Piling Events

Species	Potential disturbance range and area	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
Minke whale	Monopiles at two concurrent locations (EDR – 30km, with a disturbance area of 5,654.9km^2)	DBS East & DBS West	84.8 (0.42% of the CGNS MU)	Negligible

Species	Potential disturbance range and area	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
	Jacket pin piles at three concurrent locations (EDR – 30km, with a disturbance area of 8,482.3km^2)	DBS East, DBS West, & Offshore Export Cable Corridor	141.4 (0.70% of the CGNS MU)	Negligible

390. There is therefore the potential for a negligible magnitude of impact for minke whale from the disturbance of piling of either monopiles or jacket pin piles at DBS East and DBS West together.

11.6.1.2.3.1.4 Grey Seal and Harbour Seal

391. Regarding both grey and harbour seal, 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 *et al.* 2016). This range has been used to determine the number of grey seal and harbour seal 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 piling at DBS East, DBS West and the Offshore Export Cable Corridor (with a disturbance area of 5,890.5km^2), and applying the worst case density for each species (**Table 11-55**).

392. The magnitude of the potential impact is assessed as low for grey seal at both DBS Projects together, and negligible for harbour seal at both DBS Projects together (**Table 11-55**). Note that this does not assume any overlap between disturbance areas from the piling events and is therefore precautionary.

Table 11-55 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

Species	Potential disturbance range and area	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
Grey seal	Monopiles at two concurrent locations (EDR – 25km, with a disturbance area of 3,927km^2)	DBS East & DBS West	865.9 (2.8% of the SE England MU or 1.5% of the wider MU)	Low (Low)
	Jacket pin piles at three concurrent locations (EDR – 25km, with a disturbance area of 5,890.5km^2)	DBS East, DBS West, & Offshore Export Cable Corridor	1,376.4 (4.5% of the SE England MU or 2.4% of the wider MU)	Low (Low)
Harbour seal	Monopiles at two concurrent locations (EDR – 25km, with a disturbance area of 3,927km^2)	DBS East & DBS West	5.3 (0.11% of the SE England MU)	Negligible
	Jacket pin piles at three concurrent locations (EDR – 25km, with a disturbance area of 5,890.5km^2)	DBS East, DBS West, & Offshore Export Cable Corridor	7.3 (0.15% of the SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.2.3.2 Dose Response Curve Assessment (Harbour Porpoise and Seals Only)

393. The estimated numbers (and percentage of the relevant reference populations) of harbour porpoise, grey seal, and harbour seal disturbed as a result of underwater noise during piling at DBS East and DBS West together are presented in **Table 11-56**, based on one monopile installation at DBS East at the same time as one monopile installation at DBS West.

394. The magnitude of the potential impact is assessed as low for harbour porpoise, and negligible for harbour seal with less than 5% and less than 1% of the respective MU reference population predicted to be disturbed. For grey seal, the magnitude of the potential impact is medium to high, for monopiles installed at DBS East and DBS West concurrently (**Table 11-56**). These results for grey seal are due to the noise levels associated with piling propagating close to the coastline; where there are significantly high numbers of grey seal at Donna Nook.

395. 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 11-56 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

Marine Mammal Species	Assessment of impact (number of individuals and % of reference population)	Magnitude of Impact (temporary)
Instantaneous behavioural disturbance at maximum energy monopile strike (SEL_{SS}) at two locations (DBS East and DBS West together)		
Harbour porpoise	9,393.2 harbour porpoise (2.7% of the NS MU)	Low
Grey seal	5,502.9 grey seal (18.0% of the SE England MU or 9.74% of the wider MU population)	High (medium)
Harbour seal	15.1 harbour seal (0.31% of the SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.2.3.3 Population Modelling for Piling

396. As outlined in section 11.6.1.2.2.3, population modelling has been undertaken for both DBS East and DBS West together, and therefore the results presented for the assessment of DBS East or DBS West in isolation are valid for the Projects together. 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 Offshore Export Cable Corridor 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 100 days of piling was modelling for DBS East over a two year period, followed by DBS West (100 monopiles over two years) and randomly two monopiles in the Offshore Export Cable Corridor.

397. The potential magnitude of impact effect would be negligible for harbour porpoise, bottlenose dolphin, grey seal, and harbour seal, and would be low for minke whale.

11.6.1.2.3.4 Reduction in Foraging Due to Noise Disturbance

398. As the construction period for the DBS Projects together is the same duration as one Project being built in isolation (approximately five years for the DBS Projects together) it is unlikely to increase the predicted disturbance from DBS East or DBS West in isolation significantly. The magnitude of impact for harbour porpoise, dolphin species and minke whale is therefore low.

399. The largest disturbance range for seal species for activities within the Offshore Export Cable Corridor would be 4km (section 11.6.1.3.3), and for activities within the Array Areas has been assessed on the worst case of two installations at any one time (**Table 11-55**). The number of seals with the potential to be disturbed by three concurrent installations does not take into account the overlap between disturbance areas between the three locations making the impact highly precautionary. Due to the distance of the Array Areas from the coast, there is no potential for disturbance of seals from the identified key foraging areas of harbour seal. The magnitude for grey seal and harbour seal to a reduction in foraging due to noise disturbance is expected to remain low.

11.6.1.2.3.5 Disturbance During ADD Activation

400. As outlined in section 11.6.1.2.2.5, additional mitigation to reduce the risk of PTS could include activation of ADDs prior to the soft-start commencing, and the final requirements for mitigation in the MMMP will be determined prior to construction.

401. The maximum predicted PTS impact ranges for construction of DBS East and West are given in **Table 11-23**. The assessment has been undertaken based on the precautionary approach of totalling the number of marine mammals that may potentially be disturbed as provided in **Table 11-50**, using the worst case density for each species. The magnitude of the potential impact is assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with 1% or less of the relevant reference populations anticipated to be temporarily disturbed, and as low for bottlenose dolphin, with between 1% and 5% potentially disturbed (**Table 11-57**).

Table 11-57 Assessment of the Potential for Disturbance Due to ADD Activation Based on the Worst Case 80 Minute Duration for Monopile at DBS East and DBS West Together

Marine mammal species	Location	Assessment of impact (number of individuals and % of reference population)	Magnitude of impact* (temporary)
Harbour porpoise	DBS East, DBS West, & Offshore Export Cable Corridor	312.7 (0.09% of the NS MU)	Negligible
Bottlenose dolphin	DBS East, DBS West, & Offshore Export Cable Corridor	24.0 (1.2% of the GNS MU)	Low
Common dolphin	DBS East, DBS West, & Offshore Export Cable Corridor	8.3 (0.008% of the CGNS MU)	Negligible
White-beaked dolphin	DBS East, DBS West, & Offshore Export Cable Corridor	18.9 (0.04% of the CGNS MU)	Negligible
Minke whale	DBS East, DBS West, & Offshore Export Cable Corridor	38.2 (0.19% of the CGNS MU)	Negligible
Grey seal	DBS East, DBS West, & Offshore Export Cable Corridor	158.3 (0.52% of the SE England MU, or 0.28% of the wider MU).	Negligible (negligible)
Harbour seal	DBS East, DBS West, & Offshore Export Cable Corridor	0.7 (0.01% of the SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.1.2.3.6 Duration of Piling and ADD Activation.

402. The foundation installation period (for both monopiles and jacket pin piles) is currently expected to take place over between 18 months for both Projects installed concurrently, or for 36 months if installed sequentially. This will include transit of the foundation components in batches to the Array Areas and foundation installation, including any piling.

403. **Table 11-58** summarises the worst case scenarios for the duration of piling based on the maximum number of wind turbines, number of piles and piling duration to install each pile, including soft-start and ADD activation.

404. For monopiles, including ADD activation, there will be up to 47 days of active piling within an 18 month foundation installation period (or for 8.7% of an 18 month installation period), and for jacket pin piles, including ADD activation, there will be less than 125 days of active piling within the foundation installation period (or for 22.9%). Note that the actual active piling period will be less than this, as piling will not be required for the full 5.20 hours per pile for monopiles, or 3.10 hours per pile for jacket pin piles at all locations.

Table 11-58 Maximum Duration of Piling and ADD activation at DBS Project Areas Together, based on Worst Case Scenarios, Including Soft-Start, and ADD Activation

Parameter	Number of Piles	Maximum Active Piling Time per Pile	Total Piling Time	ADD Activation*	Total Duration
Up to 200 wind turbines	Up to 200 monopiles	320 minutes including soft-start and ramp-up	1,066 hours and 40 minutes for 200 monopiles	266 hours and 40 minutes for 80 min ADD activation per monopile	1,333 hours and 20 minutes with 80 min ADD activation for 200 monopiles
	Up to 800 jacket pin piles	190 minutes including soft-start and ramp-up	2,533 hours and 20 minutes for 400 jacket pin piles	250 hours and for 80 min ADD activation per jacket pin piles at DBS East and 71 minutes ADD activation at DBS West	2,783 hours and 20 minutes with for 400 jacket pin piles

<table>
<tr><th>Parameter</th><th>Number of Piles</th><th>Maximum Active Piling Time per Pile</th><th>Total Piling Time</th><th>ADD Activation*</th><th>Total Duration</th></tr>
<tr><td rowspan="2">Up to eight offshore platforms</td><td>Up to 8 monopiles</td><td>320 minutes including soft-start and ramp-up</td><td>42 hours and 40 minutes for 8 monopiles</td><td>10 hours and 40 minutes for 80 min ADD activation per monopile</td><td>52 hours and 20 minutes with 80 min ADD activation for 8 monopiles</td></tr>
<tr><td>Up to 64 jacket pin piles</td><td>190 minutes including soft-start and ramp-up</td><td>152 hours for 48 jacket pin piles</td><td>64 hours 80 min ADD activation per jacket pin piles</td><td>216 hours with for 80 min ADD activation for 48 jacket pin piles</td></tr>
<tr><td colspan="6">Piling of up to 208 monopiles and (including soft-start, ramp-up and ADD activation) = up to 1,109 hours and 20 minute (less than 47 days) or for 8.7% of the total piling programme days.
Or
Piling of up to 864 jacket pin piles (including soft-start, ramp-up and ADD activation) = up to 2,999 hours and 20 minutes (less than 125 days) or for 22.9% of the total piling programme days.</td></tr>
</table>

**Where the ADD is used only once per foundation*

11.6.1.2.4 Sensitivity of Receptor

405. Marine mammals may exhibit varying intensities of behavioural response at different noise levels. These 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. The response can vary due to exposure level, the hearing sensitivity of the individual, context, previous exposure history or habituation, motivation and ambient noise levels (e.g. Southall *et al.* 2007).

406. The response of individuals to a noise stimulus will vary and not all individuals will respond; however, for the purpose of this assessment, it is assumed that at the disturbance range, 100% of the individuals exposed to the noise stimulus will respond and be displaced from the area. However, 100% displacement is highly unlikely, therefore this is a very precautionary approach.

407. 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.

408. Harbour porpoise have relatively high daily energy demands and need to consume between 4% and 9.5% of their body weight in food per day (Kastelein *et al.* 1997). If a harbour porpoise does not capture enough prey to meet its daily energy requirements it can rely on stored energy (primarily blubber) for an estimated three to five days, depending on body condition (Kastelein *et al.* 1997). Should harbour porpoise be excluded from an area of key prey resource it will likely seek an alternative food resource and this could have an effect on the individual's fitness. For example, they may have to travel further or take less than optimum prey species. The effects on an individual's fitness are partly caused by the exclusion of animals from high-quality foraging areas and partly by the net energy losses associated with fleeing from disturbances (Nabe-Nielsen *et al.* 2014). Therefore, impacts in lower quality habitat are likely to have a lower potential impact on an animal's fitness.

409. Harbour porpoise are assessed as having medium sensitivity to disturbance from foraging at sea during construction.

410. Minke whales spend approximately 15% of their time foraging and have been shown to exhibit reduced foraging behaviour in the presence of increased vessel traffic. For example, in a study looking at the effects of wildlife tour boats on minke whale behaviour, a decrease in energy intake of 42% was estimated during disturbance events lasting one hour, as a result of reduced time spent foraging and surface feeding (Christiansen *et al.* 2013). It is therefore possible that construction vessels will have a similar effect, with the additional disturbance sources of noise from construction activities such as piling (see Impacts 1 and 2).

411. Minke whale are expected to move away from sources of noise and have been shown to demonstrate increased horizontal movement and swimming speeds from anthropogenic disturbance, likely leading to a short-term change in foraging behaviour (Christiansen *et al.* 2014). In addition, navy training operations have been shown to produce similar effects, with increased horizontal avoidance movements during disturbances that included vessel traffic and the use of sonar, likely resulting in a decrease in time spent foraging. It was noted these behaviours were largely short-term and isolated to during disturbance events (Durbach *et al.* 2021).

412. Minke whale are therefore assessed as having a medium sensitivity to disturbance to foraging at sea during construction.

413. For dolphin species, human-caused disturbance could result in the movement of prey away from dolphin foraging areas, the displacement of dolphins from their foraging grounds, or could reduce the ability of dolphins to forage even if both dolphins and prey remain in the area of the disturbance. As a result, dolphins may spend more energy trying to catch food, catch less food, or even be forced into a fasting state because they cannot obtain food. As the dolphins in the North Sea are part of a large, open populations with no food limitation they appeared to be able to withstand a higher probability of disturbance (New *et al.* 2020).

414. All dolphin species are therefore assessed as having a low sensitivity to disturbance to foraging at sea during construction.

415. Grey seal and 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 (Rosen and Renouf 1997; Bäcklin *et al.* 2011). Although adult seals may be relatively robust to short term (weeks rather than days compared to harbour porpoise) 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). Although disturbance to harbour or grey seal may lead to a severe or sustained avoidance of an area, these species can be considered less sensitive to such an impact than harbour porpoise (low sensitivity).

416. The sensitivity of both seal species to disturbance is therefore considered to be low in this assessment.

11.6.1.2.5 Significance of Effect – DBS East or DBS West In Isolation

417. The assessment for the potential for disturbance to marine mammals due to both monopile and jacket pin pile installation is provided in **Table 11-59,** taking into account the sensitivity and the potential magnitude of the impact.

418. The significance of effect for disturbance based only on the results of the population modelling where it was possible to undertake that assessment approach, as the most realistic assessment of the potential effect. Where it was not possible to undertake population modelling (i.e. for common dolphin and white-beaked dolphin), alternative methods of assessment have been used to inform the assessment.

419. For the potential for disturbance from piling at either DBS East or DBS West, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal, the overall effect significance has been assessed as **negligible adverse** (not significant in EIA terms). For harbour porpoise and minke whale, the overall effect has been assessed as **minor adverse** (not significant in EIA terms) (**Table 11-59**).

420. The significance of effect for disturbance from piling on disturbance to marine mammals foraging at sea has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-59**).

Table 11-59 Assessment of Significance of Effect for the Potential for Disturbance from Monopiles and Jacket Pin Piles for DBS East or DBS West In Isolation

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
Potential for disturbance			
Common dolphin and white-beaked dolphin (based on TTS / fleeing response)	Low	Negligible	Negligible adverse
Population level of effect from disturbance			
Harbour porpoise	Medium	Negligible	Minor adverse
Bottlenose dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse
Minke whale	Medium	Low	Minor adverse

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
Reduction in foraging due to underwater noise disturbance			
Harbour porpoise and minke whale	Medium	Low	Minor adverse
Bottlenose dolphin, common dolphin and white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse
Potential for disturbance from ADD activation prior to piling			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
Bottlenose dolphin, common dolphin and white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse

11.6.1.2.6 Significance of Effect – DBS East and DBS West Together

421. The assessment for the potential for disturbance to marine mammals due to both monopile and jacket pin pile installation is provided in **Table 11-60,** taking into account the sensitivity for marine mammals and the potential magnitude of the impact.

422. As for the assessment for DBS East or DBS West in isolation, the significance of effect for disturbance is based only on the results of the population modelling where it was possible to undertake that assessment approach, as the most realistic assessment of the potential effect. Where it was not possible to undertake population modelling (i.e. for common dolphin and white-beaked dolphin), alternative methods of assessment have been used to inform the assessment.

423. The significance of effect for disturbance from piling has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, common dolphin, white-beaked dolphin and minke whale, and as negligible (not significant in EIA terms) for bottlenose dolphin, grey seal and harbour seal, for either monopiles or jacket pin piles (**Table 11-60**).

424. The significance of effect for disturbance from piling on disturbance to marine mammals foraging at sea has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-60**). For disturbance from ADD activation, the overall effect significance has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-60**).

Table 11-60 Assessment of Significance of Effect for the Potential for Disturbance from Monopiles and Jacket Pin Piles for DBS East and DBS West Together

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
Potential for disturbance			
Common dolphin and white-beaked dolphin (based on TTS / fleeing response)	Low	Negligible	Minor adverse
Population level of effect from disturbance			
Harbour porpoise	Medium	Negligible	Minor adverse
Bottlenose dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse
Minke whale	Medium	Low	Minor adverse
Reduction in foraging due to underwater noise disturbance			
Harbour porpoise and minke whale	Medium	Low	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse
Potential for disturbance from ADD activation prior to piling			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
Common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Minor adverse
Bottlenose dolphin	Low	Low	Minor adverse

11.6.1.2.7 Mitigation and Residual Significance of Effect – DBS East or DBS West In Isolation

425. No mitigation is required for disturbance from underwater noise from piling for DBS East or DBS West in isolation. Therefore, the residual significance of effect for disturbance would be **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-59**).

11.6.1.2.8 Mitigation and Residual Significance of Effect – DBS East and DBS West Together

426. No mitigation is required for disturbance from underwater noise from piling at DBS East and DBS West together. Therefore, the residual significance of effect for disturbance would be **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-60**).

11.6.1.3 Impact 3: TTS and Disturbance from Underwater Noise During Other Construction Activities

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

428. 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.

429. Dredging and cable installation activities have the potential to generate underwater noise at sound levels and frequencies for sufficient durations to disturb marine mammals.

430. There are no clear indications that underwater noise caused by the installation of subsea 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).

431. The noise levels produced during dredging and cable installation activities can vary, for example, with dredger type, cable installation method, as well as environmental conditions, including sediment type, water depth, salinity and thermoclines and ambient noise levels (Jones and Marten 2016; Robinson *et al.* 2011; Theobald *et al.* 2011). These factors will influence the distance at which sounds can be detected.

432. 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.* 2014), 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). Therefore, the potential risk of any auditory injury in marine mammals as a result of dredging activity is highly unlikely.

433. 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.* 2014).

434. Underwater noise as a result of dredging and cable installation activities has the potential to disturb or result in behavioural responses in marine mammals (Pirotta *et al.* 2013; Todd *et al.* 2014; Southall *et al.* 2007). However, the results of tagging harbour seal in the Wash in 2012 (Russell 2016b), indicated foraging activity took place during wind farm construction activities at Sheringham Shoal.

435. If the response to underwater noise form 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.

436. There is limited data on the potential for a behavioural response or disturbance from other construction activities (or other continuous noise sources). Southall *et al.* (2007) presents a review of behavioural response studies in marine mammals, according to the behavioural severity scores. For continuous noise sources, the lowest SPL at which a score of five or more was recorded for whale species was 90dB to 100dB re 1 µPa (rms). However, this relates to a study involving migrating grey whales.

437. One study recorded a significant behavioural response on a single harbour seal at a received level of 100 to 110dB re 1 µPa (rms), although other studies found no response much higher received levels of up to 140dB re 1 µPa (rms).

438. The noise levels generated by the majority of the other construction activities are not significantly higher than the noise levels associated with vessels (e.g. cable laying, cable trenching and rock placement have source levels of up to 172dB re 1 μPa @ 1m (rms), compared to a source level of 168dB re 1 μPa@ 1m (rms) for a large vessel (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

11.6.1.3.1 Underwater Noise Modelling

439. To determine the potential risk for PTS and 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. Further information on the methodology of underwater noise modelling can be found in **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**.

11.6.1.3.2 Impact 3a: TTS from Underwater Noise During Other Construction Activities

440. The results of the underwater noise modelling (**Table 11-61**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) at the onset of the noise source to be exposed to noise levels that could induce PTS or TTS, with the exception of TTS for harbour porpoise.

441. It is important to note that PTS is unlikely to occur in marine mammals, as the modelling indicates that the marine mammal to be within 100m of the activity at its onset to be at potential risk of PTS (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). Therefore, PTS as a result of construction activity, other than piling, is highly unlikely and has not been assessed further.

442. Predicted impact ranges for harbour porpoise for TTS were 0.99km for rock placement, 0.23km for suction dredging, and 0.11km for cable laying, 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)**).

443. As a precautionary approach, the potential impact area for all activities occurring at the same time has also been determined (**Table 11-61**).

Table 11-61: Predicted Impact Ranges (and Areas) For TTS From 24 Hour Cumulative Exposure During Other Construction Activities

Species	Criteria and threshold (Southall ***et al.***, 2019)	Cable laying	Dredging (backhoe) / trenching	Dredging (suction)	Rock placement	All activities together
Harbour porpoise (VHF)	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)	3.378 km²
Dolphin species (HF)	SEL_{cum} Weighted (178 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03 km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	0.18km²
Minke whale (LF)	SEL_{cum} Weighted (179 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03 km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	0.18km²
Grey and Harbour seal (PCW)	SEL_{cum} Weighted (181 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.0 3km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	<0.1km (<0.03km²)	0.18km²

11.6.1.3.2.1 Magnitude of Impact – DBS East or DBS West In Isolation

444. There is unlikely to be any significant risk of any TTS, as the modelling indicates that a marine mammal would have to remain less than 100m of the source at the onset of the activity, with the exception of harbour porpoise (**Table 11-61**).

445. 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 11-61**).

446. The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

447. The magnitude of the potential impact for any TTS as a result of non-piling construction activities, for each activity individually or all together, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact from DBS East or DBS West in isolation (**Table 11-62**).

448. The potential for 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.

Table 11-62: 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	Magnitude* (temporary)	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary)
Harbour Porpoise	TTS from cumulative SEL for: Dredging (backhoe) Trenching	DBS East	0.02 (0.00001% of NS MU)	Negligible	DBS West or the Offshore Export Cable Corridor	2.0 (0.0006% of NS MU)	Negligible
		DBS West or the Offshore Export Cable Corridor	0.02 (0.00001% of NS MU)	Negligible			
	TTS from cumulative SEL for: - Cable laying	DBS East	0.023 (0.00001% of NS MU)	Negligible	DBS West or the Offshore Export Cable Corridor	2.2 (0.0006% of NS MU)	Negligible
		DBS West or the Offshore Export Cable Corridor	0.025 (0.00001% of NS MU)	Negligible			
	TTS from cumulative SEL for: Rock placement	DBS East	1.8 (0.0005% of NS MU)	Negligible	DBS West or the Offshore Export Cable Corridor	4.1 (0.001% of NS MU)	Negligible
		DBS West or the Offshore Export Cable Corridor	2.0 (0.0006% of NS MU)	Negligible			
Bottlenose dolphin	TTS from cumulative SEL for: Dredging (suction) - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.10 (0.0003% of NS MU)	Negligible	DBS East or DBS West or the Offshore Export Cable Corridor	0.005 (0.0003 % of GNS MU)	Negligible
		DBS West or the Offshore Export Cable Corridor	0.11 (0.0003% of NS MU)	Negligible			
		DBS East or DBS West	0.001 (0.00006 % of GNS MU)	Negligible			
Common dolphin	TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	Offshore Export Cable Corridor	0.001 (0.00006 % of GNS MU & 0.0006% of the CES MU)	Negligible (negligible)	Offshore Export Cable Corridor	0.005 (0.0003 % of GNS MU & 0.002% of the CES MU)	Negligible (negligible)
		DBS East or DBS West or the Offshore Export Cable Corridor	0.0005 (0.0000005% of CGNS MU)	Negligible	DBS East or DBS West or the Offshore Export Cable Corridor	0.002 (0.000002% of CGNS MU)	Negligible
White-beaked dolphin	TTS from cumulative SEL for:	DBS East	0.001 (0.000002% of CGNS MU)	Negligible	DBS East	0.004 (0.000009% of CGNS MU)	Negligible

Species	Potential Impact	Location	Maximum number of individuals (% of reference population) for TTS for each individual activity	Magnitude* (temporary)	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time	Magnitude* (temporary)
	- Cable laying - Trenching - Rock placement - Dredging	DBS West or the Offshore Export Cable Corridor	0.0012 (0.000003% of CGNS MU)	Negligible	DBS West or the Offshore Export Cable Corridor	0.005 (0.00001% of CGNS MU)	Negligible
Minke whale	TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.0003 (0.00001% of CGNS MU)	Negligible	DBS East	0.001 (0.000006% of CGNS MU)	Negligible
		DBS West or the Offshore Export Cable Corridor	0.0006 (0.000003% of CGNS MU)	Negligible	DBS West or the Offshore Export Cable Corridor	0.002 (0.00001% of CGNS MU)	Negligible
Grey seal	TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East	0.005 (0.00002% of SE England MU or 0.00001% of wider MU)	Negligible (negligible)	DBS East	0.02 (0.00007% of SE England MU or 0.00004% of wider MU)	Negligible (negligible)
		DBS West	0.008 (0.00003% of SE England MU or 0.00001% of wider MU)	Negligible (negligible)	DBS West	0.03 (0.0001 % of SE England MU or 0.00006% of wider MU)	Negligible (negligible)
		Offshore Export Cable Corridor	0.02 (0.00005% of SE England MU or 0.00003% of wider MU)	Negligible (negligible)	Offshore Export Cable Corridor	0.06 (0.0002 % of SE England MU or 0.0001% of wider MU)	Negligible (negligible)
Harbour seal	TTS from cumulative SEL for: - Cable laying - Trenching - Rock placement - Dredging	DBS East or Offshore Export Cable Corridor	0.00005 (0.000001% of SE England MU)	Negligible	DBS East or Offshore Export Cable Corridor	0.0002 (0.000004% of SE England MU)	Negligible
		DBS West	0.00003 (0.000006% of SE England MU)	Negligible	DBS West	0.0001 (0.000002% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.1.3.2.2 Magnitude of Impact – DBS East and DBS West Together

449. As a worst-case, the maximum number of marine mammals from each Project has been combined to indicate the maximum number of marine mammals that could be impacted from the Projects together, if they are developed concurrently (**Table 11-63**).

450. The magnitude of the potential impact for TTS during construction activities other than piling at DBS East and DBS West together is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-63**).

451. The noise level generated by the construction activities are barely audible above the predicted vessel noise (section 11.6.1.4). 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.

Table 11-63: 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 in all project areas	Magnitude* (temporary)
Harbour porpoise	DBS East & West including Offshore Export Cable Corridor	6.4 (0.002 % of NS MU)	Negligible
Bottlenose dolphin	DBS East & West including Offshore Export Cable Corridor	0.015 (0.0007% of GNS MU) [for all activities] 0.005 (0.002% of the CES MU) [for activities in the Offshore Export Cable Corridor only]	Negligible (Negligible)
Common dolphin	DBS East & West including Offshore Export Cable Corridor	0.006 (0.000006% of CGNS MU)	Negligible
White-beaked dolphin	DBS East & West including Offshore Export Cable Corridor	0.01 (0.00003% of CGNS MU)	Negligible

Species	Location	Maximum number of individuals (% of reference population) for TTS for all activities at the same time in all project areas	Magnitude* (temporary)
Minke whale	DBS East & West including Offshore Export Cable Corridor	0.006 (0.00003% of CGNS MU)	Negligible
Grey seal	DBS East & West including Offshore Export Cable Corridor	0.08 (0.0003% of SE England MU or 0.0002% of wider MU)	Negligible (negligible)
Harbour seal	DBS East & West including Offshore Export Cable Corridor	0.0005 (0.00001% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

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

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

453. Southall *et al*. (2007) presents a review of behavioural response studies in marine mammals, according to the behavioural severity scores. For continuous noise sources, the lowest SPL at which a score of five or more was recorded for whale species was 90dB to 100dB re 1 μPa (rms). However, this relates to a study involving migrating grey whales.

454. One study recorded a significant behavioural response on a single harbour seal at a received level of 100 to 110dB re 1 μPa (rms), although other studies found no response with much higher received levels of up to 140dB re 1 μPa (rms).

455. The noise levels generated by the majority of the other construction activities are not significantly higher than the noise levels associated with vessels themselves (e.g. cable laying, cable trenching and rock placement have source levels of <172dB re 1 μPa @ 1m (rms), compared to a source level of 168dB re 1 μPa@ 1m (rms) for a large vessel (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**)).

456. In 2012, 25 harbour seal from The Wash were tagged, as well as a further 10 from the Thames (Russell 2016b). Of those, 24 of the tags were in place for sufficient time to determine key foraging areas of harbour seal in the southern North Sea. The results of this study show foraging activity of harbour seal off the coast off Norfolk (**Plate 11-11**: Russell, 2016b). The results of this tagging study show foraging activity (in red) within Sheringham Shoal OWF which was undergoing construction, with turbine installation undertaken from 2011 to 2012, and cabling works from 2010 to 2012. This indicates that harbour seal will still undertake foraging activity during wind farm construction activities.

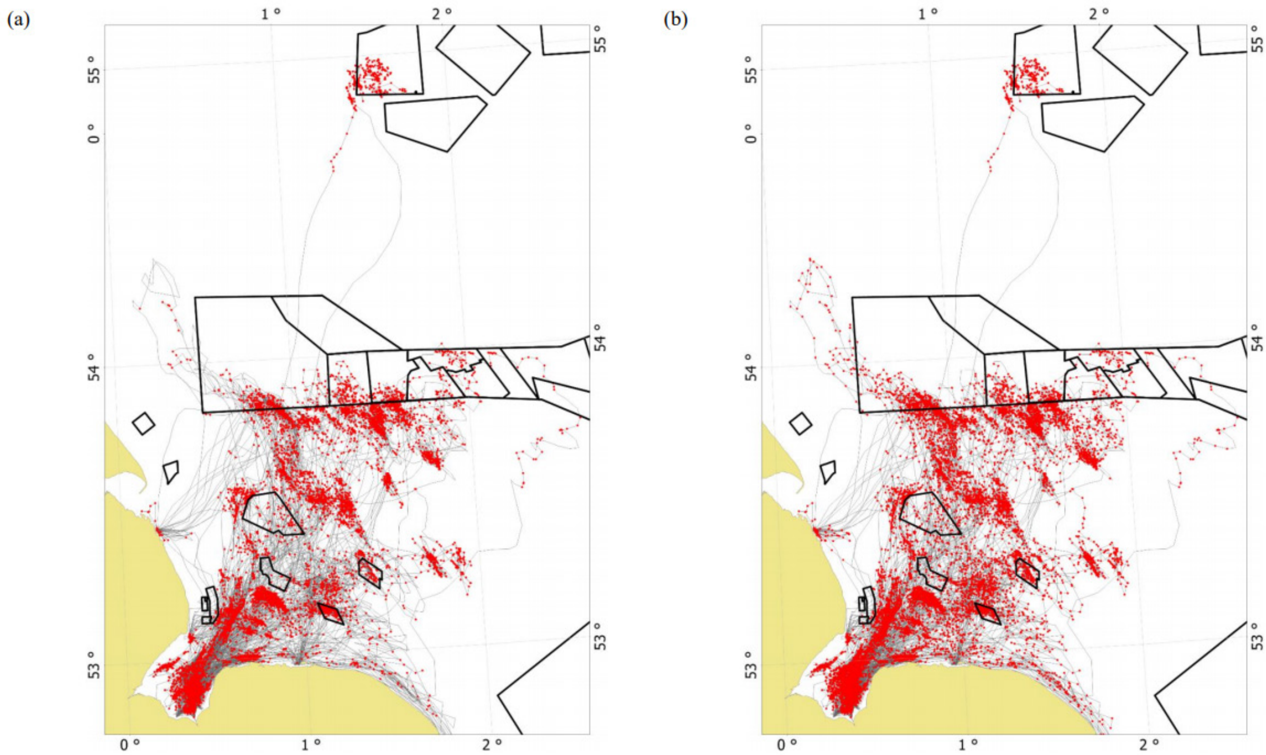

Plate 11-11 The Tracks (Grey) and Estimated Foraging Locations (Red) of Tagged Harbour Seals in Geo- (a) And Hydro- (b) Space (Russell 2016b).

457. Studies undertaken during the construction of two Scottish Wind Farms (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 concurrently, which led to high levels of vessel traffic within the OWF site.

458. A reduction in porpoise presence was detected at up to 4km from construction related vessels (**Plate 11-12**; Benhemma-Le Gall *et al.* 2021). With construction vessels at 2km from 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). It was not possible to determine what activities were being undertaken by the construction vessels in order to determine what activity was causing this effect (Benhemma-Le Gall *et al.* 2021).

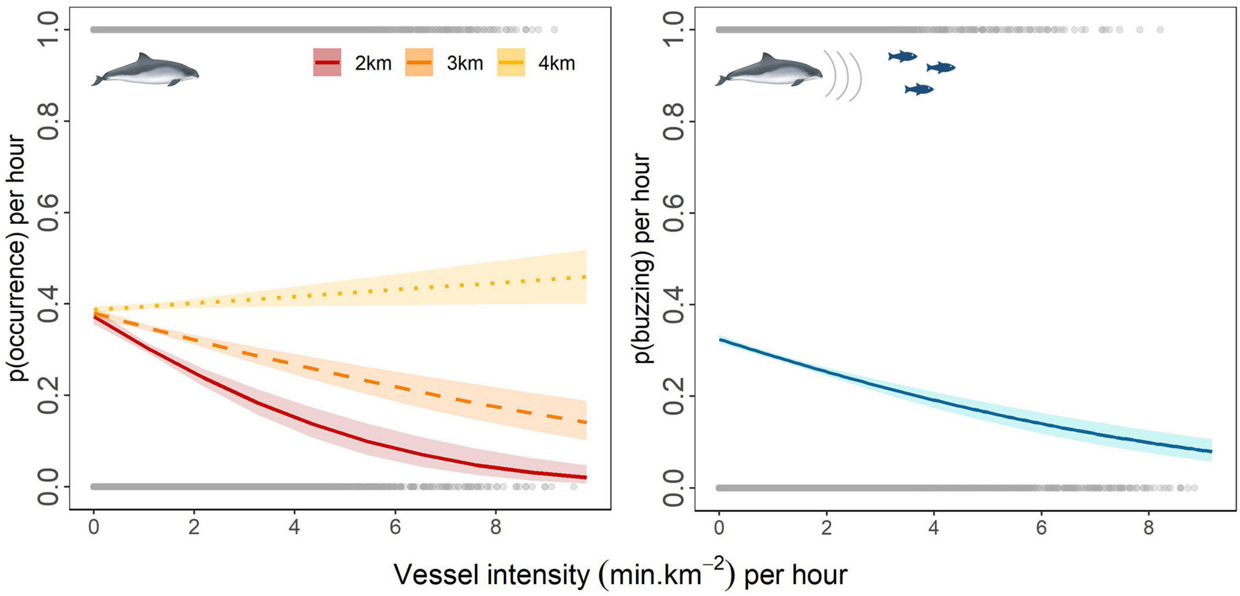

Plate 11-12 [Left] The Probability Of Harbour Porpoise Presence in Relation to Vessel Activity (Red = mean vessel distance of 2km, Orange = mean vessel distance of 3km, Yellow = mean vessel distance of 4km, and [Right] The Probability of Buzzing Activity Per Hour in Relation to Vessel Activity (Benhemma-Le Gall et al..2021)

459. While the study did not define which activities were taking place to cause the disturbance, the disturbance occurred 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 other construction activities in this assessment.

460. As harbour porpoise are the most sensitive marine mammal species, this 4km potential disturbance range has been used for all species assessed, due to the absence of any other data to inform an assessment. All related construction activities are considered to be a moving source, and therefore once the activity / vessel moves past a certain area, the marine mammals would return to baseline numbers.

461. If the response 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 impact on marine mammals.

11.6.1.3.3.1 Magnitude of Impact – DBS East or DBS West In Isolation

462. 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 11-64**. 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 project area. The potential for effect from the Offshore Export Cable Corridor could be relevant for either DBS East in isolation, or DBS West in isolation, depending on the construction scenarios.

463. The magnitude of the potential impact is assessed as negligible for all species, with the exception of bottlenose dolphin of the CES MU, with a magnitude of low (**Table 11-64**).

Table 11-64 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) for disturbance for each individual activity (50.3km²)	Magnitude* (temporary)	Maximum number of individuals (% of reference population) for disturbance for up to four construction activities at any one time (2016km²)	Magnitude* (temporary)
Harbour porpoise	DBS East	30.2 (0.009% of the NS MU)	Negligible	120.6 (0.03% of NS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	33.2 (0.01% of the NS MU)		132.7 (0.04% of NS MU)	Negligible
Bottlenose dolphin	DBS East, DBS West	2.1 (0.10% of GNS MU)	Negligible	8.4 (0.42% of GNS)	Negligible
	Offshore Export Cable Corridor	2.1 (0.10% of GNS MU & 0.94% of CES MU)	Negligible (Negligible)	8.4 (0.42% of GNS MU & 3.76% of CES MU)	Negligible (Low)
Common dolphin	DBS East, DBS West or Offshore Export Cable Corridor	0.9 (0.0008% of CGNS MU)	Negligible	3.4 (0.003% of CGNS MU)	Negligible

Species	Location	Maximum number of individuals (% of reference population) for disturbance for each individual activity (50.3km²)	Magnitude* (temporary)	Maximum number of individuals (% of reference population) for disturbance for up to four construction activities at any one time (2016km²)	Magnitude* (temporary)
White-beaked dolphin	DBS East	1.7 (0.004% of CGNS MU)	Negligible	6.8 (0.02% of CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	2.0 (0.005% of CGNS MU)		8.2 (0.02% of CGNS MU)	
Minke whale	DBS East	0.5 (0.002% of CGNS MU)	Negligible	2.0 (0.01% of CGNS MU)	Negligible
	DBS West or Offshore Export Cable Corridor	1.0 (0.005% of CGNS MU)	Negligible	4.0 (0.02% of CGNS MU)	Negligible
Grey seal	DBS East	9.1 (0.03% of SE England MU or 0.02% of wider MU)	Negligible (Negligible)	36.4 (0.12% of SE England MU or 0.06% of wider MU)	Negligible (Negligible)
	DBS West	13.1 (0.04% of SE England MU or 0.023% of wider MU)		52.3 (0.17% of SE England MU or 0.09% of wider MU)	

Species	Location	Maximum number of individuals (% of reference population) for disturbance for each individual activity (50.3km²)	Magnitude* (temporary)	Maximum number of individuals (% of reference population) for disturbance for up to four construction activities at any one time (2016km²)	Magnitude* (temporary)
	Offshore Export Cable Corridor	26.7 (0.09% of SE England MU or 0.05% of wider MU)		106.8 (0.35% of SE England MU or 0.19% of wider MU)	
Harbour seal	DBS East or Offshore Export Cable Corridor	0.085 (0.002% of SE England MU)	Negligible	0.3 (0.007% of SE England MU)	Negligible
	DBS West	0.05 (0.001% of SE England MU)		0.2 (0.004% of SE England MU	

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

464. 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.

465. The duration for the offshore construction period, including piling and export cable installation, is approximately five years for each Project. However, construction activities would not be underway constantly throughout this period. Further details on the construction schedule is provided in **Volume 7, Chapter 5 Project Description (application ref: 7.5)**.

11.6.1.3.3.2 Magnitude of Impact – DBS East and DBS West Together

466. 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 402.12km^2), is presented in **Table 11-65**.

467. 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 project area. The assessment has been undertaken on the worst case density within the DBS Offshore Development Area for each species.

468. The magnitude of the potential impact is assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, and as low for bottlenose dolphin (**Table 11-65**).

Table 11-65 Assessment of The Potential for Disturbance Due to Other Construction Activities Taking Place at Any One Time at DBS East and DBS West Together (up to Four Activities in DBS East, DBS West, and Offshore Export Cable Corridor at the same time)

Species	Location	Maximum number of individuals (% of reference population) for disturbance for all activities at the same time	Magnitude* (temporary)
Harbour porpoise	DBS East, DBS West, & Offshore Export Cable Corridor	386.0 (0.11% of NS MU)	Negligible
Bottlenose dolphin	DBS East, DBS West, & Offshore Export Cable Corridor	25.2 (1.2% of GNS MU) [for all activities] 8.4 (3.8% of CES MU) [for activities in the Offshore Export Cable Corridor only]	Low (Low)
Common dolphin	DBS East, DBS West, & Offshore Export Cable Corridor	10.3 (0.01% of CGNS MU)	Negligible
White-beaked dolphin	DBS East, DBS West, & Offshore Export Cable Corridor	23.3 (0.05% of CGNS MU)	Negligible
Minke whale	DBS East, DBS West, & Offshore Export Cable Corridor	10.0 (0.05% of CGNS MU)	Negligible
Grey seal	DBS East, DBS West, & Offshore Export Cable Corridor	195.4 (0.64% of SE England MU or 0.35% of wider MU)	Negligible (negligible)
Harbour seal	DBS East, DBS West, & Offshore Export Cable Corridor	0.9 (0.02% of SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

469. 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.

470. 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 Offshore Export Cable installation, is approximately five years for the Projects being constructed concurrently and seven years when constructed sequentially. However, construction activities would not be underway constantly throughout this period.

11.6.1.3.4 Sensitivity of Receptor

471. The sensitivity of marine mammals to temporary changes in hearing sensitivity (TTS) as a result of underwater noise during construction activities other than piling and vessels, is considered to be medium in this assessment, as a precautionary approach.

472. The sensitivity of both harbour porpoise and minke whale to disturbance is also considered to be medium, while dolphin species and seals have a sensitivity of low. 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.

11.6.1.3.5 Significance of Effect – DBS East or DBS West In Isolation

473. Taking into account the marine mammal sensitivity to TTS, and the potential magnitude of the impact, the significance of effect for construction activities other than piling at either DBS East or DBS West has been assessed as **minor adverse** (not significant in EIA terms) all species (**Table 11-66**).

474. The potential for disturbance in harbour porpoise, minke whale, and bottlenose dolphin of the CES MU has been assessed as **minor adverse** (not significant in EIA terms), and for bottlenose dolphin of the GNS MU, common dolphin, white-beaked dolphin, grey seal and harbour seal, the impact significance in **negligible adverse** (not significant in EIA terms) (**Table 11-66**).

475. 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.

Table 11-66 Assessment of Significance of Effect for the Potential for Underwater Effects Due to Other Construction Activities at DBS East or DBS West In Isolation

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
TTS due to other construction activities			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to other construction activities			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
Bottlenose dolphin (GNS MU), common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse
Bottlenose dolphin (CES MU)	Low	Low	Minor adverse

11.6.1.3.6 Significance of Effect – DBS East and DBS West Together

476. The significance of effect for TTS from construction activities other than piling, at DBS East and DBS West together, has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-67**).

477. The potential for disturbance in harbour porpoise, minke whale, and bottlenose dolphin has been assessed as **minor adverse** (not significant in EIA terms), and for common dolphin, white-beaked dolphin, grey seal and harbour seal, the impact significance in **negligible adverse** (not significant in EIA terms) (**Table 11-67**).

478. The noise level generated by the construction activities are barely audible above the predicted vessel noise (section 11.6.1.4 and **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**). 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.

Table 11-67 Assessment of Significance of Effect for the Potential for Underwater Effects Due to Other Construction Activities at DBS East or DBS West together

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
TTS due to other construction activities			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to other construction activities			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
Common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse
Bottlenose dolphin	Low	Low	Minor adverse

11.6.1.3.7 Mitigation and Residual Significance of Effect

479. No mitigation is proposed for underwater noise for construction activities other than piling, Therefore, the residual significance of effect for TTS or disturbance from underwater noise during construction activities other than piling at the Projects would be **negligible to minor adverse** (not significant in EIA terms) for all species.

11.6.1.4 Impact 4: TTS and Disturbance from Underwater Noise due to the Presence of Vessels

480. Vessels onsite will generally be associated with piling and other construction activities during the construction period as assessed in section 11.6.1.3. However, as a precautionary approach and to take into account vessels that could be in the Offshore Development Area, when these activities are not being conducted, the potential for TTS and disturbance from underwater noise and presence of vessels has also been assessed separately.

481. During the construction phase there will be an increase in the number of vessels in the windfarm sites. The peak maximum number of vessels that could be within the array sites at any one time has been estimated to be 32 vessels for each Array Area (**Table 11-1**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

482. 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 predominantly within the windfarm site. As outlined in **Volume 7**, **Chapter 14 Shipping and Navigation (application ref: 7.14)**, there would be a total of 3,857 transits to port per each five-year period during the construction phase for either Array Area in isolation (or 772 trips per year).

483. The vessels in the Offshore Development Area would 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.* (1995) 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).

484. 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. Trigg *et al.* (2020) found the predicted exposure of grey seals to shipping noise did not exceed thresholds for TTS.

485. 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.

11.6.1.4.1 Underwater Noise Modelling

486. 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)**). the underwater noise modelling was undertaken for medium and large vessels. Medium vessels are less than 100m in length, while large vessels are over 100m.

487. Impact ranges for PTS and TTS for large and medium vessels for all species are less than 100m for a fleeing animal (see **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

488. 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 be within 100m of the vessel to be 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.

11.6.1.4.2 Impact 4a: TTS from Underwater Noise and Presence of Vessels

489. As noted above, the results of the underwater noise modelling (**Table 11-68**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range), to be exposed to noise levels that could induce either PTS or TTS. There is therefore unlikely to be any significant risk of any TTS. While TTS as a result of construction vessels is highly unlikely, it has been assessed as precautionary approach.

490. 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 Offshore Export Cable Corridor. 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 Offshore Export Cable Corridor.

491. For the CES population of bottlenose dolphin, as they are known to be an inshore population only, and are found within 2km of the coastline, for the assessments against this population, it has been assumed that approximately 50% of the vessels in the Offshore Export Cable Corridor 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.

492. As a precautionary approach the potential impact area for all vessels on site at the same time has also been determined (**Table 11-68**).

Table 11-68 Predicted Impact Ranges (and Areas) For TTS Cumulative Exposure of Construction Vessels

Species	Criteria and threshold (Southall *et al.*, 2019)	Large vessel	Medium vessel
Harbour porpoise (VHF)	SEL_{cum} Weighted (153 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)
Dolphin species (HF)	SEL_{cum} Weighted (178 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)
Minke whale (LF)	SEL_{cum} Weighted (179 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)
Grey and Harbour seal (PCW)	SEL_{cum} Weighted (181 dB re 1 μPa²s) Non-impulsive	<0.1km (<0.03km²)	<0.1km (<0.03km²)

11.6.1.4.2.1 Magnitude of Impact – DBS East or DBS West In Isolation

493. 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 11-69**).

494. The magnitude of the potential impact for any TTS as a result of construction vessels, for either one vessel, or for up to 32 vessels (26 in the Array Areas, and six in the Offshore Export Cable Corridor), is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-69**).

495. The potential effect of TTS (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.

Table 11-69 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TTS 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	Maximum number of individuals (% of reference population) for up to 32 vessels	Magnitude* (temporary)
Harbour porpoise	DBS East	0.02 (0.00001% of the NS MU)	0.6 (0.0002% of the NUS MU)	Negligible
	DBS West	0.02 (0.00001% of the NS MU)	0.6 (0.0002% of the NUS MU)	
Bottlenose dolphin	DBS East or DBS West	0.001 (0.00006% of GNS MU & 0.0006% of CES MU)	0.03 (0.002% of GNS MU) [for 26 vessels in either Array Area]	Negligible
	Offshore Export Cable Corridor	0.001 (0.00006% of GNS MU & 0.0006% of CES MU)	0.004 (0.0002% of GNS MU & 0.002% of CES MU) [for 3 vessels in the inshore region of the Offshore Export Cable Corridor]	Negligible (Negligible)
Common dolphin	DBS East or DBS West	0.001 (0.0000005% of CGNS MU)	0.02 (0.00002% of the CGNS MU)	Negligible
White-beaked dolphin	DBS East	0.001 (0.000002% of CGNS MU)	0.03 (0.00007% of CGNS MU)	Negligible
	DBS West	0.001 (0.000003% of CGNS MU)	0.04 (0.00009% of CGNS MU)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Maximum number of individuals (% of reference population) for up to 32 vessels	Magnitude* (temporary)
Minke whale	DBS East	0.003 (0.000002% of CGNS MU)	0.01 (0.00005% of CGNS MU)	Negligible
	DBS West	0.006 (0.000003% of CGNS MU)	0.02 (0.0001% of CGNS MU)	
Grey seal	DBS East	0.005 (0.00002% of SE England MU or 0.00001% of wider MU)	0.2 (0.0006% of SE England MU or 0.0003% of Wider MU)	Negligible (Negligible)
	DBS West	0.008 (0.00005% of SE England MU or 0.00003% of Wider MU)	0.3 (0.0008% of SE England MU or 0.0004% of Wider MU)	
	Offshore Export Cable Corridor	0.01 (0.00004% of SE England MU or 0.00002% of Wider MU)	0.5 (0.002% of SE England MU or 0.0009% of Wider MU)	
Harbour seal	DBS East or Offshore Export Cable Corridor	0.00005 (0.000001% of SE England MU)	0.002 (0.00003% of SE England MU)	Negligible
	DBS West	0.00003 (0.000001% of SE England MU)	0.001 (0.00002% of SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.1.4.2.2 Magnitude of Impact – DBS East and DBS West Together

496. 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.

497. The magnitude of the potential impact for any 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 Offshore Export Cable Corridor), is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-70**).

498. The potential for 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 11-70 Maximum Number of Individuals (and % of Reference Population) That Could Be At Risk of TTS 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	Magnitude* (temporary)
Harbour porpoise	DBS East, DBS West, and the Offshore Export Cable Corridor	2.2 (0.0006% of NS MU)	Negligible
Bottlenose dolphin	DBS East, DBS West, and the Offshore Export Cable Corridor	0.06 (0.003% of GNS MU) [for all vessels] 0.01 (0.004% of CES MU) [for 6 vessels in the inshore region of the Offshore Export Cable Corridor only]	Negligible
Common dolphin	DBS East, DBS West, and the Offshore Export Cable Corridor	0.03 (0.00003% of CGNS MU)	Negligible

Species	Location	Maximum number of individuals (% of reference population) for up to 59 vessels	Magnitude* (temporary)
White-beaked dolphin	DBS East, DBS West, and the Offshore Export Cable Corridor	0.1 (0.0003% of CGNS MU)	Negligible
Minke whale	DBS East, DBS West, and the Offshore Export Cable Corridor	0.05 (0.0001% of CGNS MU)	Negligible
Grey seal	DBS East, DBS West, and the Offshore Export Cable Corridor (using the Offshore Export Cable Corridor density as a worst-case)	0.9 (0.003% of SE England MU or 0.002% of Wider MU)	Negligible (negligible)
Harbour seal	DBS East, DBS West, and the Offshore Export Cable Corridor (using the Offshore Export Cable Corridor density as a worst-case)	0.003 (0.00006% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.1.4.3 Impact 4b: Disturbance from Underwater Noise and Presence of Vessels

499. There is limited data on the potential for a behavioural response or disturbance from vessel noise. 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.

500. Underwater noise from vessels has been shown to affect the behaviour of marine mammals, where changes in vocalisation and behavioural state have been observed, in addition to displacement of animals from areas where ships are present (examples described in section 11.6.1.1.4).

501. 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).

11.6.1.4.3.1 Magnitude of Impact – DBS East or DBS West In Isolation

502. As outlined previously, Brandt *et al.* (2018) found that at seven German OWFs in the vicinity (up to 2km) of the construction site, harbour porpoise detections declined several hours before the start of piling as a result of increased construction related activities and vessels. Similarly, studies in the Moray Firth during piling of the Beatrice OWF, indicate higher vessel activity within 1km was associated with an increased probability of response in harbour porpoise (Graham *et al.* 2019).

503. Studies in the Moray Firth indicate that at a mean distance of 2km from construction vessels, harbour porpoise occurrence decreased by up to 35.2% as vessel intensity increased. Harbour porpoise responses decreased with increasing distance to vessels, out to 4km where no response was observed (Benhemma-Le Gall *et al.* 2021).

504. During the periods when piling and other construction activities are underway, vessel noise is unlikely to add an additional impact, as the vessels and vessel noise would be within the maximum impact areas assessed.

505. The distance at which animals may react to vessels is difficult to predict and behavioural responses can vary a great deal depending on species, location, type and size of vessel, vessel speed, noise levels and frequency, ambient noise levels and environmental conditions.

506. Vessel type and speed rather than presence seemed to be the relevant factors for the reactions of harbour porpoise to vessel traffic in the coastal waters of South-West Wales (Oakley *et al.* 2017). There was a significant correlation between numbers of vessels and number of harbour porpoise sightings. During 729 hours of survey effort (268 total surveys), there were 39 occasions when porpoise exhibited neutral or negative behaviour to vessels. With 75% of all negative reactions in response to high-speed planing-hulled vessels (Oakley *et al.*.2017).

507. Modelling by Heinänen and Skov (2015) indicates that the number of ships represents a relatively important factor determining the density of harbour porpoise North Sea 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).

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

509. Previous studies by Brandt *et al.* (2018) and Benhemma-Le Gall *et al.* (2021) show that harbour porpoise could be disturbed up to 2km from construction vessels. As a precautionary approach assessment for all species has been based on a disturbance impact range of 4km for each vessel.

510. However, with the high number of 32 vessels potentially working within DBS Offshore Development Area at one time, instead of adding a 4km disturbance range around each vessel, a 4km buffer has been added in each Array Area. This accounts for the maximum of 26 vessels in each array at once, and take account of the overlap in disturbance areas for 26 vessels present in each area (as shown on **Plate 11-13** and **Plate 11-14**). 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.

511. With the 26 vessels scattered randomly on each array, **Plate 11-13** and **Plate 11-14** shows that the 4km buffer applied to each does not exceed the 4km buffer around both DBS East and DBS West Array Area. **Table 11-71** presents the impact area of vessel disturbance, for the Array Areas plus a 4km buffer.

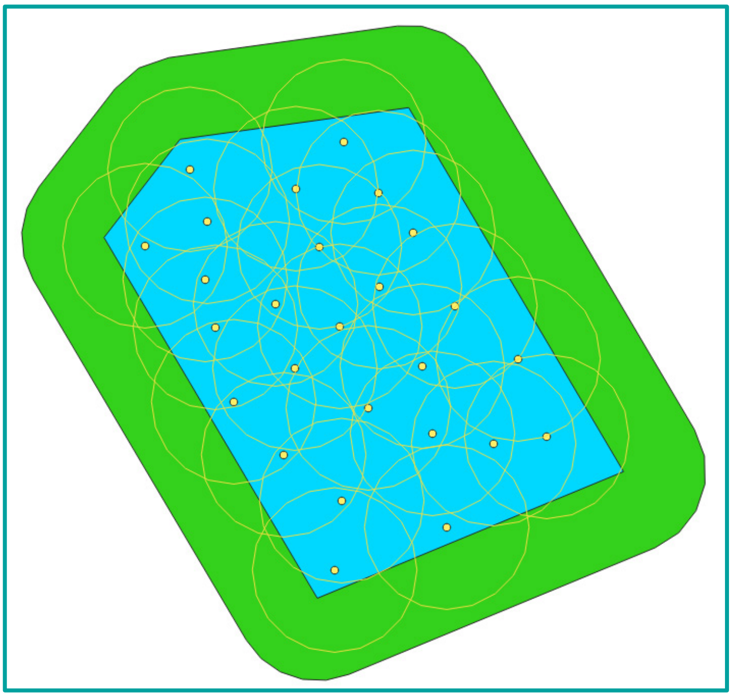

Plate 11-13 DBS East Array Area (blue), with 26 vessel (yellow dots), 4km buffer circles (yellow) and 4 km buffer around Array Area (green)

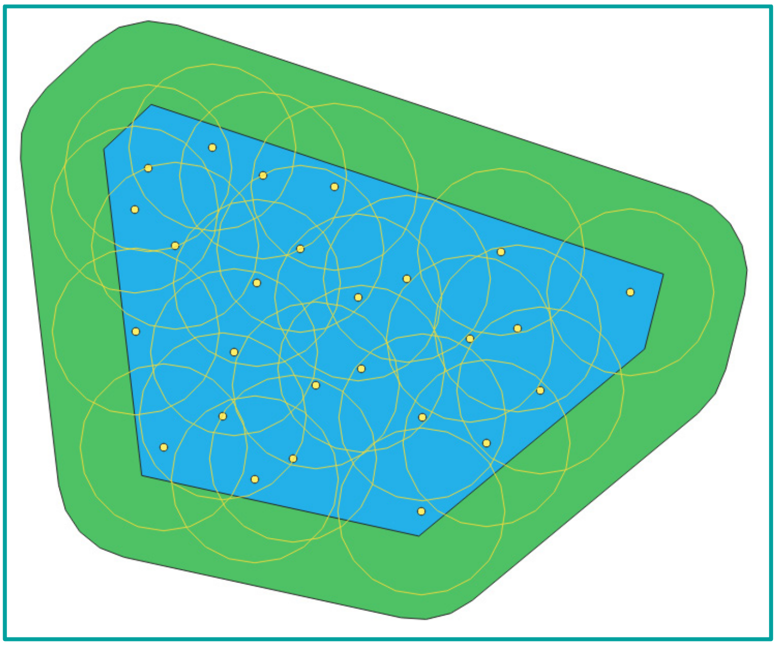

Plate 11-14 DBS West Array Area (blue), with 26 vessel (yellow dots), 4km buffer circles (yellow) and 4 km buffer around Array Area (green)

Table 11-71 Impact ranges for vessel disturbance

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

512. To assess for vessel disturbance in the Offshore Export Cable Corridor, 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. For up to three vessels associated with the inshore region of the Offshore Export Cable Corridor, the potential disturbance area is 150.8km^2.

513. The magnitude of the potential impact is assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal for up to 26 vessels in the windfarm Array Area **Table 11-72** and six vessels in the Offshore Export Cable Corridor. For bottlenose dolphin, the potential impact of disturbance from vessels is assessed as low for both the GNS population and the CES population (**Table 11-72**).

Table 11-72 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	Magnitude* (temporary)	Maximum number of individuals (% of reference population) for up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the Offshore Export Cable Corridor]	Magnitude* (temporary)
Harbour porpoise	DBS East	30.2 (0.009% of the NS MU)	Negligible	598.6 (0.17% of the NS MU)	Negligible
	DBS West	33.2 (0.01% of the NS MU)		666.9 (0.19% of the NS MU)	
Bottlenose dolphin	DBS East	2.1 (0.10% of the GNS MU & 0.86% of the CES MU)	Negligible	41.8 (2.07% of the GNS MU) [for all vessels] 6.3 (2.8% of the CES MU) [for 3 vessels in the inshore region of the Offshore Export Cable Corridor]	Low (Low)
	DBS West			42.3 (2.09% of the GNS MU) [for all vessels] 6.3 (2.8% of the CES MU) [for 3 vessels in the inshore region of the Offshore Export Cable Corridor]	
Common dolphin	DBS East	0.9 (0.0008% of the CGNS MU)	Negligible	17.0 (0.02% of the CGNS MU)	Negligible
	DBS West			17.2 (0.02% of the CGNS MU)	Negligible

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude* (temporary)	Maximum number of individuals (% of reference population) for up to 32 vessels [up to 26 within the Array Areas, and up to 6 in the Offshore Export Cable Corridor]	Magnitude* (temporary)
White-beaked dolphin	DBS East	1.7 (0.004% of the CGNS MU)	Negligible	33.9 (0.08% of the CGNS MU)	Negligible
	DBS West	2.1 (0.005% of the CGNS MU)		41.4 (0.09% of the CGNS MU)	
Minke whale	DBS East	0.5 (0.003% of CGNS MU)	Negligible	10.0 (0.05% of CGNS MU)	Negligible
	DBS West	1.0 (0.005% of CGNS MU)		20.2 (0.10% of CGNS MU)	
Grey seal	DBS East	9.1 (0.03% of SE England MU or 0.02% of the wider MU)	Negligible (negligible)	180.6 (0.59% of SE MU or 0.32% of the wider MU)	Negligible
	DBS West	13.1 (0.042% of SE England MU or 0.02% of the wider MU)		262.7 (0.86% of SE England MU or 0.46% of the wider MU)	
Harbour seal	DBS East	0.09 (0.003% of SE England MU)	Negligible	1.7 (0.006% of SE England MU)	Negligible
	DBS West	0.05 (0.0009% of SE England MU)		1.0 (0.002% of SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

514. Vessels transiting to and from the Offshore Development Area can also cause disturbance. **Table 11-73** presents a list of indicative port options that could be used during construction. As worst case, the assessment of vessel disturbance during transit from DBS West to Lowestoft is used as that is the greatest distance.

Table 11-73 Indicative port options and distance to DBS Projects

Port Longlist	Region or Estuary	Distance (km) to centre of wind farm	Distance (nm) to centre of wind farm
Grimsby	Humber	170	93
Able Marine Energy Park	Humber	185	100
Hull	Humber	192	104
Middlesborough	Tees	196	105
Able Seaton	Hartlepool	189	102
Sunderland	Wear	202	109
Blyth	N East	217	117
Newcastle ports (several)	Tyne	211	114
Seaham	N East	198	107
Hartlepool	Tees	198	102
Whitby	N East	150	81
Great Yarmouth	East England	224	120
Lowestoft	**East England**	**239**	**129**

515. **Plate 11-15** provides an indicative vessel transit disturbance area from the DBS Projects to port, with the route just for an example, and a 4km buffer. This assessment therefore takes account of any vessel transiting to and from port to be a moving disturbance source, rather than a point source. 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.

516. **Table 11-74** 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.

Table 11-74 Indicative Impact ranges for vessel disturbance during transit for DBS East or DBS West In Isolation

Example port location	Impact Area (Transit Route plus 4km Buffer) (km^2)
Lowestoft	1,200km^2

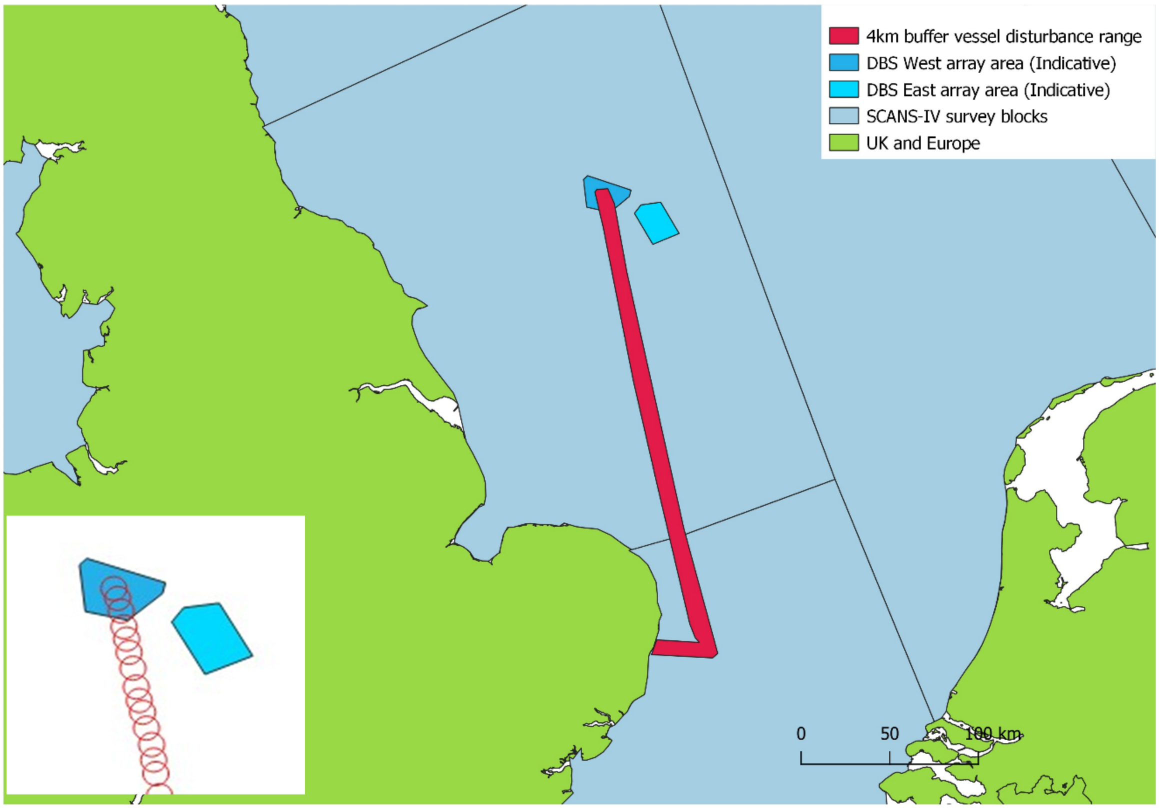

Plate 11-15 Worse carse vessel disturbance due to one transiting vessel

517. **Table 11-75** presents the number of individuals that could be temporarily disturbed by the vessel transits, for the area of potential disturbance of 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 Offshore Development Area.

518. The magnitude of the potential impact is assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale and harbour seal. The magnitude of the potential impact is low for bottlenose dolphin and grey seal (**Table 11-75**).

519. The majority of the vessel transit would be offshore, rather than inshore (as shown by **Plate 11-15**), and therefore, for bottlenose dolphins, the majority of the effect would be for the GNS population, rather than the CES MU, which may be exposed to vessel transit disturbance while the vessel was entering and exiting the port only. Therefore, for bottlenose dolphins, the assessment for disturbance from transiting vessels has been assessed on the GNS population only.

520. The impact ranges are very precautionary as the impact range will be constantly moving with the vessel, and not remain the full area as assessed in **Table 11-75**.

Table 11-75 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)	Magnitude* (temporary)
Harbour porpoise	792. 0 (0.23% of the NS MU)	Negligible
Bottlenose dolphin	50.3 (2.49% of the GNS MU)	Low
Common dolphin	20.4 (0.02% of the CGNS MU)	Negligible
White-beaked dolphin	49.2 (0.11% of the CGNS MU)	Negligible
Minke whale	24.0 (0.12% of the CGNS MU)	Negligible
Grey seal	637. 2 (2.09% of the SE England MU & 1.13% of the Wider MU)	Low (Low)
Harbour seal	2.0 (0.007% of the SE England MU)	Negligible

* *Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.1.4.3.2 Magnitude of Impact – DBS East and DBS West Together

521. 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 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.

522. 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 Offshore Export Cable Corridor, has been combined to provide an overall total for the Projects together (**Table 11-77**). This assessment is therefore based on the total area 1,404.910km² for the Array Areas, and 603.19km² for the Offshore Export Cable Corridor (**Table 11-76**). For up to six vessels in the inshore region of the Offshore Export Cable Corridor, the disturbance area would be 301.59km².

Table 11-76 Potential impact ranges for vessel disturbance at DBS East and DBS West together

Area	Impact Area (km²)
DBS East and DBS West Array Area	1,404.9
Offshore Export Cable Corridor (up to 12 vessels)	603.19

523. The magnitude of the potential impact is assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, and harbour seal for up to 59 vessels in both Array Areas and the Offshore Export Cable Corridor (**Table 11-77**). The magnitude of the potential impact is assessed as low for bottlenose dolphin of the GNS MU, as well as for grey seal, and as medium for the CES population of bottlenose dolphin (**Table 11-77**).

Table 11-77 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	Maximum number of individuals (% of reference population) potentially disturbed from 47 vessels within the Array Areas, and 12 in the Offshore Export Cable Corridor	Magnitude* (temporary)
Harbour porpoise	1,084.5 (0.31% of the NS MU)	Negligible
Bottlenose dolphin	71.5 (3.5% of the GNS MU) [for vessels in all project areas] 12.7 (5.65% of the CES MU) [for 6 vessels in the inshore region of the Offshore Export Cable Corridor only]	Low (Medium)
Common dolphin	29.0 (0.03% of CGNS MU)	Negligible
White-beaked dolphin	65.1 (0.15% of the CGNS MU)	Negligible
Minke whale	27.2 (0.14% of the CGNS MU)	Negligible
Grey seal	906.2 (2.96% of SE England MU or 1.60% of the wider MU)	Low (Low)

Species	Maximum number of individuals (% of reference population) potentially disturbed from 47 vessels within the Array Areas, and 12 in the Offshore Export Cable Corridor	Magnitude* (temporary)
Harbour seal	2.9 (0.24% of SE England MU)	Negligible

* *Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

524. 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 period is five. As stated within section 11.6.1.4.3.2, 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 (**Table 11-74** and **Table 11-75**).

11.6.1.4.4 Sensitivity of Receptor

525. The sensitivity of marine mammals to temporary changes in hearing sensitivity (TTS) as a result of underwater noise from construction vessels, is considered to be medium in this assessment, as a precautionary approach.

526. 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 noise had ceased or they had become habituated to the sound.

527. 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.* 2018).

528. 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). In a large scale study of harbour porpoise density in UK waters, including the North Sea MU and the Irish Sea MU, increased vessel activity was associated with lower porpoise densities. However, in North West Scottish waters, shipping had little effect on the density of individuals (Heinänen and Skov, 2015). In addition, displacement has also be recorded with harbour porpoise detections around a pile driving site, where detections declined several hours prior to the start of pile driving. The decline was assumed to be due to the increase in other construction related activities and vessel presence in advance of the actual pile driving (Brandt et al., 2018; Benhemma-Le Gall et al., 2020).

529. As well as the potential to have displacement effects, vessel activity has also been shown to elicit other potential behavioural changes. One study between 2012 - 2016, tagged seven harbour porpoises in a region of high shipping density in the inner Danish waters and Belt seas. The tagging of individuals provided data on responses to stressors in the marine environment. High noise levels coincided with erratic behaviour including 'vigorous fluking', bottom diving, interrupted foraging, and the cessation of vocalisations. Four out of six of the animals that were exposed to noise levels above 96 dB re 1 μPa (16 kHz third octave levels) produced significantly fewer buzzes with high quantities of vessel noise. In one case, the proximity of a single vessel resulted in a 15 minute cessation in foraging (Wisniewska et al., 2018). 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; therefore, harbour porpoise are deemed to have a medium sensitivity to disturbance from construction vessels.

530. Other cetacean species in the study area may also be disturbed by construction vessels, however, this is expected to a lesser degree than harbour porpoise. Minke whale have been shown to decrease foraging behaviour around wildlife tour boats, displaying horizontal avoidance behaviour and increased swimming speeds which may incur an energy cost (Machernis *et al.*, 2018). The sensitivity of minke whale to disturbance as a result of underwater noise due to construction vessels is considered to be medium in this assessment as a precautionary approach.

531. Dolphin species are considered to have a sensitivity of low to disturbance effects. Common dolphins in the vicinity of the construction of a pipeline in north-west Ireland left the area due to vessel presence, however patterns suggested disturbance impacts were only short term (Culloch et al. 2016). Studies for bottlenose dolphin have indicated vessel presence has the potential to increase swimming speeds and reduce the time spent for foraging, resting and socialising (Marley et al., 2017b; Piwetz 2019). Behavioural changes, associated with disturbance, have also been seen with common dolphins, due to the presence of vessels. Foraging and resting activity was significantly disrupted by vessel activity and returns to foraging activity took significantly longer than returns to other states (Stockin et al. 2008, Meissner et al. 2015). Behavioural changes have also been seen with minke whale with vessel interactions including a decrease in foraging activity, increase in swim speeds and energy expenditure (Christiansen et al., 2014).

532. Pinnipeds 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-Gutierrez, 2017). The relationship between where grey seals forage and breed is not known. Such information enables the determination of where the effects of any given at-sea impact (during the foraging phase) may be reflected on hauled out or breeding population ashore. This is of particular relevance in monitoring the putative effects of at-sea disturbance on haul out sites (Russel and McConnell 2014).

533. 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, 2021). In areas of high vessel traffic, there are habituation effects and disturbance behaviour is generally reduced (Strong *et al.* 2010). 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% four hours after disturbance (Paterson *et al.* 2019). Seals are therefore considered to have a low sensitivity to disturbance from construction vessel traffic.

534. However, a recent UK telemetry study on harbour seal showed there was no evidence of reduced seal presence as a result of vessel traffic. This was despite distributional overlaps (overlaps were most frequently within 50km of the coast) between seal and vessel presence and high cumulative sound levels (Jones *et al.* 2017). Another study of grey seal pup tracks in the Celtic Sea and adult grey seals in the English Channel found that no animals were exposed to cumulative shipping noise that exceeded thresholds for TTS (using the Southall *et al.* 2019 thresholds) (Trigg *et al.* 2020).

535. Evidence suggests marine mammal species respond to vessel presence in a variety of ways, but all have the potential to be disturbed either through displacement, behavioural changes or both. Responses depend on a range of environmental factors but also the type and size of vessels. Some of the studies mentioned above had based findings on fast moving vessels and vessels seeking close proximity to species such as fast ferries and whale watching vessels (Wisniewska et al., 2018; Christiansen et al., 2014). Therefore, less of a disturbance effect is likely for the proposed construction vessels which will be slow moving or stationary.

11.6.1.4.5 Significance of Effect – DBS East or DBS West In Isolation

536. Taking into account the marine mammal sensitivity to TTS and disturbance, and the potential magnitude of the impact for TTS and disturbance, the potential for disturbance from construction vessels at the Projects either DBS East or DBS West has been assessed as **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-78**).

537. If the response is displacement from the area, it is predicted that marine mammals 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 marine mammals.

Table 11-78 Assessment of Significance of Effect for the Potential for Disturbance Due to Construction Vessels at DBS East or DBS West In Isolation

Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
TTS due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to construction vessels on site			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
Common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse
Bottlenose dolphin	Low	Low	Minor adverse
Disturbance due to construction vessels in transit			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse

Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Common dolphin, white-beaked dolphin and harbour seal	Low	Negligible	Negligible adverse
Bottlenose dolphin and grey seal	Low	Low	Minor adverse

11.6.1.4.6 Significance of Effect – DBS East and DBS West Together

538. Taking into account the medium to low sensitivity to TTS and disturbance, and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise of construction vessels at DBS East and DBS West together has been assessed as **negligible to minor adverse (not significant in EIA terms)** for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-79**).

Table 11-79 Assessment of Significance of Effect for the Potential for Disturbance Due To Construction Vessels at DBS East and DBS West Together

Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
TTS due to construction vessels			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Disturbance due to construction vessels on site			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
Common dolphin, white-beaked dolphin and harbour seal	Low	Negligible	Negligible adverse
Bottlenose dolphin	Low	Low to medium	Minor adverse
Grey seal	Low	Low	Minor adverse
Disturbance due to construction vessels in transit			
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse

Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Common dolphin, white-beaked dolphin and harbour seal	Low	Negligible	Negligible adverse
Bottlenose dolphin and grey seal	Low	Low	Minor adverse

11.6.1.4.7 Mitigation and Residual Significance of Effect

539. No mitigation is proposed for underwater noise from construction vessels, as the significance of effect is **negligible to minor adverse** which is not significant in EIA terms.

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

11.6.1.5.1 Magnitude of Impact – DBS East or DBS West In Isolation

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

541. DBS East is located approximately 122km from the nearest point on the coast, and DBS West is approximately 100km. The Array Areas are not located on any known migration routes for marine mammals.

542. The marine mammal species that could potentially be most affected by barrier effects from underwater noise are harbour porpoise accessing foraging areas, bottlenose dolphin, common dolphin and white-beaked dolphin, and minke whale if they are moving between areas, and grey and harbour seal as they move to and from haul-out sites.

543. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the environmental conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al*. 1997). Therefore, any barrier effects that could restrict harbour porpoise accessing foraging areas could have implications for individuals.

544. Based on **Table 11-1**, if DBS East or DBS West were constructed in isolation the maximum duration of piling, based on worst-case scenarios, including soft-start and ADD activation would be:

- Piling of up to 100 turbine monopiles and four platform monopiles (including soft-start, and ADD activation) = up to 694 hours (less than 30 days) with 80 minute ADD activation; and
- Piling of 400 turbine jacket pin piles and 32 platform jacket pin piles (including soft-start, ramp-up and ADD activation) = up to 1,544 hours (65 days) with 70-80 minute ADD activation.

545. The greatest potential barrier effect for marine mammals could be from underwater noise during piling. As outlined in section 11.6.1.2, 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.

546. The maximum duration of any barrier effects would be for the maximum piling duration at DBS East or DBS West, based on worst-case scenarios, including soft-start, ramp-up and ADD activation, as assessed in section 11.6.1.2.3. There is unlikely to be the potential for any barrier effects from underwater noise for other construction activities (section 11.6.1.3) and vessels (section 11.6.1.4), as 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 barrier effects that could significantly restrict the movements of marine mammals.

547. Marine mammals are wide ranging. For example, grey seals have been recorded to travel over 448km between haul-out sites (Carter *et al.* 2022) and with foraging trips lasting up to 30 days (SCOS, 2022). Data from The Wash (from 2003- 2005) suggest that harbour seals in this area travel and forage between 75km and 120km offshore (Sharples *et al.et al.* 2008) and are predicted to have maximum 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.

548. The maximum area for any potential barrier effects due to underwater noise for the construction phase would be during impact piling. The maximum predicted impact range for TTS from cumulative exposure (SEL_{cum}) during installation of monopile with maximum hammer energy of 6,000kJ is between 48km to 61km for harbour porpoise and 74km to 93km for minke whale, based on worst-case without any mitigation.

549. Therefore, there is 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 marine mammals and would not be continuous throughout the offshore construction period. The magnitude of impact for any potential temporary barrier effects, based on worst case, is assessed as negligible for all species.

11.6.1.5.2 Magnitude of Impact – DBS East and DBS West Together

550. If DBS East and DBS West were constructed concurrently, and assuming piling at the same time on each site the maximum duration of piling, based on worst-case scenarios, including soft-start, ramp-up and ADD activation would be:

- Piling of up to 200 monopiles and 8 platform monopiles (including soft-start, ramp-up and ADD activation) = up to 1,110 hours (up to 47 days) with 80 minute activation; or
- Piling of 800 jacket pin piles and 64 platform jacket pin piles (including soft-start, ramp-up and ADD activation) = 2,999 hours and 20 minutes (up to 125 days) with 70-80 minute ADD activation.

551. Taking into account that piling would not be constant, that marine mammals are likely to return to the area once the piling has completed, and that marine mammals are wide-ranging (as set out in section 11.6.1.5.1 above), there is unlikely to be any significant long-term impacts from any barrier effects. The magnitude of impact for any potential temporary barrier effects, based on worst case, is therefore assessed as negligible for all species as for DBS East or DBS West is isolation.

11.6.1.5.3 Sensitivity of Receptor

552. All marine mammal species are considered to have a similar sensitivity to barrier effects from underwater noise, as from the disturbance from underwater noise. Therefore, harbour porpoise and minke whale have a sensitivity of medium to barrier effects from underwater noise, while dolphin and seal species have a sensitivity of low.

11.6.1.5.4 Significant of Effect DBS or DBS West Isolation

553. There is 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 marine mammals and would not be continuous throughout the offshore construction period. The magnitude of impact for any potential temporary barrier effects, based on worst-case, is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-80**).

554. Taking into account the marine mammal sensitivity and the potential magnitude of the impact, the significance of effect for any potential barrier effects as a result of underwater noise during construction at DBS East or DBS West has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-80**).

Table 11-80 Assessment of Significance of Effect for Any Potential Barrier Effects from Underwater Noise during Construction at DBS East or DBS West

Species	Sensitivity	Magnitude	Significance	Residual Impact
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Minor adverse	Minor adverse

11.6.1.5.5 Significance of Effect – DBS East and DBS West Together

555. Taking into account the marine mammal sensitivity and the potential magnitude of the impact, as assessed for DBS East or DBS West in isolation, the significance of effect for any potential barrier effects as a result of underwater noise during concurrent construction at DBS East and DBS West has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-81**)

Table 11-81 Assessment of Significance of Effect for Any Potential Barrier Effects from Underwater Noise during Construction at DBS East and DBS West Together

Species	Sensitivity	Magnitude	Significance	Residual Impact
Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Minor adverse	Minor adverse

11.6.1.5.6 Mitigation and Residual Significance of Effects

556. No mitigation is proposed for barrier effects as a result of underwater noise. Therefore, the residual significance of effect for barrier effects as a result of underwater noise during construction activities at the Project would be **minor adverse** (not significant in EIA terms) for all species.

11.6.1.6 Impact 6: Increased Collision Risk with Vessels During Construction

11.6.1.6.1 Magnitude of Impact – DBS East or DBS West In Isolation

557. During the construction phase, there will be an increase in the number of vessels in the Array Areas. The maximum number of vessels that could be at either of the Array Areas at any one time has been estimated as up to 80 vessels (**Table 11-1**). The number, type and size of vessels will vary depending on the activities taking place at any one time.

558. Vessel movements to and from any port will be incorporated within existing vessel routes, where possible. The construction vessels in the windfarm site are likely to be stationary or slow moving, depending on the activity with which they are involved.

559. As outlined in **Volume 7**, **Chapter 14 Shipping and Navigation (application ref: 7.14)**, there could be up to 3,857 round trips to port over the five year construction period for either DBS East or DBS West in isolation.

560. 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).

561. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (Nowacek *et al.* 2001, Lusseau 2003, 2006).

562. In 2016, SMRU conducted a study to determine the likelihood of harbour seal injury occurring due to co-presence with large vessels within the Moray Firth (Onoufriou *et al.* 2016). This study used telemetry data of harbour seal within the Moray Firth, alongside vessel AIS data. The data indicated vessel and seal co-occurrence was high (defined as over 2,500 co-occurrence minutes per year) in very localised areas. However, there appeared to be no relationship between areas in high co-occurrence and incidences of injury (Onoufriou *et al.* 2016).

563. 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).

564. There is currently limited information on the collision risk of marine mammals in the North Sea.

565. Between 2005 and 2015, the UK Cetacean Strandings Investigation Programme (CSIP) conducted 849 post-mortem examinations of the 3,598 reported harbour porpoise strandings. A cause of death was established in 815 examined individuals, of these, 45 had died from physical trauma of unknown cause and 17 (2%) died as a result of physical trauma following probable impact from a ship or boat (CSIP 2011-2016; **Table 11-82**).

Table 11-82 Summary of Strandings and Causes of Death from Physical Trauma of Unknown Causes and Physical Trauma Following Possible Collision With a Vessel

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	6,599	1,535	71	16	0.0567
Bottlenose dolphin	183	43	1	0	0.0233
Common dolphin	2,043	533	27	13	0.0750
White-beaked dolphin	297	104	3	0	0.0288
Minke whale	373	93	2	3	0.0538
Grey seal	2,987	577	22	4	0.0451
Harbour seal	624	185	5	0	0.0270

566. To estimate the potential collision risk of vessels associated with either of the Projects during construction, the potential risk rate per vessel has been calculated for all relevant species (**Table 11-82**), which is then used to calculate the risk to marine mammal species due to the increased number of vessel movements during construction.

567. 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 Project, within the Offshore Development Area, or an average of 772 per year per year for either DBS East or DBS West in isolation.

568. 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, and the potential collision risk rate of each species based on the CSIP and Scottish Marine Animal Standing Scheme data.

569. The total UK populations are taken from IAMMWG (2023) for all cetacean species, and the total UK 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 AIS data, which is the latest publicly available.

570. 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 either of the Projects has been used to determine the possible magnitude of the permanent effect (**Table 11-83**).

571. For harbour porpoise, white-beaked dolphin and minke whale, the magnitude of impact is negligible. For common dolphin, grey seal and harbour seal the magnitude of impact is low. Bottlenose dolphin has been assessed to have a magnitude of impact of low to medium. (**Table 11-83**).

572. This is a highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, that vessels within DBS East or DBS West 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 to negligible for all species.

Table 11-83 Predicted Number of Marine Mammals at Risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (Magnitude of Impact Based on the Percentage of the Reference Population at Risk) at DBS East or DBS West In Isolation

Marine mammal species	Collision risk rate	Estimated total number of individuals in UK waters	Estimated number of individuals at risk within UK waters	Annual number of vessel transits in UK and RoI for 2015	Number of marine mammals at risk of collision per vessel in UK waters	Number annual vessel transits associated with construction	Additional marine mammals at risk due to increase in vessel number (collision rate* vessel increase)	% reference population and Magnitude* (permanent)
Harbour porpoise	0.0567	200,714	11,376	3,852,030	0.00295	772	Up to 3 per year (2.3)	0.0007% of the NS MU Negligible
Bottlenose dolphin	0.0233	7,252	169	3,852,030	0.00004	772	Up to 1 every 25 years (0.03 per year)	0.002% of the GNS MU & 0.02% of the CES MU Low (Medium)
Common dolphin	0.0750	57,417	4,309	3,852,030	0.00112	772	Up to 1 per year (0.9)	0.001% of the CGNS MU Low
White-beaked dolphin	0.0288	34,025	981.5	3,852,030	0.00025	772	Up to 1 every 5 years (0.2)	0.0005% of the CGNS MU Negligible
Minke Whale	0.0538	10,288	553	3,852,030	0.00014	772	Up to 1 every 10 years (0.1)	0.0006% of the CGNS MU Negligible
Grey Seal	0.0451	162,000	7,300	3,852,030	0.0019	772	Up to 2 every year (1.5)	0.005% of the SE MU & 0.003% of the wider MU Low (Low)
Harbour Seal	0.0270	42,900	1,159	3,852,030	0.0003	772	Up to 1 every 3 years (0.2)	0.005% of the SE MU Low

* Magnitudes given in brackets are for the secondary MU assessed for secondary populations

11.6.1.6.2 Magnitude of Impact – DBS East and DBS West Together

573. 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 11-1**).

574. 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 (**Table 11-84**), which is then used to calculate the risk to marine mammal species due to the increased number of vessel movements during construction.

575. The increased number of vessel movements has been based on the estimated average of 1,502 return vessel trips per year during the five year construction period (as a worst-case) for DBS East and DBS West together (**Table 11-84**) and a total of 7,510 over the five years of construction. The assessments for collision risk to marine mammals for the construction of DBS East and DBS West together has been based on the same approach as set out above (section 11.6.1.6.1; **Table 11-83**).

576. 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 together has been used to determine the potential magnitude of the permanent effect (**Table 11-84**).

577. The magnitude for potential increased collision risk with construction vessels based on a precautionary worst-case scenario has been assessed as low for harbour porpoise, common dolphin, white-beaked dolphin and minke whale. For harbour seal the magnitude is medium, and is low to medium for bottlenose dolphin and grey seal (**Table 11-84**).

578. 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 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.

Table 11-84 Predicted Number of Marine Mammals at risk of Collision with Construction Vessels, Based on Current UK Collision Rates and Vessel Presence (Magnitude of Impact Based on the Percentage of the Reference Population at Risk) at DBS East and DBS West Together

Species	Number annual vessel transits associated with construction	Number of marine mammals at increased risk	% of reference population and Magnitude* (permanent)
Harbour porpoise	1,502	Up to 5 every year (4.4)	0.0013% of the NS MU Low
Bottlenose dolphin	1,502	Up to 1 every 10 years (0.1)	0.004% of the GNS MU & 0.031% of the CES MU Low (Medium)
Common dolphin	1,502	Up to 2 every year (1.7)	0.002% of the CGNS MU Low
White-beaked dolphin	1,502	Up to one every two years (0.4)	0.001% of the CGNS MU Low
Minke Whale	1,502	Up to one every three years (0.2)	0.0011% of the CGNS MU Low
Grey Seal	1,502	Up to three every year (3.0)	0.010% of the SE MU & 0.005% of the wider MU Medium (Low)
Harbour Seal	1,502	Up to one every two years (0.5)	0.01% of the SE MU Medium

* Magnitudes given in brackets are for the secondary MU assessed for secondary populations

11.6.1.6.3 Sensitivity of Receptor

579. 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 out with recognised vessel routes, can pose an increased risk of vessel collision to marine mammals.

580. Harbour porpoise are small and highly mobile, and, given their responses to vessel noise (e.g. Thomsen *et al.* 2006; Polacheck and Thorpe 1990), are expected to largely avoid vessel collisions. As previously outlined, the Heinänen and Skov (2015) modelling indicates a negative relationship between the number of ships and the distribution of harbour porpoise in the Irish and Celtic Seas during summer, suggesting that the species could exhibit avoidance behaviour which reduces the risk of collision risk with vessels. Therefore, harbour porpoise are assessed as having a sensitivity of low to vessel collision risk. Dolphin and seal species are also small and agile, and able to avoid collision with vessels, and are therefore also assessed as having a low sensitivity.

581. Whale species are generally less able to avoid collision with vessels due to their larger size, and are more at risk of vessel collision than other mammal species. Therefore, the sensitivity of minke whale as a precautionary approach to collision risk with vessels to be medium. While marine mammals are expected to be able to avoid collision with vessels, in the case that a collision were to take place, there is the potential for fatal injury to occur.

11.6.1.6.4 Significance of Effect – DBS East or DBS West In Isolation

582. Taking into account the marine mammal sensitivity and the potential magnitude of impact, the significance of effect for any potential increased collision risk as a result of construction vessels without mitigation has been assessed as **minor or negligible adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-85**).

583. However, as outlined above, this is highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, considering that vessels within the windfarms would be stationary for much of the time or very slow moving.

Table 11-85 Assessment of Significance of Effect for Increased Collision Risk with Vessels during Construction for DBS East or West In Isolation

Species	Sensitivity	Magnitude	Significance
Harbour porpoise and white-beaked dolphin	Low	Negligible	Negligible adverse
Bottlenose dolphin	Low	Low to medium	Minor adverse
Minke whale	Medium	Negligible	Minor adverse
Common dolphin, grey seal and harbour seal	Low	Low	Minor adverse

11.6.1.6.5 Significance of Effect – DBS East and DBS West Together

584. Taking into account the marine mammal sensitivity, and the potential magnitude of impact for construction of DBS East and DBS West together, the significance of effect for any potential increased collision risk as a result of construction vessels has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-86**).

585. There have been no known reported incidents of marine mammal collisions with OWF vessels. The expected magnitude for collision risk would be very low to negligible for all species and the significance of effect for the Projects in isolation is seen as more representative. As such, the magnitude would be considered as low as the worst case and the significance effect for DBS East and DBS West together would be **moderate adverse** for all species.

Table 11-86 Assessment of Significance of Effect for Increased Collision Risk with Vessels during Construction for DBS East and West Together

Species	Sensitivity	Magnitude	Significance
Harbour porpoise, common dolphin and white-beaked dolphin	Low	Low	Minor adverse
Bottlenose dolphin and grey seal	Low	Low to medium	Minor adverse
Minke whale	Medium	Low	Minor adverse
Harbour seal	Low	Medium	Minor adverse

11.6.1.6.6 Mitigation and Residual Significance of Effect

586. As outlined in section 11.6.1.4, vessel movements, where possible, would follow set vessel routes where available and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. All vessel movements would be kept to the minimum number that is required to reduce any potential collision risk. Additionally, vessel operators would use good practice to reduce any risk of collisions with marine mammals. These measures would be detailed within the PEMP as secured through a deemed Marine Licence Condition.

587. The residual impact, taking into account good practice to reduce any risk of collisions with marine mammals, would be **minor adverse** (not significant in EIA terms) at either DBS East or DBS West Array Areas including the Offshore Export Cable Corridor for all marine mammals.

11.6.1.7 Impact 7: Changes to Prey Resources

588. Potential effects to prey species that may cause changes to prey resources for marine mammals include:

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

589. Relevant marine mammal prey species in the study area include Atlantic herring, Atlantic cod, mackerel, Atlantic horse mackerel, whiting, sandeels, European sprat, which are key prey species for:

- Harbour porpoise – 'schooling fish', e.g. herring, whiting, sprat, sandeels;
- Bottlenose dolphin – 'opportunistic feeders', e.g., mackerel, cod, whiting, sprat, sandeels and cephalopods;
- Common dolphin – 'cooperative feeders', e.g. mackerel, whiting, and cephalopods;
- White-beaked dolphin – whiting, cod, herring and cephalopods;
- Minke whale - sandeel, mackerel, herring;
- Grey seal – 'generalist feeders', e.g. sandeel, whiting, cod, , flatfish and cephalopods; and
- Harbour seal – 'flexible', e.g. sandeels, sprat, herring, flatfish and cephalopods.

590. **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. 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 marine mammal populations.

11.6.1.7.1 Physical Disturbance and Temporary Habitat Loss

591. 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 Habitats (application ref: 7.9)** and **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

592. 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.

11.6.1.7.1.1 Magnitude of Impact – DBS East or DBS West In Isolation

593. 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 19.9km².

594. 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.

595. Of the two Projects, DBS West 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.

596. 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.

597. The low magnitude of impact for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor group and the medium sensitivity of effect for the demersal fish, pelagic fish and shellfish receptor groups, results in the assessment that the magnitude of impact in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** is assessed as low for all species at DBS East and DBS West in isolation. With a low adverse magnitude of impact the significance of effect for fish species is assessed as **minor adverse** (not significant in EIA terms). Therefore, any potential changes to prey availability as a result of physical disturbance and temporary habitat loss is assessed as having a low magnitude of impact for marine mammals.

11.6.1.7.1.2 Magnitude of Impact – DBS East and DBS West Together

598. The worst case scenario footprint of temporary habitat disturbance and direct damage associated with the construction phase of both DBS Projects is 59.5km². This represents approximately 0.18% of the total Fish and Shellfish Ecology Study Area. The footprint for all generation asset construction works, including the Array Areas, and Inter-Platform Cables, and offshore platforms, is 22.7km². The footprint for all offshore transmission works, including the Offshore Export Cable installation, is 36.8km².

599. The low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the low sensitivity of effect for the elasmobranch receptor and the medium sensitivity of effect for the demersal fish, pelagic fish, and shellfish receptor groups, results in the assessment that the magnitude of impact in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** is assessed as low for all species at DBS East and DBS West in isolation. With a low adverse magnitude of impact the significance of effect for fish species is assessed as **minor adverse** (not significant in EIA terms).

600. Therefore, any potential changes to prey availability as a result of physical disturbance and temporary habitat loss is assessed as having a low magnitude of impact for marine mammals.

11.6.1.7.2 Increased Suspended Sediments Concentrations and Sediment Deposition

601. Construction activities such as seabed preparation, foundation installation, drilling operations and cable installation may lead to the potential for increased suspended sediment concentrations (SSC) in the water column and subsequent sediment re-deposition. 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.

11.6.1.7.2.1 Magnitude of Impact – DBS East or DBS West In Isolation

602. 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 sea bed level when the sediments are deposited. In **Volume 7, Chapter 9 Benthic Habitats (application ref: 7.9)**, the impact magnitude is considered to be negligible at DBS East and DBS West in isolation. The magnitude of impact in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** is assessed as low for all species at DBS East and DBS West in isolation. With a low adverse magnitude of impact the significance of effect for fish species is assessed as **minor adverse** (not significant in EIA terms). Therefore, any potential changes to prey availability as a result of increased SSCs and sediment deposition is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.2.2 Magnitude of Impact – DBS East and DBS West Together

603. As the low adverse magnitude of impact for both Projects together (DBS East and DBS West), combined with the negligible sensitivity of effect for adult individuals within the elasmobranch, demersal fish, pelagic fish, and migratory fish receptor groups, results in the assessment that an increase in SSC and sediment settlement has a negligible effect.

604. The medium sensitivity of effect for eggs and / or larvae within the elasmobranch, demersal fish, pelagic fish, migratory fish and shellfish receptor groups, results in the assessment that the magnitude of impact in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** is assessed as low for all species at DBS East and DBS West together. With a low adverse magnitude of impact the significance of effect for fish species is assessed as **minor adverse** (not significant in EIA terms).

605. Therefore, any potential changes to prey availability as a result of increased SSCs and sediment deposition is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.3 Re-Mobilisation of Contaminated Sediment

606. 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.

607. **Volume 7**, **Chapter 8 Marine Physical Environment (application ref: 7.8)** indicates that the likely nature of the seabed sediments within the Offshore Development Areas significantly reduces the potential for contaminants to accumulate and this is reflected in the historical data collected for Dogger Bank A & B which has similar sediment types. It is therefore predicted that contaminant levels would be similar in the Offshore Development Area but this will be confirmed with project-specific data that will be incorporated into the assessment for the ES.

608. 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).

11.6.1.7.3.1 Magnitude of Impact – DBS East or DBS West In Isolation

609. The magnitude of impact in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** for DBS West (as the worst case scenario footprint assigned to both DBS East and DBS West), combined with the localised, short-term disturbance of sediments, and the low likelihood of significant contamination within the Offshore Development Area. Therefore, the magnitude of impact is considered negligible sensitivity for all fish and shellfish receptor groups, resulting in the assessment that the release of sequestered contaminants following sediment disturbance has a negligible effect for marine mammals.

610. Therefore, any potential changes to prey availability as a result of re-mobilisation of sediments is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.3.2 Magnitude of Impact – DBS East and DBS West Together

611. The magnitude of impact in **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.

612. Therefore, any potential changes to prey availability as a result of re-mobilisation of sediments is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.4 Underwater Noise

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

614. 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.

615. Underwater noise modelling (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) assessed the following fish groups (based on Popper *et al.* 2014):

- No swim bladder (e.g. sole, plaice, lemon sole, mackerel and sandeels);
- Swim bladder not involved in hearing (e.g. sea bass, salmon and sea trout); and
- Swim bladder which is involved in hearing (e.g. cod, whiting, sprat and herring).

616. The underwater noise modelling results (**Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**) indicate that fish species in which the swim bladder is involved in hearing are the most sensitive to the impact of underwater noise, therefore the worst-case scenario assessment uses these species as an indicator of overall effects.

11.6.1.7.4.1 Magnitude of Impact - DBS East or DBS West In Isolation

617. Effects associated with underwater noise and vibration via all sources are likely occur. Noise and vibration associated with both piling and UXO is likely to result in a change that is outside the natural variation in background conditions. However, both noise sources pertain to discrete events, with noise and vibrations emissions occurring only in the short term (0 – 1 year). Noise and vibration associated with construction and vessel activities is likely to result in emissions that is within the natural variation of background conditions, but that may occur over the full construction period of five years for a Project in isolation. Therefore, the magnitude of impact for underwater noise and vibration is considered low.

618. 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 SELcum, and mortality until 207dB SEL_{cum}. 560km² (2.09% of the Fish and Shellfish Ecology Study Area). Mortality is likely to be limited to an area of 97km² (see the **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

619. When considering noise associated with construction and vessel activities, the magnitude on fish and shellfish is considered negligible within the context of the fish and shellfish ecology study area. 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.

620. The magnitude of impact in underwater noise at DBS East or DBS West along with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment conclusion that impacts associated with noise and vibration have a **minor adverse** effect. All other fish and shellfish receptor groups present a low magnitude of impact, resulting in the assessment conclusion that impacts associated with noise and vibration are negligible.

621. Therefore, any potential changes to prey availability as a result of underwater noise is assessed as having a negligible magnitude of impact for marine mammals.

622. It is important to note that there is unlikely to be any additional displacement of marine mammals as a result of any changes in prey availability during piling as marine mammals would already be disturbed from the area (see section 11.6.1.2).

623. The magnitude of impact for any changes in prey resource from underwater noise and vibration during construction for marine mammals would be low to negligible.

11.6.1.7.4.2 Magnitude of Impact - DBS East and DBS West Together

624. The cumulative area of exposure to 186dB SEL_{cum} increases to a total of 15,000km^2 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 730km^2 (2.72% of the fish and shellfish ecology Study Area). Mortality is likely to be limited to an area of 270km^2 (see the **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**).

625. The magnitude of impact in underwater noise at DBS East and DBS West together with the medium sensitivity of effect for fish and shellfish with a swim bladder used in hearing results in the assessment conclusion 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 conclusion that impacts associated with noise and vibration are negligible.

626. Therefore, the magnitude of impact for any changes to prey availability as a result of underwater noise is assessed as having a negligible magnitude of impact for marine mammals.

11.6.1.7.5 Changes in Fishing Activity

627. 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 within **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**.

628. The low magnitude of impact for DBS East and DBS West in isolation and together, combined 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).

11.6.1.7.6 *Summary of Magnitudes of Impact*

629. The following sections summarise the potential effects to fish species, based on the assessments provided in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**. The magnitude of impact to marine mammal species is based on the magnitude of impact to prey species, although it should be noted that this is a precautionary approach as marine mammals are generally opportunistic foragers, and would be able to prey upon a range of other species.

Table 11-87 Magnitude of Potential Changes to Prey Resources During Construction, Based on Assessments in ***Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)***

<table>
<tr><th colspan="2">Potential effect to prey resources</th><th>Magnitude as assessed in Chapter 10</th></tr>
<tr><td colspan="2">Physical disturbance and temporary habitat loss</td><td>Low (overall significance of effect of minor to negligible)</td></tr>
<tr><td colspan="2">Increased SSC and sediment deposition</td><td>Low (overall significance of effect of minor to negligible).</td></tr>
<tr><td colspan="2">Re-mobilisation of contaminated sediment</td><td>Negligible (overall significance of effect of negligible).</td></tr>
<tr><td rowspan="3">Underwater noise</td><td>Piling noise</td><td>Negligible to low (overall significance of negligible), or for fish and shellfish with a swim bladder used in hearing, an overall significance of effect of minor (with an increased sensitivity).</td></tr>
<tr><td>Other construction activities</td><td>Low (overall significance of effect of negligible).</td></tr>
<tr><td>UXO clearance</td><td>Low (overall significance of effect of minor).</td></tr>
<tr><td colspan="2">Changes in fishing activity</td><td>Low (overall significance of effect of negligible).</td></tr>
</table>

11.6.1.7.7 *Sensitivity of Receptor*

630. As outlined in **Volume 7**, **Appendix 11-1 (application ref: 7.11.11.1)**, the diet of harbour porpoise consists of a wide variety of prey species and varies geographically and seasonally, reflecting changes in available food resources. Harbour porpoise have relatively high daily energy demands and need to capture enough prey to meet daily energy requirements. It has been estimated that, depending on the environmental conditions, harbour porpoise can rely on stored energy (primarily blubber) for three to five days, depending on body condition (Kastelein *et al.* 1997). Harbour porpoise are therefore considered to have low to medium sensitivity to changes on prey resources.

631. Dolphin species, including bottlenose dolphin, common dolphin and white-beaked dolphin have a broad diet, feeding on a wide range of prey species. All dolphin species are considered to have large foraging ranges, and a broad range of prey species, and are therefore considered to have low sensitivity to changes in prey resources.

632. Minke whale feed on a variety of prey species, but in some areas, they have been found to prey upon specific species. Therefore, minke whale are considered to have a low to medium sensitivity to changes in prey resource.

633. Grey seal are opportunistic feeders, preying on a variety of species, dominated by sandeel. Within the southern North Sea, diet is more varied in composition where grey seals also prey on flat fish, sandy benthic, large gadid prey and scorpion fish (the latter mainly during autumn/winter) (Wilson and Hammond 2019).

634. Harbour seals are considered generalist feeders, and feed on a variety of species, e.g. large gadid prey (Wilson and Hammond 2019).

635. Both grey and harbour seals are able to forage in other areas and have relatively large foraging ranges. Grey seal and harbour seal are therefore considered to have low sensitivity to changes in prey resources.

636. Further information on the diet of marine mammal species is provided in **Volume 7**, **Appendix 11-2 (application ref: 7.11.11.2)**.

11.6.1.7.8 Significant of Effect – DBS East or DBS West In Isolation

637. Taking into account the low to medium marine mammal sensitivity, and the potential magnitude of impact of negligible to low (**Table 11-88**) for all fish species, the significance for any effect of the changes of prey for marine mammals has been assessed as **negligible** to **minor adverse** for harbour porpoise, minke whale, grey seal and harbour seal and **negligible adverse** (not significant in EIA terms) for bottlenose dolphin, common dolphin and white-beaked dolphin (**Table 11-88**).

Table 11-88 Assessment of Significance of Effect for the Potential of an Indirect Effect to Marine Mammals Through Changes to Prey Resources During Construction

Potential effect	Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Physical disturbance and temporary habitat loss	Harbour porpoise and minke whale	Low to medium	Low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low		Negligible adverse

Potential effect	Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Increased suspended sediments and sediment deposition	Harbour porpoise and minke whale	Low to medium	Low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low		Negligible adverse
Re-mobilisation of contaminated sediment	Harbour porpoise and minke whale	Low to medium	Negligible	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low		Negligible adverse
Underwater noise	Harbour porpoise and minke whale	Low to medium	Negligible to low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low		Negligible to Minor adverse
Change in fishing activity	Harbour porpoise and minke whale	Low to medium	Low	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low		Negligible adverse

11.6.1.7.9 *Significant of Effect – DBS East and DBS West Together*

638. Taking into account the low to medium marine mammal sensitivity, and the potential magnitude of impact of negligible to low (**Table 11-88**) for all fish species, the significance for any effect of the changes of prey for marine mammals has been assessed as **negligible** to **minor adverse** for harbour porpoise, minke whale, grey seal and harbour seal and **negligible adverse** (not significant in EIA terms) for all dolphin species (**Table 11-88**).

11.6.1.7.10 Mitigation and Residual Significance of Effect

639. Mitigation in the final MMMP and SIP to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species. No further mitigation is required or proposed in relation to any changes in prey availability.

11.6.1.8 Impact 8: Changes to Water Quality

640. As described in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** potential changes in water quality during construction could occur through:

- Deterioration in water quality due to an increase in suspended sediment associated with seabed preparation for the installation of foundations, and cables;
- Deterioration in water quality due to an increase in sediment concentrations due to drill arisings for installation of piled foundations for wind turbines and platforms;
- Deterioration in water quality due to increases in suspended sediment associated with the installation of the export cable; and
- Deterioration in water quality associated with release of sediment bound contaminants.

641. All vessels involved with the Projects will be required to comply with the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. An **Volume 8, Outline PEMP** (**application ref: 8.21)** has been submitted alongside the DCO application and sets out all procedures and measures (in the form of a Marine Pollution Contingency Plan (MPCP)) to be followed to minimise the risk of, and effects in the event of an accidental spill or leak. The final PEMP would be agreed with the MMO prior to construction and would include, for example, measures to control accidental release of drilling fluids whilst ensuring that any chemicals used are listed on the OSPAR List of Substances Used and Discharged Offshore which Are Considered to Pose Little or No Risk to the Environment (PLONOR) (OSPAR, 2021).

11.6.1.8.1 Magnitude of Impact – DBS East or DBS West In Isolation

642. The magnitude for the potential changes in water quality has been based on the assessments in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** and has been assessed as negligible for the Projects in-isolation and together.

11.6.1.8.2 Magnitude of Impact – DBS East and DBS West together

643. There would be no change in the magnitude of the impact if DBS East and DBS West were constructed separately or concurrently. The magnitude for the potential changes in water quality has been based on the assessments in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**.

11.6.1.8.3 Sensitivity of Receptor

644. Marine mammals often inhabit turbid environments and cetaceans use sonar to sense the environment around them and there is little evidence that turbidity affects cetaceans directly (Todd *et al.* 2014).

645. Pinnipeds are not known to produce sonar for prey detection purposes; however, it is likely that other senses are used instead of, or in combination with, vision, such as sensing the environment with the vibrissae in their whiskers. Studies have shown that vision is not essential to seal survival, or ability to forage (Todd *et al.* 2014).

646. Increased turbidity is therefore unlikely to have a substantial direct impact on marine mammals that often inhabit naturally turbid or dark environments. Therefore, harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal have negligible sensitivity to increases in suspended sediments during construction.

647. Any direct impacts to marine mammals as a result of any contaminated sediment during construction activities are unlikely because any exposure is more likely to be through potential indirect impacts via prey species, as assessed in section 11.6.1.7. Therefore, marine mammals are considered to have negligible sensitivity to any direct impacts from contaminated sediment during construction activities.

11.6.1.8.4 Significance of Effect – DBS East or DBS West In Isolation

648. Looking at the potential magnitude of the impact, the significance of effect for any potential changes in water quality during construction at DBS West or DBS East has been assessed as **negligible adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-89**).

Table 11-89 Assessment of Significance of Effect for any Changes in Water Quality during Construction at DBS East or/and DBS West

Species	Location	Sensitivity	Magnitude	Significance of Effect
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	DBS East	Negligible	Low	Negligible adverse
	DBS West	Negligible	Low	Negligible adverse

11.6.1.8.5 Significance of Effect – DBS East and DBS West Together

649. The impacts for DBS East and DBS West concurrently would be the same as those assessed for DBS East and DBS West in isolation due to the limited range of potential changes in water quality with a low magnitude of impact and a **negligible adverse** (not significant in EIA terms) significance of effect (**Table 11-89**).

11.6.1.8.6 Mitigation and Residual Significance of Effect

650. No mitigation is proposed for changes to water quality, as the significance of effect is **negligible adverse** (which is not significant in EIA terms) (**Table 11-89**).

11.6.1.9 Impact 9: Disturbance of Seals at Haul-Out Sites

651. Seals vary in their reaction to construction disturbance depending on disturbance type (vessel noise/presence, piling etc,) and proximity to haul-out sites.

652. Grey seal and harbour seal have been shown to be sensitive at haul-out sites to disturbance from anthropogenic sources such as vessel traffic, construction activities including piling, and approaches from land (Cates and Acevedo-Gutierrez 2017; Paterson *et al.* 2019; Machernis *et al.* 2018). The most common disturbance effects at haul out sites include increased vigilance and 'flushing' behaviour, which can be energetically taxing especially if pups are present or during moulting season when seals tend to spend more time on land (Machernis *et al.* 2018).

653. During construction, piling represents the loudest and most likely source of disturbance to seal haul-outs, as well as increased vessel activity, and the number of seals spending time on land has been shown to decrease during the construction phase of wind farms (e.g. up to 60% reduction in number of seals hauling out at sites 4km away from construction activities during piling periods) (Edren *et al.* 2010).

654. A 2016 study at Sheringham Shoal OWF demonstrated that there was no significant displacement of seals overall during construction. However, during pile driving activities there was a significant reduction in seals at haul-out sites up to 25km away, returning to typical levels two hours after piling had ceased (Russel *et al.* 2016).

655. 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.

656. 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 vessel 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).

657. 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).

658. In areas of high vessel traffic, there can be habituation effects and disturbance behaviours are generally reduced over time (Strong *et al.* 2010).

11.6.1.9.1 Magnitude of Impact DBS East or DBS West In Isolation

659. The closest seal haul out is at Filey Brigg which is the located approximately 28km from landfall, 25km from the Offshore Export Cable Corridor, 106km from DBS East and 132km from DBS West. The haul-out site is referred to as a 'transient resting spot for seals' with a maximum of 15 individuals recorded at any one time (Yorkshire Seals org, 2023), and harbour seal counts in single numbers (Filey bird Observatory Group, 2023). Other haul-out sites further from the Projects are Ravenscar (52km from landfall, 62km from export cable corridor, 140km from DBS East and 150km from DBS West). Donna Nook (62km from landfall, 65km from export cable corridor, 153km form DBS East and 151km from DBS West) mean grey seal count recorded in 2012 was 3,897 and harbour seal 122 (SCOS, 2021).

660. The closest seal haul out site is 106km from the DBS East Array Area site and 25km from the Offshore Export Cable Corridor, there is therefore no potential for any direct disturbance as a result of construction activities from either DBS East or DBS West (including landfall and the export cable corridor).

661. As outlined above, the studies by Edren *et al.* (2010) and Russel *et al.* (2016), demonstrate there could be disturbance at seal haul-out sites 4km for construction activities and 25km for piling, respectively, during construction of OWFs. Taking into account the distance from shore of the windfarm site (100km closest point) and the distances to the seal haul-out sites, there is unlikely to be any significant disturbance of seals at haul-out sites.

662. However, vessel transition from the Offshore Development Area to port has 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 an indicative short list has been provided (**Table 11-73**). Grimsby port which is most likely to be used during operation and maintenance is close to Donna Nook, as is Able Marine Energy Park. The last seal count at Donna Nook counted 3,897 grey seal and 122 harbour seal (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**; SCOS, 2022)

663. Able Seaton port is close to Tees seal haul-out site with 30 grey seal and 86 harbour seal counted in 2021 (SCOS 2022).

664. If the ports at Lowestoft or Great Yarmouth are utilised, these are close to seal haul out sites; Horsey, Scorby sand and Blakeney Point;

- Horsey; 380 grey seal and 12 harbour seal;
- Scroby Sands; 1,377 grey seal and 25 harbour seal; and
- Blakeney Point; 493 grey seal and 181 harbour seal (SCOS 2022).

665. 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.

666. 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.et al.* 2019).

667. There is no pathway for impact due to distances from the seal haul out sites, therefore the only impact would be construction vessels to ports that we consider any further.

668. 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 an average of 772 round trips per year during five year construction period, for both DBS East and DBS West (equating to up to five one-way vessel transits per day) (**Table 11-1**).

669. 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 magnitude of impact of grey and harbour seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be low.

11.6.1.9.2 Magnitude of Impact – DBS East and DBS West Together

670. There is no potential for any direct disturbance as a result of construction activities from either DBS East or DBS West (including landfall and the Offshore Export Cable Corridor). The magnitude of impact for disturbance at seal haul-out sites during piling and other construction activities in the windfarm site has been assessed as negligible.

671. In total, for the construction of DBS East and DBS West together, there may be up to 7,510 round trips to port from the Array Areas during the construction phase. This represents a slight increase in the current number of vessels in the area with an average of 1,502 vessel round trip transits per year.

672. 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 magnitude of impact of grey and harbour seals at haul-out sites to disturbance from vessels moving to and from the port(s) during construction is likely to be negligible.

11.6.1.9.3 Sensitivity of Receptor

673. Both grey seal and harbour seal may become disturbed from haul-out sites due to the presence of vessels, which, if occurring in the breeding season, can result in the abandonment of pups. Due to this, both grey seal and harbour seals are considered to be sensitive to vessel disturbance at haul-out sites, particularly if that occurs within the breeding season.

674. A study 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 (Jansen *et al.et al.* 2010). 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 (Jansen *et al.* 2010). Beyond 600m, there was no discernible effect on the behaviour of harbour seal.

675. Therefore, it is considered that, for grey seal, vessels travelling within 300m of a haul-out site, a grey seal may flee into water, but significant disturbance would be expected at a distance of less than 150m. For harbour seal, if a vessel travels within 600m of a haul-out site, there is the potential for a flee response, and if a vessel is within 300m, a large number of harbour seal would flee.

676. The sensitivity of both seal species to disturbance from seal haul-out sites is therefore low, and as a very precautionary approach, it is proposed that sensitivity during the breeding season and annual moult could be slightly higher and has therefore been considered as medium in this assessment.

11.6.1.9.4 Significance of Effect – DBS East or DBS West Together

677. Taking into account the low to medium sensitivity, and the potential magnitude of negligible low for the temporary impact, the significance of effect for disturbance at seal haul-out sites during construction of DBS East and DBS West in isolation has been assessed as **negligible to minor adverse** (not significant in EIA terms) for both grey seal and harbour seal **(Table 11-90**).

Table 11-90 Assessment of significance of effect for Disturbance at Seal Haul-Out Sites During Construction

Species	Impact	Sensitivity	Magnitude	Significance
Grey seal	Disturbance from construction activities Disturbance from vessels	Low to Medium	Negligible Low	Negligible to minor adverse Minor adverse
Harbour seal	Disturbance from construction activities Disturbance from vessels	Low to Medium	Negligible Low	Negligible to minor adverse Minor adverse

11.6.1.9.5 Significance of Effect – DBS East and DBS West Together

678. Taking into account the low to medium sensitivity, and the potential magnitude of negligible low for the temporary impact, the significance of effect for disturbance at seal haul-out sites during construction of DBS East and DBS West together has been assessed as **negligible to minor adverse** (not significant in EIA terms) for both grey seal and harbour seal; the assessments for the Projects together is therefore the same as presented for the Projects in isolation (**Table 11-90**).

11.6.1.9.6 Mitigation and Residual Significance of Effect

679. No mitigation is required for the disturbance of seals at haul-out sites. However, as outlined in the section 11.3.3 where possible and safe to do so, transiting vessels would maintain distances at least 1km distance from the coast, particularly in areas near known seal haul-out sites during sensitive periods, such as pupping and moulting.

11.6.2 Potential Effects During Operation

680. The potential effects during operation and maintenance (O&M) that have been assessed for marine mammals are:

- Impact 1: Impacts from underwater noise associated with operational wind turbines;
  - Impact 1a: Temporary auditory injury (TTS).
  - Impact 1b: Disturbance or behavioural impacts.
- Impact 2: Impacts from underwater noise associated with O&M activities;

- Impact 2a: Temporary auditory injury (TTS).
- Impact 2b: Disturbance.

- Impact 3: Underwater noise and presence from O&M vessels;
  - Impact 3a: Temporary auditory injury (TTS).
  - Impact 3b: Disturbance.
- Impact 4: Barrier effects as a result of underwater noise;
- Impact 5: Increased collision risk with vessels during operation and maintenance;
- Impact 6: Changes to water quality;
- Impact 7: Changes to prey resource; and
- Impact 8: Disturbance at seal haul-out sites.

681. The realistic worst case scenario on which the assessments are based is outlined in **Table 11-1**.

11.6.2.1 Impact 1: Impacts from Underwater Noise Associated with Operational Wind Turbines

682. The operational wind turbines will operate nearly continuously, except for occasional shutdowns for maintenance or severe weather. The Projects' operation and maintenance period in a Sequential Scenario is a maximum of 32 years.

683. 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 (Tougaard *et al.*, 2009a; Sigray and Andersson, 2011).

684. 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 (e.g., Godin, 2008).

685. 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.* 2009a).

686. 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 (Tougaard *et al.* 2020).

687. 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)**).

11.6.2.1.1 Underwater Noise Modelling

688. 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. Further information on the methodology of underwater noise modelling is provided in **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**.

11.6.2.1.2 Impact 1a: TTS Due to Operational Wind Turbine Noise

689. The results of the underwater noise modelling show potential PTS and TTS ranges of less than 100m. The model used does not define specific effect ranges of less than 100m and therefore, where the effect ranges are less than that, it is possible that the actual effect ranges are considerably lower.

690. 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 be within 100m of a wind turbine for any potential risk of PTS. Therefore, PTS is highly unlikely and has not been assessed further.

11.6.2.1.2.1 Magnitude of Impact - DBS East or DBS West In Isolation

691. The number of marine mammals 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 11-91**).

692. More than one wind turbine would 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.

Table 11-91 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 range (km) and area (km^2)	Area of impact for up to 100 wind turbines (km^2)
Harbour porpoise (VHF)	PTS or TTS	<0.1 (0.031km^2)	3.1km^2
Dolphin species (HF)	PTS or TTS	<0.1 (0.031km^2)	3.1km^2
Minke whale (LF)	PTS or TTS	<0.1 (0.031km^2)	3.1km^2
Grey seal and harbour seal (PCW)	PTS or TTS	<0.1 (0.031km^2)	3.1km^2

693. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that the marine mammal would have to be within 100m from a turbine (**Table 11-92**). However, as a precautionary approach, the number of marine mammals that could be at risk of TTS has been estimated (**Table 11-92**). As outlined previously, this is likely to be an overestimation as ranges smaller than 100m for SEL_{cum} have been reported as 100m.

694. The magnitude of the potential impact for any TTS as a result of underwater noise from 100 operational wind turbines at DBS East or DBS West, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 0.01% of the reference populations exposed to any long-term impact (**Table 11-92**).

Table 11-92 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS as a Result of Underwater Noise Associated with Operational Wind Turbines at DBS East or DBS West In Isolation

Species	Location	Maximum number of individuals (% of reference population) for 100 wind turbines	Magnitude* (Long-term)
Harbour porpoise	DBS East	1.9 (0.0005% of NS MU)	Negligible
	DBS West	2.1 (0.0006% of NS MU)	
Bottlenose dolphin	DBS East or DBS West	0.1 (0.007% of GNS)	Negligible
Common dolphin	DBS East or DBS West	0.05 (0.00005% of CGNS MU)	Negligible
White-beaked dolphin	DBS East	0.11 (0.0002% of CGNS MU)	Negligible
	DBS West	0.13 (0.0003% of CGNS MU)	Negligible
Minke whale	DBS East	0.03 (0.0002% of CGNS MU)	Negligible
	DBS West	0.06 (0.0003% of CGNS MU)	
Grey seal	DBS East	0.6 (0.002% of SE England MU or 0.001% of wider MU)	Negligible (negligible)
	DBS West	0.8 (0.003% of SE England MU or 0.001% of wider MU)	
Harbour seal	DBS East	0.005 (0.0001% of SE England MU)	Negligible
	DBS West	0.003 (0.00007% of SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal*

11.6.2.1.2.2 Magnitude of Impact - DBS East and DBS West Together

695. The number of marine mammals 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 11-1**).

696. The predicted impact ranges for TTS from 24-hour cumulative exposure of underwater noise from operational turbines is less than 100m, and the potential impact area for the 200 operational wind turbines at DBS East and DBS West together is up to 6.28km^2.

697. 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 11-93**. This is assessment is based on the number of individuals at risk from DBS East totalled with the number at risk from DBS West (as presented in **Table 11-92**).

698. The magnitude of the potential impact is assessed as negligible for all species for the potential long-term effect with less than 0.01% of the reference population impacted. The potential TTS effect ranges are significantly lower than the turbine spacing, (less than 100m, and turbine spacing of at least 830m) and therefore there is no potential for an overlap in effect areas.

Table 11-93 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS 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	Magnitude* (Long-term)
Harbour porpoise	4.0 (0.001 % of NS MU)	Negligible
Bottlenose dolphin	0.3 (0.013% of GNS MU)	Negligible
Common dolphin	0.1 (0.0001% of CGNS MU)	Negligible
White-beaked dolphin	0.2 (0.0005% of CGNSMU)	Negligible
Minke whale	0.09 (0.0005% of CGNS MU)	Negligible
Grey seal	1.4 (0.005% of SE England MU or 0.002% of wider MU)	Negligible (negligible)
Harbour seal	0.008 (0.0002% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.2.1.3 Impact 1b: Disturbance Due to Operational Wind Turbine Noise

699. Currently available data indicates that there is no lasting disturbance or exclusion of harbour porpoise or seals around wind farm sites during operation (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). Data collected suggests that any behavioural responses for harbour porpoise and seal may only occur up to a few hundred metres away (Touggard *et al.* 2009b; McConnell *et al.* 2012).

700. Monitoring was carried out at the Horns Rev and Nysted wind farms in Denmark during the operation between 1999 and 2006 (Diederichs *et al.* 2008). Numbers of harbour porpoise within Horns Rev were slightly reduced compared to the wider area during the first two years of operation, however, it was not possible to conclude that the wind farm was solely responsible for this change in abundance without analysing other dynamic environmental variables (Tougaard *et al.* 2009a). Later studies by Diederichs *et al.* (2008) recorded no noticeable effect on the abundances of harbour porpoise at varying wind velocities at both of the OWFs studied, following two years of operation.

701. Monitoring studies at Nysted and Rødsand have also 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 wind farm sites (Alpha Ventus in Germany and Sheringham Shoal in UK) with the movement of several of the seals suggesting foraging behaviour around wind turbines fixed foundation structures (Russell *et al.* 2014).

702. Both harbour porpoise and seals have been shown to forage within operational wind farm sites (e.g., Lindeboom *et al.* 2011; Russell *et al.* 2014), indicating no restriction to movements in operational OWF sites. There is currently limited information for other marine mammal species, however, bottlenose dolphin is frequently observed in and around the Aberdeen Offshore Wind Farm (European Offshore Wind Deployment Centre; pers. comm.).

703. 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.

704. Based on the review of marine mammals and operational wind farms, the noise levels associated with operational wind turbines and duration of the operational life of the Projects, a precautionary magnitude of impact of low has been given to all marine mammal species for DBS East and DBS West in isolation or together.

11.6.2.1.4 Sensitivity of Receptor

705. The sensitivity of marine mammals to TTS as a result of underwater noise due to operational wind turbines is considered to be medium.

706. As a precautionary approach, harbour porpoise, dolphin species, and seal species are likely to have low sensitivity (rather than negligible) to disturbance from underwater noise as a result of operational wind turbines.

707. Taking into account that minke whales are more sensitive to low frequency noise, it is probable that they could be more sensitive to operational wind turbine noise (Marmo *et al.* 2013). Therefore, as a precautionary approach minke whale are classed as having medium sensitivity.

11.6.2.1.5 Significance of Effect – DBS East or DBS West In Isolation

708. Taking into account the medium sensitivity of all marine mammal species, and the precautionary negligible magnitude for 100 operational turbines (**Table 11-92**), the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for TTS from underwater noise of operational turbines during the operational life of DBS East or DBS West isolation (**Table 11-94**).

709. For the potential for disturbance due to operational turbines at either DBS East or DBS West in isolation, the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammals (**Table 11-94**) during the operational life of the Projects.

Table 11-94 Assessment of Significance of Effect for the Potential for Disturbance Due to Operational Wind Turbines at DBS East and DBS West In Isolation

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
TTS due to operational wind turbines, from either a single turbine or 100 turbines			
All marine mammals	Medium	Negligible	Minor adverse
Disturbance due to operational wind turbines, from either a single turbine or 100 turbines			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse
Minke whale	Medium	Low	Minor adverse

11.6.2.1.6 Significance of Effect – DBS East and DBS West Together

710. Taking into account the medium sensitivity of all marine mammal species and the precautionary negligible magnitude for 200 operational turbines (**Table 11-93**), the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for TTS from underwater noise of operational turbines during the operational life of DBS East and DBS West together (**Table 11-95**).

711. For the potential for disturbance due to operational turbines at DBS East and DBS West together, the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for all marine mammals (**Table 11-95**) during the operational life of the Projects.

Table 11-95 Assessment of Significance of Effect for the Potential for Disturbance Due to Operational Wind Turbines at DBS East and DBS West Together

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
TTS due to operational wind turbines, from up to 200 turbines			
All marine mammals	Medium	Negligible	Minor adverse
Disturbance due to operational wind turbines, from up to 200 turbines			
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse

Marine mammal species	Sensitivity	Magnitude of impact	Potential significance of effect
Minke whale	Medium	Low	Minor adverse

11.6.2.1.7 Mitigation and Residual Significance of Effect

712. No mitigation is required, therefore, the residual significance of effect for TTS or disturbance from underwater noise of operational turbines at DBS East or DBS West arrays would be **minor adverse (not significant in EIA terms)** for all species.

11.6.2.2 Impact 2: Impacts from Underwater Noise Associated with Operation and Maintenance Activities

11.6.2.2.1 Impact 2a: TTS from Underwater Noise Associated with Operation and Maintenance Activities

713. The requirements for any potential O&M activities, 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 11-1** 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.

714. As outlined in section 11.6.1.3 and **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**, the potential for PTS is only likely in very close proximity to cable laying or rock placement activities (less than 100m). Therefore, it is highly unlikely for there to be any PTS due to maintenance activities.

715. 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.

11.6.2.2.1.1 Magnitude of Impact - DBS East or DBS West In Isolation

716. The magnitude of impact for TTS from underwater noise during maintenance activities (e.g., cable laying and rock placement) has been based on the underwater noise modelling undertaken for other construction activities (see section 11.6.1.3 and **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

717. The magnitude of the potential impact for any TTS as a result of non-piling construction activities, for each activity individually or all together, is negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact from DBS East or DBS West in isolation (**Table 11-62**).

718. The potential for 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 O&M period for the Projects and would be limited to only part of the overall Offshore Development Area at any one time.

719. The potential for TTS effects that could result from underwater noise during maintenance activities, such as cable laying and protection would be localised and temporary to where and when the work was undertaken.

11.6.2.2.1.2 Magnitude of Impact - DBS East and DBS West Together

720. The magnitude of impact for TTS from underwater noise during maintenance activities (e.g. cable laying and rock placement) has been based on the underwater noise modelling undertaken for other construction activities taking into account activities at DBS East and DBS West in combination (see section 11.6.1.3 and **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**).

721. 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 11-63**).

722. The magnitude of the potential impact for TTS during construction activities other than piling at DBS East and DBS West together is assessed as negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-63**).

723. As previously stated, the potential for TTS effects that could result from underwater noise during maintenance activities, such as cable laying and protection would be localised and temporary to where and when the work was undertaken.

11.6.2.2.2 Impact 2b Disturbance from Underwater Noise Associated with O&M Activities

11.6.2.2.2.1 Magnitude of Impact - DBS East or DBS West In Isolation

724. 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 11.6.1.3.3).

725. 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 concurrently (**Table 11-64**).

726. The magnitude of the potential impact is assessed as negligible for all species for up to four maintenance activities occurring, with the exception of bottlenose dolphin of the CES population, with a magnitude of low (**Table 11-66**).

727. 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.

11.6.2.2.2.2 Magnitude of Impact - DBS East and DBS West Together

728. The potential disturbance from construction activities occurring at the same time has also been assessed based on maximum impact area of 402.12km^2 for up to eight construction activities at the same time (**Table 11-65**).

729. The magnitude of the potential impact is assessed as negligible for all species for all activities together, with the exception of bottlenose dolphin, with a magnitude of low (**Table 11-65**). This has been taken as a precautionary worst case for the O&M phase.

730. 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.

11.6.2.2.3 Sensitivity of Receptor

731. The sensitivity of marine mammals to TTS as a result of underwater noise is considered to be medium for maintenance activities (see section 11.6.1.3.4). Harbour porpoise and minke whale are considered to have a medium sensitivity to underwater noise disturbance, while dolphin and seal species have a low sensitivity.

732. Marine mammals within the potential disturbance area would be expected to return to the area once the disturbance had ceased or they had become habituated to the sound.

11.6.2.2.4 Significance of Effect - DBS East or DBS West In Isolation

733. Taking into account the marine mammal sensitivity to TTS and disturbance and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise during maintenance activities at either DBS East or DBS West has been assessed as **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-96**).

Table 11-96 Assessment of Significance of Effect for TTS or Disturbance from Underwater Noise During Maintenance Activities at the DBS East and DBS West Array Areas

Potential Impact	Species	Sensitivity	Magnitude	Significance
TTS	All marine mammals	Medium	Negligible	Minor adverse
Disturbance	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse
	Bottlenose dolphin (CES MU)	Low	Low	Minor adverse
	Bottlenose dolphin (GNS MU)	Low	Low	Minor adverse
	Common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Low	Negligible	Negligible adverse

11.6.2.2.5 Significance of Effect - DBS East and DBS West Together

734. Taking into account the marine mammal sensitivity to TTS and disturbance and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise during maintenance activities concurrently happening at DBS East and DBS West is the same as for those activities at the Projects in isolations, and has been assessed as **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-96**).

11.6.2.2.6 Mitigation and Residual Significance of Effect

735. No mitigation is required, therefore, the residual significance of effect for TTS or disturbance from underwater noise during maintenance activities at the Array Area would be **negligible to minor adverse** (not significant in EIA terms) for all species.

11.6.2.3 Impact 3: Impacts from Underwater Noise due to the Presence of Vessels

736. Vessels will generally be in the Array Areas during maintenance activities; however, as a precautionary approach and to take into account vessels that could be in the Array Areas when these activities are not being conducted, the potential for TTS and disturbance from underwater noise and presence of vessels has also been assessed separately.

737. 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 operation and maintenance will be within the windfarm site.

738. The vessels in the windfarm site during operation and maintenance will be slow moving or stationary.

11.6.2.3.1 Impact 3a: TTS from Underwater Noise due to the Presence of Vessels

739. During the operation and maintenance phase there would be an increase in the number of vessels in the 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, or 21 for both Projects together (**Table 11-1**). The number, type and size of vessels would vary depending on the activities taking place at any one time.

740. The magnitude of impact for TTS from underwater noise from maintenance vessels has been based on the underwater noise modelling undertaken for construction vessels (see section 498 and **Volume 7, Appendix 11-3 (application ref: 7.11.11.3)**).

741. The results of the underwater noise modelling (**Table 11-68**) indicate that any marine mammal would have to be less than 100m (precautionary maximum range) from the continuous noise source, to be exposed to noise levels that could induce TTS, based on the Southall *et al.* (2019) non-impulsive thresholds and criteria for SEL_{cum}.

742. 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 be less than 100m 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.

743. There is unlikely to be any significant risk of any TTS, as again the modelling indicates that the marine mammal would have to remain less than 100m from the source. Although TTS as a result of vessels is highly unlikely, it has been assessed as precautionary approach.

11.6.2.3.1.1 Magnitude of Impact – DBS East or DBS West In Isolation

744. As a precautionary approach, the potential impact area of 0.6km^2 for up to 20 vessels at either DBS East or DBS West at the same time has been determined. The assessments use the worst-case densities for each project.

745. The magnitude of the potential impact for any TTS as a result of vessels, for individual vessels, or up to 20 vessels, is negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-97**). For bottlenose dolphin, the magnitude is negligible for the GNS population, and low for the CES population. This is considered to be over precautionary however, as it is unlikely that 20 vessels would be within 2km of the coastline (and therefore have the potential to impact the CES population) at the same time.

746. The potential for TTS effects that could result from underwater noise from vessels would be localised and temporary.

Table 11-97 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS 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	Magnitude* (long-term)
Harbour porpoise	DBS East	0.4 (0.0001% of NS MU)	Negligible
	DBS West	0.4 (0.0001% of NS MU)	Negligible
Bottlenose dolphin	DBS East or DBS West	0.03 (0.001% of GNS MU & 0.01% of the CES MU)	Negligible (Low)
Common dolphin	DBS East or DBS West	0.01 (0.00001% of CGNS MU)	Negligible
White-beaked dolphin	DBS East	0.02 (0.00005% of CGNS MU)	Negligible
	DBS West	0.02 (0.00006% of CGNS MU)	Negligible
Minke whale	DBS East	0.006 (0.00002% of CGNS MU)	Negligible
	DBS West	0.01 (0.00006% of CGNS MU)	
Grey seal	DBS East or DBS West (using the Offshore Export Cable Corridor density as a worst-case)	0.3 (0.001% of SE England MU or 0.0006% of Wider MU)	Negligible (negligible)

Species	Location	Maximum number of individuals (% of reference population) for up to 20 vessels	Magnitude* (long-term)
Harbour seal	DBS East or DBS West (using the Offshore Export Cable Corridor density as a worst-case)	0.001 (0.00002% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider population for grey seal species*

11.6.2.3.1.2 Magnitude of Impact – DBS East and DBS West Together

747. As a precautionary approach, the potential impact area for up to 21 vessels in either Array Area at the same time has also been considered. As the worst case the TTS impact range for 21 vessels is 0.66km^2. The assessments have been undertaken using the worst-case density estimate across the Projects.

748. The magnitude of the potential impact for any TTS as a result of up to 21 vessels in the Array Area at the same time using the worst case density across the Offshore Development Area is negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal, with less than 1% of the reference populations exposed to any temporary impact (**Table 11-98**).

749. As for either DBS East or DBS West in isolation, for bottlenose dolphin, the magnitude is negligible for the GNS population, and low for the CES population. This is considered to be over precautionary however, as it is unlikely that 21 vessels would be within 2km of the coastline (and therefore have the potential to impact the CES population) at the same time.

Table 11-98 Maximum Number of Individuals (and % of Reference Population) That Could Be at Risk of TTS 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 at DBS East and DBS West together	Magnitude* (long-term)
Harbour porpoise	0.4 (0.0001% of the NS MU)	Negligible
Bottlenose dolphin	0.03 (0.001% of the GNS MU & 0.01% of the CES MU)	Negligible (Low)
Common dolphin	0.01 (0.00001% of the CGNS MU)	Negligible
White-beaked dolphin	0.03 (0.00006% of the CGNS MU)	Negligible
Minke whale	0.01 (0.00007% of the CGNS MU)	Negligible
Grey seal	0.4 (0.001% of the SE England MU &0.0006% of the wider MU).	Negligible (Negligible)
Harbour seal	0.001 (0.00002% of the SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.2.3.2 *Impact 3b: Disturbance from Underwater Noise and Presence of Vessels*

11.6.2.3.2.1 Magnitude of Impact – DBS East or DBS West In Isolation

750. There could be a maximum of 20 vessels in the Offshore Development Area; two of these could be in the Offshore Export Cable Corridor and the remaining 18 could be in the Array Area. As a precautionary approach, a 4km buffer around the Array Area has also been used as a potential disturbance range for operational and maintenance vessels, based on construction vessels (see section 11.6.1.4.3). Therefore, the potential disturbance from up to 18 vessels in the DBS East or DBS West Array Area at the same time has also been assessed based on the maximum impact area of 696.01km^2 for DBS East and 708.90km^2 for DBS West.

751. To assess for vessel disturbance in the Offshore Export Cable Corridor, there will be a maximum of two vessels at one time, therefore a 4km impact range has been added per vessel, therefore with two vessels the total impact range for the potential of disturbance from vessel activity is 100.53km^2.

752. There is the potential for vessels to be present in the operational wind farm for extended time periods, and therefore is considered to be a long-term impact.

753. Therefore, the magnitude of the potential impact is assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, and harbour seal, for the disturbance form an individual vessel (**Table 11-99**). For disturbance from all vessels at the Project, the magnitude is low for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, and grey seal, negligible for harbour seal, and medium for bottlenose dolphin.

754. The potential for disturbance that could result from underwater noise from vessels during operation and maintenance would be localised and temporary.

Table 11-99 Maximum Number of Individuals (and % of Reference Population) That Could Be Disturbed 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 one vessel	Magnitude* (long-term)	Maximum number of individuals (% of reference population) for up to 32 vessels [up to 18 within the Array Areas, and up to 2 in the Offshore Export Cable Corridor]	Magnitude* (long-term)
Harbour porpoise	DBS East	30.2 (0.009% of the NS MU)	Negligible	477.9 (0.14% of the NS MU)	Low
	DBS West	33.2 (0.01% of the NS MU)		534.2 (0.15% of the NS MU)	
Bottlenose dolphin	DBS East	2.1 (0.10% of the GNS MU & 0.86% of the CES MU)	Low	33.4 (1.65% of the GNS MU) [for all vessels] 4.2 (1.73% of the CES MU) [for all vessels in the Offshore Export Cable Corridor]	Medium (Medium)
	DBS West			33.9 (1.68% of the GNS MU) [for all vessels] 4.2 (1.73% of the CES MU) [for all vessels in the Offshore Export Cable Corridor]	
Common dolphin	DBS East	0.9 (0.0008% of the CGNS MU)	Negligible	13.5 (0.01% of the CGNS MU)	Low
	DBS West			13.8 (0.01% of the CGNS MU)	
White-beaked dolphin	DBS East	1.7 (0.004% of the CGNS MU)	Negligible	27.1 (0.06% of the CGNS MU)	Low
	DBS West	2.1 (0.005% of the CGNS MU)		33.2 (0.08% of the CGNS MU)	

Species	Location	Maximum number of individuals (% of reference population) for one vessel	Magnitude* (long-term)	Maximum number of individuals (% of reference population) for up to 32 vessels [up to 18 within the Array Areas, and up to 2 in the Offshore Export Cable Corridor]	Magnitude* (long-term)
Minke whale	DBS East	0.5 (0.003% of CGNS MU)	Negligible	8.0 (0.04% of CGNS MU)	Low
	DBS West	1.0 (0.005% of CGNS MU)		16.2 (0.08% of CGNS MU)	
Grey seal	DBS East	9.1 (0.03% of SE England MU or 0.02% of the wider MU)	Low (Low)	144.2 (0.47% of SE MU or 0.26% of the wider MU)	Low (low)
	DBS West	13.1 (0.042% of SE England MU or 0.02% of the wider MU)		210.5 (0.69% of SE England MU or 0.37% of the wider MU)	
Harbour seal	DBS East	0.09 (0.003% of SE England MU)	Negligible	1.4 (0.004% of SE England MU)	Negligible
	DBS West	0.05 (0.0009% of SE England MU)		0.8 (0.001% of SE England MU)	

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

755. **Plate 11-16** provides an indicative impact range for vessels transiting from the DBS Projects to port, with an indicative transit route from the most likely O&M port, there is a 4km buffer moving with the vessel.

756. **Table 11-73** (section 11.6.1.4.3) presents the possible port list, with Grimsby being the most likely port option during O&M. The number of round trips for DBS East or DBS West in isolation is 239 per year. This is less compared to the number of vessels during construction phase in section 11.6.1.4.3, and a less distance, therefore the number of marine mammals at risk of vessel disturbance (and the overall magnitude) would be less than as assessed for construction.

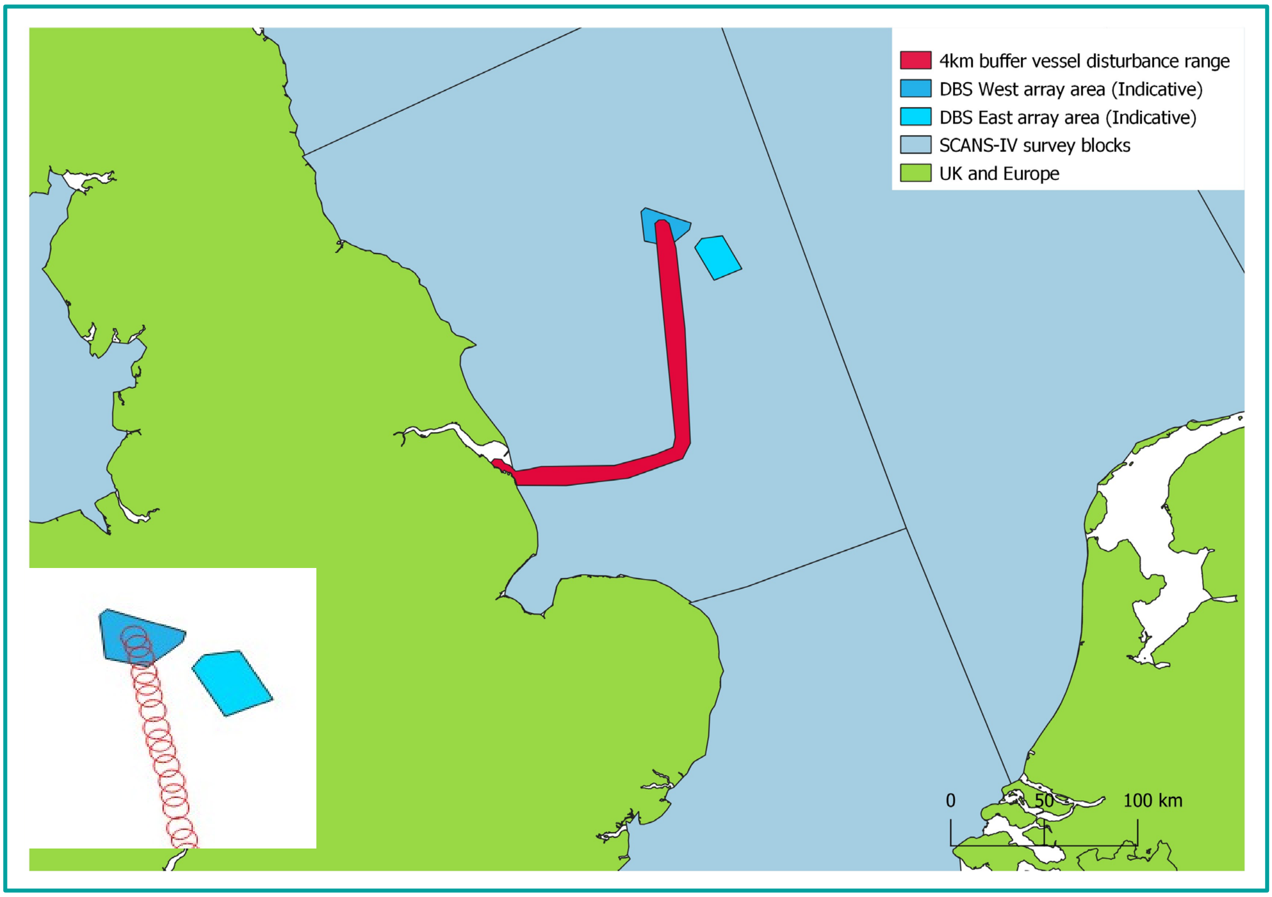

Plate 11-16 Indicative disturbance range from a single vessel during transit to port during O&M

757. Taking the assessments as undertaken for construction (**Table 11-75**), and using the long-term magnitude levels, results in a magnitude of low for harbour porpoise, common dolphin, white-beaked dolphin, and minke whale, medium for bottlenose dolphin and grey seal, and negligible for harbour seal.

11.6.2.3.2.2 Magnitude of Impact – DBS East and DBS West Together

758. The maximum number of O&M vessels on site at any one time will be up to 21 vessels, with two of those vessels being within the Offshore Export Cable Corridor. This would equate to up to 19 vessels across the Array Areas at any one time.

759. To assess for potential disturbance of the vessels, the number of individuals from DBS East and DBS West in isolation, with the Offshore Export Cable Corridor (as assessed in section 11.6.2.3.1.1) has been totalled together. These numbers have been combined to get the potential total number of individuals that could be disturbed by O&M vessels for both DBS East and DBS West (**Table 11-77**). This makes the total area 1,404.910km^2 for the Array Areas, and 100.53km^2 for the Offshore Export Cable Corridor (**Table 11-100**).

Table 11-100 Potential impact ranges for vessel disturbance at DBS East and DBS West together

Area	Impact Area (km^2)
DBS East and DBS West Array Area	1,404.9km^2
Offshore Export Cable Corridor (up to two vessels)	100.53km^2

760. For all species for up to 19 vessels in both Array Areas, plus two vessels in the Offshore Export Cable Corridor, the magnitude of the potential impact is assessed as low for harbour porpoise, common dolphin, white-beaked dolphin, and minke whale, as medium for bottlenose dolphin and grey seal, and as negligible for harbour seal (**Table 11-101**).

Table 11-101 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	Maximum number of individuals (% of reference population) potentially disturbed from 19 vessels within the Array Areas, and 2 in the Offshore Export Cable Corridor	Magnitude* (long-term)
Harbour porpoise	951.8 (0.27% of the NS MU)	Low
Bottlenose dolphin	63.1 (3.1% of the GNS MU) [for vessels in all project areas] 4.2 (1.73% of the CES MU) [for vessels in the Offshore Export Cable Corridor only]	Medium (Medium)
Common dolphin	25.6 (0.02% of CGNS MU)	Low
White-beaked dolphin	56.9 (0.13% of the CGNS MU)	Low
Minke whale	23.2 (0.12% of the CGNS MU)	Low
Grey seal	799.4 (2.61% of SE England MU or 1.41% of the wider MU)	Medium (Medium)
Harbour seal	2.6 (0.009% of SE England MU)	Negligible

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

761. **Table 11-75** (section 11.6.1.4.3) presents the possible port list, with Grimsby being the most likely port option during O&M. The number of round trips for DBS East and DBS West together is 474 per year. This is less compared to the number of vessels during construction phase in section 11.6.1.4.3 and a less distance, therefore the magnitude of impact would be less.

762. Therefore, the magnitude of the potential impact, using the long-term magnitude levels, is assessed as low for harbour porpoise, common dolphin, white-beaked dolphin, and minke whale, medium for bottlenose dolphin and for grey seal, and negligible for harbour seal.

11.6.2.3.3 Sensitivity of Receptor

763. The sensitivity of marine mammals to TTS as a result of underwater noise from vessels, is considered to be medium, as a precautionary approach. The sensitivity of disturbance is assessed as medium for harbour porpoise and minke whale, and low for bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal (see section 11.6.1.4.4).

764. Marine mammals within the potential disturbance area would be expected to return to the area once the noise had ceased or they had become habituated to the sound.

11.6.2.3.4 Significance of Effect – DBS East or DBS West In Isolation

765. Taking into account the marine mammal sensitivity to TTS and disturbance, and the potential magnitude of the impact, the significance of effect for TTS and disturbance from underwater noise of operational and maintenance vessels, at either DBS East or DBS West, has been assessed as **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-102**).

766. The significance of effect for disturbance from vessels in transit is assessed as **negligible to minor adverse** (not significant in EIA terms) for all species (**Table 11-102**).

Table 11-102 Assessment of Significance of Effect for the Potential for Disturbance from Vessels During Operation and Maintenance at DBS East and DBS West In Isolation or Together

Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
TTS due to construction vessels			
Harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse
Bottlenose dolphin	Medium	Negligible to low	Minor adverse
Disturbance due to O&M vessels on site			
Harbour porpoise and minke whale	Medium	Negligible to low	Minor adverse
Bottlenose dolphin	Low	Low to medium	Minor adverse
Common dolphin and white-beaked dolphin		Negligible to low	Negligible to minor adverse

Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Grey seal		DBS East or DBS West: Low DBS East & DBS West: Medium	Minor adverse
Harbour seal		Negligible	Negligible adverse
Disturbance due to O&M vessels during transit			
Harbour porpoise and minke whale	Medium	Low	Minor adverse
Common dolphin and white-beaked dolphin	Low	Low	Minor adverse
Bottlenose dolphin and grey seal		Medium	Minor adverse
Harbour seal		Negligible	Negligible adverse

11.6.2.3.5 Significance of Effect – DBS East and DBS West Together

767. The significance of effect for DBS East and DBS West together is assessed to have the same level of effect as DBS East or DBS West in isolation for TTS and disturbance; **negligible to minor adverse** (not significant in EIA terms) (**Table 11-102**).

11.6.2.3.6 Mitigation and Residual Significance of Effect

768. No mitigation is required. Therefore, the residual significance of effect for TTS or disturbance from underwater noise of vessels at the Array Areas, and in transit to and from the site, during operation and maintenance would remain the same for all species **negligible to minor adverse** (not significant in EIA terms).

11.6.2.4 Impact 4: Barrier Effects

11.6.2.4.1 DBS East or DBS West In Isolation

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

770. As assessed in section 11.6.2.1, the significance of effect for displacement (based on TTS / fleeing response) as a result of underwater noise from operational turbines has been assessed as **minor adverse** (not significant in EIA terms) for all species from TTS for either DBS East or DBS West operating in isolation.

771. 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.

772. As assessed in section 11.6.1.5 the significance of effect as a result of barrier effects from underwater noise from operation and maintenance activities is assessed as **minor adverse** (not significant in EIA terms) for either DBS East or DBS West.

773. Therefore, any potential barrier effects as a result of underwater noise during operation and maintenance has not been assessed further for DBS East and DBS West in isolation.

11.6.2.4.2 DBS East and DBS West Together

774. No barrier effects as a result of underwater noise during operation and maintenance are anticipated for DBS East and DBS West together.

775. As assessed in section 11.6.2.1, the significance of effect for displacement (based on TTS or disturbance) as a result of underwater noise from operational turbines has been assessed as **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal for DBS East and DBS West operating together.

776. Therefore, any potential barrier effects as a result of underwater noise during operation and maintenance has not been assessed further.

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

777. The increased risk of collision with vessels during operation and maintenance will be less than assessed for the construction period (section 11.6.1.6).

778. During the operation and maintenance phase, the maximum number of vessels that could be on the windfarm site at any one time has been estimated at up to a total of 20 for either DBS East or DBS West, and 21 vessels for DBS East and DBS West (**Table 11-1**). The number, type and size of vessels will vary depending on the activities taking place at any one time. The vessels in the windfarm site during operation and maintenance will be slow moving or stationary.

779. 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.

11.6.2.5.1 Magnitude of Impact – DBS East or DBS West In Isolation

780. 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 20 at DBS East or DBS West Array Area, which is less than the 32 vessels that could be on site during construction (**Table 11-103**). At either DBS East or DBS West, there may be up to 239 vessel round trips, or up to 478 transits, which is significantly less than the round trips required for construction. However, as a precautionary approach the assessment for construction has been used for the operation and maintenance assessment, as a worst-case scenario.

781. The assessment of vessel collision risk during the operational phase has been based on the same approach as presented in (section 11.6.1.6.1; **Table 11-83**).

782. The potential for increased collision risk with construction or operation and maintenance vessels based on a precautionary worst-case scenario has been assessed as negligible for harbour porpoise, common dolphin, white-beaked dolphin and minke whale the magnitude is negligible. For bottlenose dolphin, grey seal and harbour seal, the magnitude is low (**Table 11-103**).

783. This is a highly precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during operation and maintenance, 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.

Table 11-103 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels at DBS East or DBS West In Isolation

Species	Number annual vessel transits associated with Operation and Maintenance	Number of marine mammals at increased risk	% of reference population (magnitude of impact* - permanent)
Harbour porpoise	478	Up to three every two years (1.4)	0.0004% of the NS MU Negligible
Bottlenose dolphin	478	Up to one every 50 years (0.02)	0.001% of the GNS MU & 0.009% of the CES MU Low (Low)
Common Dolphin	478	Up to one every two years (0.5)	0.0005% of the CGNS MU Negligible
White-beaked dolphin	478	Up to one every ten years (0.1)	0.0003% of the CGNS MU Negligible
Minke whale	478	Up to one every ten years (0.1)	0.0003% of the CGNS MU Negligible
Grey Seal	478	Up to one every year (0.9)	0.003% of the SE MU & 0.002% of the winder MU Low (Low)
Harbour Seal	478	Up to one every ten years (0.1)	0.003% of the SE MU Low

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.2.5.2 Magnitude of Impact – DBS East and DBS West Together

784. It is estimated that the maximum number of vessels that could be required both Array Areas at any one-time during operation and maintenance could be 21 at DBS East and DBS West Array Areas, which is less than the 59 vessels that could be on site during construction (**Table 11-1**). For DBS East and DBS West together, there may be up to 474 vessel round trips, or up to 948 transits, which is significantly less than the round trips required for construction. However, as a precautionary approach the assessment for construction has been used for the operation and maintenance assessment, as a worst-case scenario.

785. The assessment of vessel collision risk during the operational phase has been based on the same approach as presented in (section 11.6.1.6.1; **Table 11-83**).

786. Based on the information in **Table 11-103** and 948 transits per year for operation and maintenance at DBS East and DBS West together, the potential for increased collision risk with operation and maintenance vessels, based on a precautionary worst-case scenario, has been assessed as negligible for harbour porpoise, white-beaked dolphin and minke whale. The magnitude of impact is low for common dolphin, grey seal and harbour seal, and low to medium for bottlenose dolphin (**Table 11-104**).

Table 11-104 Predicted Number of Marine Mammals at Risk of Collision with Operation and Maintenance Vessels at DBS East and DBS West Together

Species	Number annual vessel transits associated with Operation and Maintenance	Number of marine mammals at increased risk	% of reference population (magnitude of impact)
Harbour porpoise	948	Up to three every year (2.8)	0.0008% of the NS MU Negligible
Bottlenose dolphin	948	Up to one every 25 years (0.04)	0.002% of the GNS MU & 0.02% of the CES MU Low (Medium)

Species	Number annual vessel transits associated with Operation and Maintenance	Number of marine mammals at increased risk	% of reference population (magnitude of impact)
Common dolphin	948	Up to two every year (1.1)	0.001% of the CGNS MU Low
White-beaked dolphin	948	Up to one every 5 years (0.2)	0.0006% of the CGNS MU Negligible
Minke whale	948	Up to one every 10 years (0.1)	0.0007% of the CGNS MU Negligible
Grey seal	948	Up to two every year (1.8)	0.006% of the SE MU & 0.003% of the wider MU Low
Harbour seal	948	Up to one every 3 years (0.3)	0.006% of the SE MU Low

** Magnitudes given in brackets are for the secondary MU assessed for the wider populations*

11.6.2.5.3 Sensitivity of Receptor

787. As outlined in section 11.6.1.6.3, the sensitivity of minke whale to collision risk with vessels is considered to be medium, and low for all other species.

11.6.2.5.4 Significance of Effect – DBS East or DBS West In Isolation

788. Taking into account the marine mammal sensitivity, and the potential magnitude of impact, as assessed in **Table 11-103**, the significance of effect for any potential increased collision risk as a result of operation and maintenance vessels has been assessed as **negligible to minor adverse** (not significant) for all marine mammals (**Table 11-105**).

789. It is unlikely that marine mammals would be at increased collision risk with vessels, in the Project area, as vessels within the Array Areas would be stationary for much of the time or very slow moving. Taking into account the collision risk from vessels, the actual risk is likely to be very low or negligible for all species.

Table 11-105 Assessment of Significance of Effect for Increased Collision Risk with Vessels During Operation and Maintenance

Species	Sensitivity	Magnitude	Significance
Harbour porpoise and white-beaked dolphin	Low	Negligible	Negligible adverse
Bottlenose dolphin	Low	Low to medium	Minor adverse
Common dolphin	Low	DBS East or DBS West: Negligible DBS East & DBS West: Low	Negligible to minor adverse
Minke whale	Medium	Negligible	Minor adverse
Grey seal and harbour seal	Low	Low	Minor adverse

11.6.2.5.5 Significance of Effect – DBS East and DBS West Together

790. As for the potential impacts from vessels during operation and maintenance for DBS East and DBS West in isolation, any potential increased collision risk as a result of operation and maintenance vessels for DBS East and DBS West together has been assessed as **negligible to minor adverse** (not significant in EIA terms) for all marine mammal species (**Table 11-105**).

11.6.2.5.6 Mitigation and Residual Significance of Effect

791. As outlined in section 11.3.3, 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 to reduce any potential collision risk. Additionally, vessel operators will use good practice to reduce any risk of collisions with marine mammals. These measures will be detailed within the PEMP which will be secured through the DCO.

792. Taking into account the best practice measures to reduce the risk of collision with vessels, the residual significance of effect would be **negligible to minor adverse** (not significant in EIA terms) for all species (section 11.3.3), with the proposed best practice measures.

11.6.2.6 Impact 6: Changes to Prey

793. 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;
- Barrier Effects from Underwater Noise or EMF;
- Introduction of Hard Substrate; and
- Changes in Fishing Activity.

794. 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 or DBS West in isolation or together.

11.6.2.6.1 Magnitude of Impact

11.6.2.6.1.1 Long Term Habitat Loss

795. 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 protection and cable protection would increase habitat heterogeneity through the introduction of hard structures in an area predominantly characterised by sediment habitats.

796. Long term habitat loss has not been assessed as a direct impact on marine mammals, as any impacts of habitat loss would only cause an indirect effect in terms of changes in prey availability.

797. As outlined in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**, total long term habitat loss would be up to 0.89km^2 for DBS East and 1.2km^2 the Offshore Export Cable Corridor, and up to 0.92km^2 at DBS West and 0.99km^2 the Offshore Export Cable Corridor. This is considered not significant 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 magnitude of impact of long-term habitat loss is considered to be low.

798. Based on the low sensitivity of prey species and a low magnitude of impact in relation to long term habitat loss during the operational phase of DBS East and DBS West, the significance of effect is assessed as **minor adverse** for prey species. Therefore, the magnitude of impact is negligible for marine mammals.

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

799. 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).

800. 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).

801. 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 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 magnitude of impact is considered low.

802. Based on the low sensitivity of prey species and a low to medium magnitude of impact in relation to temporary habitat disturbance during the operational phase of DBS East and DBS West, the significance of effect is assessed as **negligible** to **minor adverse** for prey species. Therefore, the magnitude of impact is negligible for marine mammals.

11.6.2.6.1.3 Increased SSCs and Sediment Deposition

803. 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. 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.

804. Increases in SSCs are expected to cause localised and short-term increases at the point of discharge. Released sediment may then be transported in suspension in the water column by tidal currents. The worst-case scenario for volume of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational lifetime of DBS East is 1,666,500m^3 within the Array Area and 84,000m^3 within the Offshore Export Cable Corridor.

805. The worst-case scenario for volume of sediment disturbed with the potential to increase SSC, and associated sediment settlement, during the operational lifetime of DBS West is 1,666,500m^3 within the Array Area and 60,000m^3 within the Offshore Export Cable Corridor.

806. Increased SSCs and levels of sediment re-deposition will be localised and short term. Therefore, the magnitude of SSC and re-deposition during the operational phase is considered to be negligible for prey species and marine mammals.

11.6.2.6.1.4 Re-Mobilisation of Contaminated Sediments

807. 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 of DBS East and DBS West, either in isolation or together (**Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**).

808. The impact arising from remobilisation of contaminated sediments is considered to be negligible for both DBS East and DBS West in isolation for prey species and marine mammals.

11.6.2.6.1.5 Underwater Noise During Operation and Maintenance

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

810. 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)**).

811. 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.

812. In **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)** it is expected that during operation there will be only a slight and localised increase above background noise levels, therefore the magnitude of impact for fish species at either the DBS East Array Area or the DBS West Array Area is considered to be low. Therefore, there would be no additional impact on marine mammals as a result of any impacts on fish species from underwater noise during operation and maintenance. The magnitude of any potential impact would be negligible for marine mammals.

11.6.2.6.1.6 Electromagnetic Fields (EMF)

813. 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.

814. 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.

815. There will be no direct effects of EMF on marine mammals, 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).

816. 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 magnitude of this impact is considered to be negligible, and the significance of effect is **negligible** to **minor adverse** (not significant in EIA terms).

817. The magnitude of impact for any changes in prey resource for marine mammals from EMF during operation and maintenance would be negligible.

11.6.2.6.1.7 Changes in Fishing Activity

818. 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 windfarm site, due to presence of the subsurface structures. However, the Array Areas are located in an area with relatively low fishing intensity.

819. Therefore, any changes to prey resources as a result of changes to fishing activity during operational phase of the Project would be negligible to marine mammals.

11.6.2.6.2 Summary of Magnitudes of Impact

820. The magnitude for the potential changes in prey has been based on the assessments in **Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)**. The magnitude of impact to marine mammal species is based on the magnitude of impact to prey species, although it should be noted that this is a precautionary approach as marine mammals are generally opportunistic foragers and would be able to prey upon a range of other species (**Table 11-106**).

Table 11-106 Magnitude of Potential Changes to Prey Resources During Operation, Based on Assessments in ***Volume 7, Chapter 10 Fish and Shellfish Ecology (application ref: 7.10)***

Potential effect to prey changes	Magnitude as assessed in Chapter 10
Long-term habitat loss	Low (effect significance of negligible to minor adverse)
Temporary habitat disturbance	Low (effect significance of n negligible to minor adverse)
Increased SSCs and sediment deposition	Low (effect significance of negligible to minor adverse)
Re-mobilisation of contaminated sediment	Negligible (effect significance of negligible)
Underwater noise and vibration	Low (effect significance of minor adverse)

Potential effect to prey changes	Magnitude as assessed in Chapter 10
Electromagnetic fields	Negligible (effect significance of negligible)
Changes in fishing activity	Low (effect significance of negligible)

11.6.2.6.3 Sensitivity of Receptor

821. As outlined in section 11.6.1.7.7, harbour porpoise is considered to have low to medium sensitivity to changes in prey resources. All dolphin species are considered to have low sensitivity to changes in prey resources. Minke whale are considered to have a low to medium sensitivity to changes in prey resource. Grey seal and harbour seal are considered to have low to medium sensitivity to changes in prey resources.

11.6.2.6.4 Significance of Effect

822. Taking into account the marine mammal sensitivity for each species, and the negligible potential magnitude of the impact, the significance for any changes in prey resource during operation and maintenance has been assessed as **minor adverse** (not significant in EIA terms) for all species (**Table 11-107**).

11.6.2.6.5 Mitigation and Residual Significance of Effect

823. No mitigation is required or proposed. Therefore, the residual significance of effect for any changes to prey resource during the operation and maintenance at the Projects would be **minor adverse** (not significant in EIA terms) for all species (**Table 11-107**).

Table 11-107 Assessment of Significance of Effect for the Potential of an Indirect Effect to Marine Mammals Through Changes to Prey Resources During Operation and Maintenance

Potential effect	Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Long-term habitat loss Temporary habitat disturbance	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Increased SSCs and sediment deposition	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse

Potential effect	Marine mammal species	Sensitivity	Magnitude of impact	Significance of effect
Re-mobilisation of contaminated sediment	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Underwater noise and vibration Electromagnetic fields	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Changes in fishing activity Long-term habitat loss	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Negligible	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Temporary habitat disturbance Increased SSCs and sediment deposition	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse
Re-mobilisation of contaminated sediment Underwater noise and vibration	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Negligible	Negligible to Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Negligible adverse
Electromagnetic Fields	Harbour porpoise, minke whale, grey seal and harbour seal	Low to medium	Low	Minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low		Minor adverse

11.6.2.7 Impact 7: Changes to Water Quality

824. As outlined in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)**, potential changes in water quality during operation and maintenance are:

- Deterioration in water quality through an increase in suspended sediment due to cable repairs / reburial; and
- Deterioration in water quality through an increase in suspended sediment due to maintenance activities.

11.6.2.7.1 Magnitude of Impact - DBS East or DBS West In Isolation

825. As assessed in **Volume 7, Chapter 8 Marine Physical Environment (application ref: 7.8)** any potential changes in water quality at DBS East and DBS West during operation and maintenance would be negligible.

11.6.2.7.2 Magnitude of Impact - DBS East and DBS West Together

826. The magnitude of impact for DBS East and DBS West together is considered to be the same as the Projects in isolation.

11.6.2.7.3 Sensitivity of Receptor

827. As outlined in section 11.6.1.8, marine mammals are considered to have negligible sensitivity to any changes in water quality.

11.6.2.7.4 Significance of Effect – DBS East or DBS West In Isolation

828. Taking into account the negligible sensitivity of marine mammals and negligible magnitude of impact, the significance of effect for any changes in water quality during operation and maintenance at DBS East and DBS West in isolation has been assessed as **negligible adverse** (not significant in EIA terms).

11.6.2.7.5 Significance of Effect – DBS East and DBS West Together

829. Taking into account the negligible sensitivity of marine mammals and negligible magnitude the significance of effect for any changes in water quality during operation and maintenance at DBS East and DBS West together has been assessed as **negligible adverse** (not significant in EIA terms).

11.6.2.8 Impact 8: Disturbance at Seal Haul-Out Sites

11.6.2.8.1 Magnitude of Impact -DBS East or DBS West In Isolation

830. As assessed in section 11.6.1.9, the closest seal haul out sites are Filey brigg (28km from landfall, 25km from the export cable corridor, 106km from DBS East and 132km from DBS West); Ravenscar (52km from landfall, 62km from export cable corridor, 140km from DBS East and 150km from DBS West at closest point); and Donna Nook (62km from landfall, 65km from export cable corridor, 153km from DBS East and 151km from DBS West at closest point).

831. As outlined in section 11.6.1.9, the studies by Edren *et al.* (2010) and Russel *et al.* (2016), there could 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. vessel movement from the Projects to port. 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.

832. In total, for the operation and maintenance of either DBS East or DBS West, up to 239 round trips to port from the Array Area each year for five years. This represents a slight increase in the current number of vessels in the area.

833. Taking into account the proximity of shipping channels to and from existing ports as outlined in section 11.6.1.9, 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 magnitude of impact of grey and harbour seals at haul-out sites to disturbance from vessels during operation is assessed as low.

834. As noted in section 11.6.1.9 it has not been confirmed which ports will be used, but a short list has been provided in **Table 11-73**. However, vessels would use established vessel routes to the port and, where possible, transiting vessels would maintain distances of 600m or more off the coast, particularly in areas near known seal haul-out sites during sensitive periods.

11.6.2.8.2 Magnitude of Impact -DBS East and DBS West Together

835. The impacts for DBS East and DBS West would be similar to that presented for DBS East and DBS West in isolation. While the number of vessels, under the scenario of DBS East and DBS West together, will be an increase in comparison to the DBS East and DBS West scenario, up to 474 round trips to port from the Array Area each year. The majority will be small vessels and are unlikely to cause any disturbance to seals at haul-out sites. In addition, this is a small increase in terms of vessel transits per day above baseline levels.

11.6.2.8.3 Sensitivity of Receptor

836. The sensitivity of disturbance to both grey seal and harbour seal at haul-out sites would be the same for the operational period as for the construction period (section 11.6.1.9). Therefore, the sensitivity is low for both species, and is increased to medium during the pupping and moult periods of both species, to account for their increased sensitivity during that period.

11.6.2.8.4 Significance of Effect at DBS East or DBS West In Isolation

837. Taking into account the low to medium sensitivity and negligible magnitude of the temporary impact from maintenance activities, the significance of effect for disturbance at seal haul-out sites has been assessed as **negligible to minor adverse** (not significant in EIA terms) for both grey seal and harbour seal (**Table 11-108)**. For disturbance from vessels during the O&M phase, the magnitude of impact is low, and the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for both grey seal and harbour seal (**Table 11-108)**.

Table 11-108 Assessment of Significance of Effect for Disturbance at Seal Haul-Out Sites During Operation and Maintenance

Species	Impact	Sensitivity	Magnitude	Significance
Grey seal	Disturbance from O&M activities	Low to Medium	Negligible	Negligible to minor adverse
	Disturbance from vessels		Low	Minor adverse
Harbour seal	Disturbance from O&M activities	Low to Medium	Negligible	Negligible to minor adverse

Species	Impact	Sensitivity	Magnitude	Significance
	Disturbance from vessels		Low	Minor adverse

11.6.2.8.5 Significance of Effect at DBS East and DBS West Together

838. It is considered the significance of effect of impacts for the Projects together will be equal to the effects of DBS East or DBS West in isolation. As such, the significance of effect has been assessed as **minor adverse** (not significant in EIA terms) for both grey seal and harbour seal (**Table 11-108)**.

11.6.2.8.6 Mitigation and Residual Significance of Effect

839. No mitigation is required for the disturbance of seals at haul-out sites. However, as best practice where possible and safe to do so, transiting vessels would maintain distances of 600m or more off the coast, particularly in areas near known seal haul-out sites during sensitive periods. See section 11.6.1.9.6 for further information.

11.6.3 Potential Effects During Decommissioning

840. The scope of the decommissioning works would most likely involve removal of the accessible installed components. This is outlined in **Volume 7, Chapter 5 Project Description (application ref: 7.5)** and the detail would be agreed with the relevant authorities at the time of decommissioning. Offshore, this is likely to include removal of all the turbine elements, part of the foundations (those above seabed level), removal of some or all of the infield cables, interlink cables, and export cables.

841. The potential impacts during decommissioning that will be assessed for marine mammals include:

- Impact 1: Underwater noise and disturbance from decommissioning activities;
- Impact 2: Underwater noise and disturbance from vessels;
- Impact 3: Barrier effects as a result of underwater noise;
- Impact 4: Increased collision risk with vessels;
- Impact 5: Changes to prey resource;
- Impact 6: Changes to water quality; and
- Impact 7: Disturbance at seal haul-out sites.

842. Potential impacts on marine mammals 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 decommissioning programme will be submitted to the Secretary of State for approval prior to commencement of offshore works that will give details of any relevant mitigation measures required.

843. 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 would be comparable to construction of DBS East and DBS West in isolation (with the exception of pile driving noise which would not occur).

844. The potential impacts on marine mammals during decommissioning would be expected to be the same or less than those assessed for construction in section 11.6.1.

11.7 Cumulative Effects Assessment

11.7.1 Identification of Potential Cumulative Effects

845. The first step in the Cumulative Effects Assessment (CEA) process is the identification of which residual effects assessed for DBS East and DBS West on their own have the potential for a cumulative effect with other schemes.

846. All potential cumulative impacts are detailed in **Table 11-109**, and a rationale for either screening in or out to the cumulative assessment is provided. For all cumulative impacts screened in, further information and assessment is provided in the following sections.

847. The cumulative effects that have screened in for assessment are;

- Impact 1: Disturbance due to underwater noise;
- Impact 2: Cumulative barrier effects from disturbance of wind farms;
- Impact 3: Increased collision risk with vessels;
- Impact 4: Disturbance at seal haul-out sites;
- Impact 5: Changes to prey resources.

Table 11-109 Potential Cumulative Effects

Impact	Potential for cumulative effect	Rationale
Permanent Auditory Injury due to Underwater Noise	No	If there If there is the potential for any PTS, from any project, suitable mitigation would be put in place to reduce any risk to marine mammals. Therefore, this has been screened out from further consideration in the CEA. The potential risk of PTS in marine mammals from cumulative impacts has been screened out from further consideration in the CEA. See **Volume 7**, **Appendix 11-5 (application ref: 7.11.11.5)** for more information.
Temporary Auditory Injury and Disturbance from Underwater Noise	Yes	Disturbance is likely to have greater effect range and area than TTS, and the risk of TTS will be within disturbance ranges for marine mammals. Where there is little information on the potential disturbance ranges for marine mammals, TTS has been used to indicate possible fleeing response.

Impact	Potential for cumulative effect	Rationale
		Therefore, the potential risk of TTS in marine mammals from cumulative effects will be considered alongside that of disturbance from underwater noise, and the highest known potential effect ranges (of either TTS or disturbance) will be used to the inform the cumulative assessment. The potential for disturbance to marine mammals from underwater noise has been screened into the CEA. See section 11.7.3.1 and 11.7.3.2 for the full assessment.
Barrier Effects due to Disturbance of Wind Farms	Yes	The potential for cumulative projects to cause a barrier effect has been screened into the CEA. See section 11.7.3.3 for the full assessment.
Increased Collision Risk with Vessels	Yes	The potential for an increase in vessel collision risk due to an increase in vessels has been considered further in section 11.7.3.4.
Disturbance at Seal Haul-Out Sites	Yes	The potential for disturbance at seal haul-out sites has been screened into the CEA. See section 11.7.3.5 for the full assessment.
Changes to Water Quality	No	No significant effects with regard to water quality are expected as a result of DBS East and DBS West. All other projects would be required to have equivalent mitigation and prevention as DBS East and DBS West and therefore have no significant effects. Any changes to water quality as a result of aggregate extraction and dredging would be very localised and temporary. Changes to water quality (including from aggregate extraction and dredging) has been screened out from the CEA. See **Volume 7**, **Appendix 11-5 (application ref: 7.11.11.5)** for more information.
Changes to Prey Resources	Yes	The potential changes to prey resources, has been considered further in section 11.7.3.6.

11.7.2 Screening of Other Schemes

848. The second step in the cumulative assessment is the identification of the other schemes that may result in cumulative effects for inclusion in the CEA (described as 'project screening'). This information is set out in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)** together with a consideration of the relevant details of each, including current status (e.g., under construction), planned construction period, closest distance to the offshore project area, status of available data and rationale for including or excluding from the assessment.

849. The project screening has been informed by the development of a CEA project list which forms an exhaustive list of schemes within the study area (**Volume 7**, **Appendix 11-5 (application ref: 7.11.11.5)**) relevant to DBS East and DBS West. The list has been appraised, based on the confidence in being able to undertake an assessment from the information and data available, enabling individual schemes to be screened in or out.

11.7.3 Assessment of Cumulative Effects

850. The CEA screening identified that there is a potential for cumulative effects on marine mammals as a result of disturbance from underwater noise during piling and other construction activities. Other potential effects, including PTS from underwater noise, were screened out of the CEA (see **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**). In addition, all operational and decommissioning effects have also been screened out of assessment.

851. The potential sources of cumulative underwater noise which could disturb marine mammals, and which are screened into the CEA are:

- Piling at OWFs;
- Other construction activities at OWFs (vessels, cable installation works, dredging, seabed preparation and rock placement);
- Geophysical surveys for OWFs;
- Aggregate extraction and dredging;
- Seismic surveys;
- Subsea cable and pipelines; and
- UXO clearance.

852. Where possible, the cumulative assessments are based on project specific data and assessments (i.e. project specific EIAs). Where a quantitative assessment is required but no project specific information is available, an assessment has been undertaken using a generic approach, using potential effect ranges for DBS East and DSB West, and desk-based data sources, such as SCANS-IV (Gilles *et al.* 2023) and Carter (*et al.* 2022). The potential magnitude of disturbance is based on the total number of harbour porpoise, bottlenose dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal from the cumulative projects.

853. It should be noted that a large amount of uncertainty is inherent in the CEA. At the project level, uncertainty in the assessment process has been expressed as a level of the confidence in the data used in the assessment. This relates to confidence in both the understanding of the consequences of the potential effects on marine mammals, but also the information used to inform the predicted magnitude and significance of project impacts on marine mammals. As outlined in the tier approach, there is more information and certainty for lower tiers, compared to higher tiers (Natural England and Defra, 2022).

854. In the CEA, the potential for effects over wider spatial and temporal scales means that the uncertainty arising from the consideration of a large number of plans or projects leads to a lower confidence in the information used in the assessment, but also the conclusions of the assessment itself. To take this uncertainty into account, where practicable, a precautionary approach has been taken at multiple stages of the assessment process.

855. The approach to dealing with uncertainty has led to a highly precautionary assessment of the cumulative effects, especially for pile driving, as the CEA is based on the worst-case scenarios for all projects included. It should therefore be noted that building precaution on precaution can lead to unrealistic worst-case scenarios within the assessment.

856. Therefore, the assessment is based on the most realistic worst-case scenario to reduce any uncertainty and avoid presentation of highly unrealistic worst case scenarios, while still providing a conservative assessment. Careful consideration has been given to determine the most realistic worst-case scenario for the CEA.

857. At this stage, on a precautionary basis an assessment is undertaken for each species in relation to the relevant reference population. The assessment has then determined how many individuals may be affected by each impact as a percentage of the reference population. In the case of a potential effect significance of moderate or major adverse (i.e. significant in EIA terms), further assessment has been undertaken to determine the population level consequence of the effect in the form of population modelling.

11.7.3.1 Cumulative Impact 1: Assessment of Underwater Noise from Piling at other OWFs

858. One of the greatest potential noise sources during OWF construction is from pile driving. The CEA considers the potential disturbance of marine mammals during piling for DBS East and DBS West, with the piling at other OWF projects screened into the CEA, where there is the potential for concurrent piling.

859. The CEA screening (see **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**) identified 13 UK OWFs with the potential for construction to take place at the same time as the construction of DBS East and / or DBS West, taking into account the relevant spatial areas for each species. The worst-case scenario would be if the following OWFs were constructed sequential with sequential piling in the years 2027 to 2030:

- Berwick Bank;
- Dudgeon Extension;
- East Anglia One North;
- Five Estuaries;
- GreenVolt;
- Hornsea Project Three;
- Hornsea Project Four;
- North Falls;
- Outer Dowsing;
- Rampion 2;
- Seagreen 1A;
- Sheringham Shoal Extension; and
- West of Orkney.

860. 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 CEA have the potential for piling to overlap with DBS East and DBS West, there is a lot of uncertainty on when OWFs could be piling. This assessment is therefore considered the worst-case. Where possible, the CEA screening 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. Unless further information is available (for example, in the case of the East Anglia Hub where two sites could be developed at the same time).

11.7.3.1.1 Potential for Disturbance during Offshore Wind Farm Piling

861. The commitment to the mitigation measures agreed through the final MMMP for piling as outlined above (**Table 11-4**) would reduce the risk of physical injury or permanent auditory injury (PTS) for all marine mammals. As such, DBS East and DBS West would not contribute to any cumulative impacts for physical injury or permanent auditory injury (PTS) from piling activities, and therefore the following assessment only considers potential disturbance effects to marine mammals.

11.7.3.1.1.1 Sensitivity to Disturbance

862. As outlined in section 11.6.1.1.2, harbour porpoise and minke whale are assessed as having a medium sensitivity to disturbance from underwater noise sources, and bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal have a low sensitivity to disturbance.

11.7.3.1.1.2 Magnitude of Potential Disturbance

863. The magnitude of the potential disturbance from piling activities has been estimated for the schemes screened in for assessment, based on the data presented in the project specific assessments (e.g. EIA or PEIR). A single monopiling event at both DBS East and DBS West has been included in the CEA as a worst-case scenario.

864. The approach to the CEA for piling at offshore wind farms is based on the potential for single piling at each screened in wind farm, at the same time as:

- A single piling at either DBS East or DBS West; and

- Concurrent piling at DBS East and/or DBS West with either one pile at each Project or both in one Array Area depending on the worst case scenario for each species.

865. This approach allows for some of the OWFs not to be piling at the same time, while others could be concurrently piling (further information is available in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**). This is considered to be the most realistic worst-case scenario, as it is highly unlikely that all other wind farms would be concurrently piling at exactly the same time as piling at the Projects.

866. 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 50 days for DBS East and DBS West in isolation, 100 days in total plus an additional day for the Offshore Export Cable Corridor, based on the estimated maximum duration to install individual piles (**Table 11-1**).

867. 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.

868. The tables in this section are colour coded for project scenario to make the results more presentable (**Table 11-110**).

Table 11-110 Protect scenario colour code

With DBS East	Green
With DBS West	Blue
DBS Projects together	Dark blue
Without DBS Projects	Orange

11.7.3.1.1.2.1 Potential for Cumulative Disturbance

11.7.3.1.1.2.1.1 Harbour Porpoise

869. For the screened in OWFs with the potential for piling overlap with the Projects, the maximum number of harbour porpoise that could potentially be temporarily disturbed is 43,424.8 individuals for both Projects together, which represents up to 13% of the NS MU reference population (**Table 11-111**). Therefore, the potential magnitude of the temporary impact is assessed as high for the Projects together. For either DBS East or DBS West in isolation, the magnitude of impact is also high. However, this is very precautionary, as it is unlikely that all projects could be concurrently piling at exactly the same time as piling at DBS East and/or DBS West and other OWF projects.

Table 11-111 Quantified CEA for the potential disturbance of harbour porpoise during single piling at the OWF projects which could be concurrently piling at the same time as DBS East and/or DBS West

OWF Project	Harbour porpoise density (/km²)	Maximum number of individuals potentially disturbed during single piling
DBS East	*0.6*	4,295.5
DBS West	*0.66*	5,097.7
DBS East & West concurrently	-	10,195.40
Berwick Bank	0.599	1,754.0
Dudgeon Extension	0.888	804.0
East Anglia One North	0.607	1,289.0
Five Estuaries	1.82	7,031.0
Green Volt	0.888	450.9
Hornsea Project Three	0.76	4,999.0
Hornsea Project Four	1.019	6,417.0
North Falls	1.74	1,071.5
Outer Dowsing	2.375	5,229.0
Rampion 2	0.213	752.0
Seagreen 1A	2.822	1,501.0
Sheringham Shoal Extension	0.599	582.0

OWF Project	Harbour porpoise density (/km²)	Maximum number of individuals potentially disturbed during single piling
West or Orkney	0.15	1,349.0
Total number of harbour porpoise with DBS East *Magnitude of cumulative impact*		**37,524.9 (10.82% of the NS MU)** *High*
Total number of harbour porpoise with DBS West *Magnitude of cumulative impact*		**38,327.1 (11.5% of the NS MU)** *High*
Total number of harbour porpoise with both DBS Projects *Magnitude of cumulative impact*		**43,424.8 (12.53% of the NS MU)** *High*
Total number of harbour porpoise without DBS projects *Magnitude of cumulative impact*		**33,229.4 (9.58% of the NS MU)** *Medium*

11.7.3.1.1.2.1.2 Bottlenose Dolphin

870. For bottlenose dolphin, the maximum number of individuals that could potentially be disturbed is 139.6 (or 6.9% of the GNS MU **Table 11-112**) for the Projects together, with a potential magnitude of medium. For either DBS East or DBS West, the magnitude of disturbance would also be medium.

871. Note that the CES bottlenose dolphin population has not been included in this assessment, as none of the screened in OWFs are within the CES MU.

Table 11-112 Quantitative CEA for the potential Disturbance of bottlenose dolphin during single piling at OWF projects which could be concurrently piling at the same as DBS East and DBS West.

OWF Project	Bottlenose dolphin density (/km²)	Maximum number of individuals potentially disturbed during piling
DBS East	*0.0419*	*0.13*
DBS West	*0.0419*	*0.10*
DBS East & West concurrently	*0.0419*	*8.4*
Berwick Bank	0.0298	64
Dudgeon Extension	0.03	0.013
East Anglia One North	-	-
Five estuaries	-	-
Green Volt	0.0298	1.14

OWF Project	Bottlenose dolphin density (/km²)	Maximum number of individuals potentially disturbed during piling
Hornsea Project Three	-	-
Hornsea Project Four	-	14
North Falls	-	-
Outer Dowsing	0.002	4
Rampion 2	-	-
Seagreen 1A	-	48
Sheringham Shoal Extension	-	-
West or Orkney	-	-
Total number of bottlenose dolphin with DBS East *Magnitude of cumulative impact*		**131.3 (6.49% of the GNS MU)** *Medium*
Total number of bottlenose dolphin with DBS West *Magnitude of cumulative impact*		**131.3 (6.49% of the GNS MU)** *Medium*
Total number of bottlenose dolphin with all DBS Projects *Magnitude of cumulative impact*		**139.6 (6.90% of the GNS MU)** *Medium*
Total number of bottlenose dolphin without DBS projects *Magnitude of cumulative impact*		**131.2 (6.49% of the GNS MU)** *Medium*

11.7.3.1.1.2.1.3 Common Dolphin

872. Common dolphin has only been assessed from offshore windfarms Rampion 2 and West of Orkney that could be potentially piling at the same time as DBS East and/or DBS West.. In the SCANS-IV, summer survey in 2022, it was the first time that common dolphin were recorded in the any of the SCANS surveys in survey block NS-C. Common dolphin are primarily distributed in the Celtic Sea and Western Approaches to the Channel, and off southern and western Ireland (BEIS 2022b; Hammond *et al*. 2021; Waggitt *et al*. 2019) (**Volume 7, Appendix 11-2 (application ref: 7.11.11.2)**), however as stated in section 11.5.9.8 common dolphin presence is increasing in the North Sea, however it is only recently being documented hence why not other OWFs have included common dolphin in the projects impact assessment.

873. **Table 11-113** presents the number of common dolphin that could be impacted from cumulative disturbance from other OWFs that could be piling at the same time as DBS East and/or DBS West. For common dolphin, the maximum number of individuals that could potentially be disturbed is 592.4 (or less than 1% of the CGNS MU (**Table 11-113**) for the Projects together, with a potential magnitude of negligible. For either DBS East or DBS West, the magnitude of disturbance would also be negligible.

Table 11-113 Quantitative CEA for the potential Disturbance of common dolphin during single piling at OWF projects which could be concurrently piling at the same as DBS East and DBS West.

OWF Project	Common dolphin density (/km²)	Maximum number of individuals potentially disturbed during piling
DBS East	*0.017*	*0.06*
DBS West	*0.017*	*0.04*
DBS East & DBS West concurrently	*0.017*	*3.4*
Berwick Bank	-	-
Dudgeon Extension	-	-
East Anglia One North	-	-
Five Estuaries	-	-
Green Volt	-	-
Hornsea Project Three	-	-
Hornsea Project Four	-	-
North Falls	-	-
Outer dowsing	-	-
Rampion 2	0.171	499
Seagreen 1A	-	-
Berwick Bank	-	-
West of Orkney	0.01	90

OWF Project	Common dolphin density (/km²)	Maximum number of individuals potentially disturbed during piling
Total number of common dolphin with DBS East *Magnitude of cumulative impact*	**589.1 (0.573% of the CGNS MU)** *Negligible*	
Total number of common dolphin with DBS West *Magnitude of cumulative impact*	**589 (0.573% of the CGNS MU)** *Negligible*	
Total number common dolphin with all DBS Projects *Magnitude of cumulative impact*	**592.4 (0.577% of the CGNS MU)** *Negligible*	
Total number of common dolphin without DBS projects *Magnitude of cumulative impact*	**589 (0.573% of the CGNS MU)** *Negligible*	

11.7.3.1.1.2.1.4 White-Beaked Dolphin

874. For white-beaked dolphin, the maximum number of individuals that could potentially be disturbed is 2,497.9 (5.68% of the reference population; **Table 11-114**) for DBS East and DBS West together, with a magnitude for the cumulative impact of piling of medium. The magnitude of impact is also medium for either DBS East or DBS West in isolation. It is the high number of white-beaked dolphins that could potentially be disturbed at West of Orkney that is resulting in a medium magnitude. Unfortunately, population modelling cannot be carried out for white-beaked dolphin as there are no set parameters to use.

Table 11-114 Quantitative CEA for the potential Disturbance of white-beaked dolphin during single piling at OWF projects which could be concurrently piling at the same as DBS East and DBS West.

OWF Project	White-beaked dolphin density (/km²)	Maximum number of individuals potentially disturbed during piling
DBS East	*0.034*	*0.11*
DBS West	*0.041*	*0.09*
DBS East & DBS West concurrently	*-*	*8.2*
Berwick Bank	0.243	516
Dudgeon Extension	0.002	0.003

OWF Project	White-beaked dolphin density (/km²)	Maximum number of individuals potentially disturbed during piling
East Anglia One North	-	-
Five Estuaries	-	-
Green Volt	0.002	9.3
Hornsea Project Three	0.243	5.4
Hornsea Project Four	0.002	85
North Falls	-	-
Outer dowsing	0.02	4
Rampion 2	-	-
Seagreen 1A	0.243	161
Sheringham Shoal Extension	0.243	0.002
West of Orkney	0.19	1,709.0
Total number of white-beaked dolphin with DBS East *Magnitude of cumulative impact*		**2,489.8 (5.66% of the CGNS MU)** *Medium*
Total number of white-beaked dolphin with DBS West *Magnitude of cumulative impact*		**2,489.8 (5.66% of the CGNS MU)** *Medium*
Total number of white-beaked dolphin with all DBS Projects *Magnitude of cumulative impact*		**2,497.9 (5.68% of the CGNS MU)** *Medium*
Total number of white-beaked dolphin without DBS projects *Magnitude of cumulative impact*		**780.7 (5.66% of the CGNS MU)** *Medium*

11.7.3.1.1.2.1.5 Minke Whale

875. For minke whale, the maximum number of individuals that could potentially be disturbed is 946.7 (4.71%) of the reference population (**Table 11-115**), with a magnitude of low, for both Projects together. The potential magnitude for the cumulative impacts of piling from either DBS East or DBS West is also low for minke whale.

Table 11-115 Quantitative CEA for the potential Disturbance of minke whale during single piling at OWF projects which could be concurrently piling at the same as DBS East and DBS West.

OWF Project	Minke whale density (/km^2)	Maximum number of individuals potentially disturbed during piling
DBS East	*0.01*	*65*
DBS West	*0.02*	*162*
DBS East & DBS West concurrently	-	*324*
Berwick Bank	0.0387	82.0
Dudgeon Extension	0.01	11.0
East Anglia One North	-	-
Five Estuaries	-	-
Green Volt	0.0387	1.5
Hornsea Project Three	0.01	38.0
Hornsea Project Four	0.01	46.0
North Falls	0.02	42.0
Outer dowsing	0.01	22.0
Rampion 2	0.0023	8.0
Seagreen 1A	0.039	275.0
Sheringham Shoal Extension	0.01	7.2
West of Orkney	0.01	90.0
Total number of minke whale with DBS East *Magnitude of cumulative impact*		**687.7 (3.42% of the CGNS MU)** *Low*
Total number of minke whale with DBS West *Magnitude of cumulative impact*		**784.7 (3.90% of the CGNS MU)** *Low*
Total number of minke whale with all DBS Projects *Magnitude of cumulative impact*		**946.7 (4.71% of the CGNS MU)** *Low*
Total number of minke whale without DBS projects *Magnitude of cumulative impact*		**622.7 (3.10% of the CGNS MU)** *Low*

11.7.3.1.1.2.1.6 Grey Seal

876. For grey seal, the maximum number of individuals that could potentially be disturbed is 9,366.3 (30.62% of the SE England MU and 16.58% of the wider MU), with a magnitude of impact of high (**Table 11-116**). For either DBS East or DBS West in isolation, the potential magnitude of impact is also high.

Table 11-116 Quantitative CEA for the potential Disturbance of grey seal during single piling at OWF projects which could be concurrently piling at the same as DBS East and DBS West.

OWF Project	Grey seal density (/km²)	Maximum number of individuals potentially disturbed during single piling
DBS East	*0.181*	*3,124.2*
DBS West	*0.26*	*2,378.7*
DBS East & DBS West concurrently	-	*6,248.40*
Berwick Bank	-	-
Dudgeon Extension	0.78	374.0
East Anglia One North	0.03	2.0
Five Estuaries	0.106	112.0
Green Volt	-	-
Hornsea Project Three	0.499	48.2
Hornsea Project Four	0.303	1,489.0
North Falls	0.18	139.7
Outer dowsing	0.85	615.0
Rampion 2	-	-
Seagreen 1A	-	-
Sheringham Shoal Extension	0.01	338.0
West of Orkney	-	-
Total number of grey seals with DBS East *Magnitude of cumulative impact*		**6,242.1 (20.40% of the SE England MU & 11.67% of the wider MU)** *High (High)*

OWF Project	Grey seal density (/km²)	Maximum number of individuals potentially disturbed during single piling
Total number of grey seal with DBS West *Magnitude of cumulative impact*		**5,496.6 (17.97% of the SE England MU & 10.27% of the wider MU)** *High (High)*
Total number of grey seal with all DBS Projects *Magnitude of cumulative impact*		**9,366.3 (30.62% of the SE England MU & 16.58% of the wider MU)** *High (High)*
Total number of grey seal without DBS projects *Magnitude of cumulative impact*		**3,117.9 (10.19% of the SE England MU & 5.83% of the wider MU)** *High (Medium)*

11.7.3.1.1.2.1.7 Harbour Seal

877. For harbour seal, the maximum number of individuals that could potentially be disturbed is 189.1 (3.88% of the SE England MU), with a magnitude impact of low (**Table 11-117**). The potential magnitude for the cumulative impacts of piling is also assessed as low for either DBS East or DBS West together.

Table 11-117 Quantitative CEA for the potential Disturbance of harbour seal during single piling at OWF projects which could be concurrently piling at the same as DBS East and DBS West.

OWF Project	Harbour seal density (/km²)	Maximum number of individuals potentially disturbed during single piling
DBS East	*0.0017*	*3.3*
DBS West	*0.001*	*1.9*
DBS East & DBS West concurrently	-	*6.6*
Berwick Bank	-	-
Dudgeon Extension	0.076	43.0
East Anglia One North	0.008	1.0
Five Estuaries	0.018	2.0
Green Volt	-	-

OWF Project	Harbour seal density (/km²)	Maximum number of individuals potentially disturbed during single piling
Hornsea Project Three	0.00126	4.5
Hornsea Project Four	0.0715	5.0
North Falls	0.0034	8.0
Outer dowsing	0.13	35.0
Rampion 2	-	-
Seagreen 1A	-	-
Sheringham Shoal Extension	0.23	84
West of Orkney	-	-
Total number of harbour seal with DBS East *Magnitude of cumulative impact*		**185.8 (3.82% of the SE England MU)** *Low*
Total number of harbour seal with DBS West *Magnitude of cumulative impact*		**184.4 (3.79% of the SE England MU)** *Low*
Total number of harbour seal with all DBS Projects *Magnitude of cumulative impact*		**189.1 (3.88% of the SE England MU)** *Low*
Total number of harbour seal without DBS projects *Magnitude of cumulative impact*		**182.5 (3.75% of the SE England MU)** *Low*

11.7.3.1.1.2.1.8 Summary of Cumulative Disturbance from OWF Piling Assessments

878. The assessments outlined in section 11.7.3.1.1.2 show there is the potential for high magnitudes of impact for harbour porpoise and grey seal, and medium for bottlenose dolphin. In order to determine whether this may have a population level of impact, population modelling has been undertaken for these species. Modelling has also been undertaken for minke whale and harbour seal.

11.7.3.1.1.2.2 Results from Population Modelling of Cumulative Piling Disturbance

879. The modelling has been undertaken based on the same information as provided in section 11.7.3.1.1.2, using iPCoD.

11.7.3.1.1.2.2.1 Harbour Porpoise

880. 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 NS MU, the iPCoD model predicts a slight decrease in harbour porpoise population size over time (**Table 11-118; Plate 11-17**).

881. The median population size was predicted to be 99.71% of the un-impacted population size at the end of 2028 (1 year after the piling has commenced). By the end of 2037 the median population size for the impacted population is predicted to be 99.14% of the un-impacted population size. Beyond 2037, the impacted population is expected to maintain the same stable trajectory as the un-impacted population (as far as 2052 which is the end point of the modelling, at which point the median impacted to un-impacted ratio remains 99.14%)

882. For harbour porpoise, the potential magnitude of the CEA for disturbance from underwater noise from piling is assessed as negligible due to there being less than a 1% population level impact over both the first six years and 25 year modelled periods.

Table 11-118 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the harbour porpoise population (NS MU) 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 population mean	Impacted population mean	Median impacted as % of un-impacted
Start	346,602	346,602	100.00%
End 2028	346,289	345,269	99.83%
End 2029	345,889	342,280	99.27%
End 2032	345,528	341,389	99.23%
End 2037	345,649	341,391	99.20%
End 2047	346,433	342,160	99.20%
End 2052	347,639	343,354	99.20%

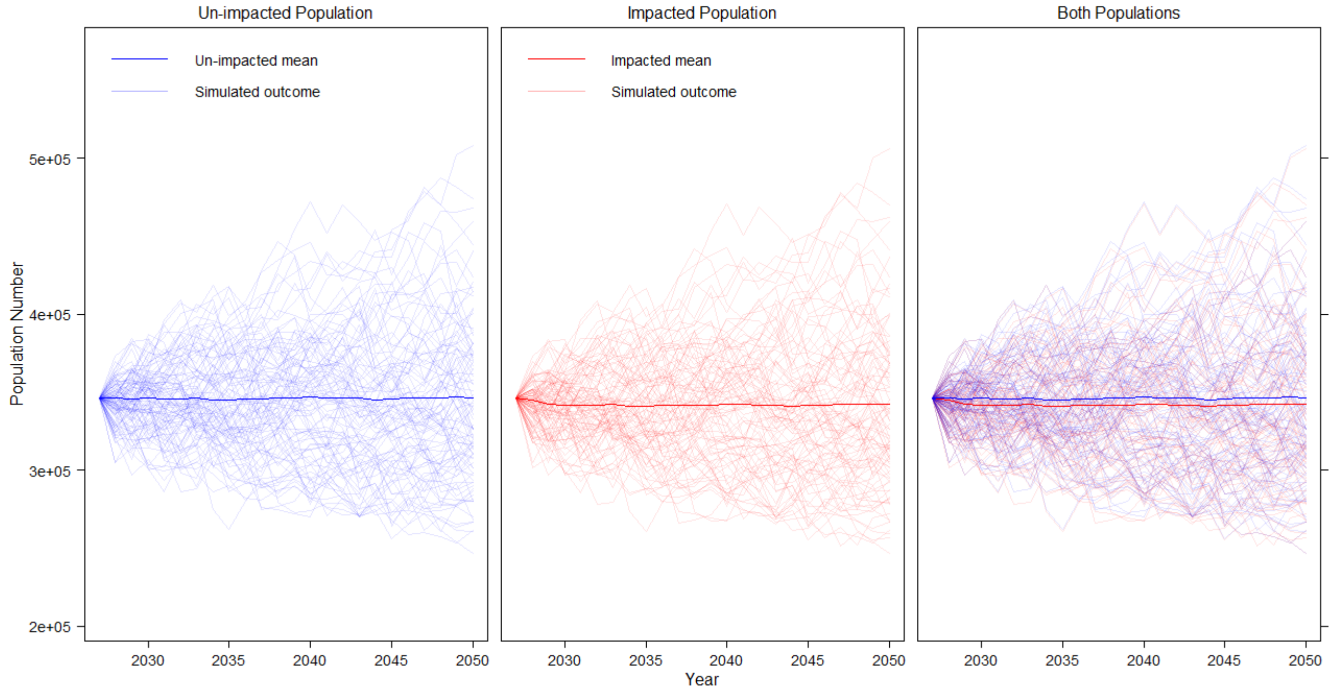

Plate 11-17 Simulated worst-case harbour porpoise population sizes for both the un-impacted and the impacted populations

11.7.3.1.1.2.2.2 Bottlenose Dolphin

883. For the cumulative scenario assessed (see **Volume 7**, **Appendix 11.4 (application ref: 7.11.11.4)** section 7.1 for details of the schemes considered, and their parameters) within the Greater North Sea MU, the iPCoD model predicts a slight decrease in bottlenose dolphin population size over time (**Table 11-119** and **Plate 11-18**).

884. The median population size was predicted to be 100% of the un-impacted population size at the end of 2028 (1 year after piling has commenced). This lack of discernible effect on the impacted population is maintained until 2052, which is the end point of the modelling.

885. For bottlenose dolphin, the potential magnitude of the CEA for disturbance from underwater noise from piling is assessed as negligible due to there being less than a 1% annual population level impact over the 25 year modelled periods.

Table 11-119 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the bottlenose dolphin population (GNS MU) 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 population mean	Impacted population mean	Median impacted as % of un-impacted
Start	2,020	2,020	100.00%
End 2028	2,010	1,988	100.00%
End 2029	1,995	1,953	100.00%
End 2032	1,960	1,927	100.00%
End 2037	1,908	1,878	100.00%
End 2047	1,801	1,772	100.00%
End 2052	1,745	1,716	100.00%

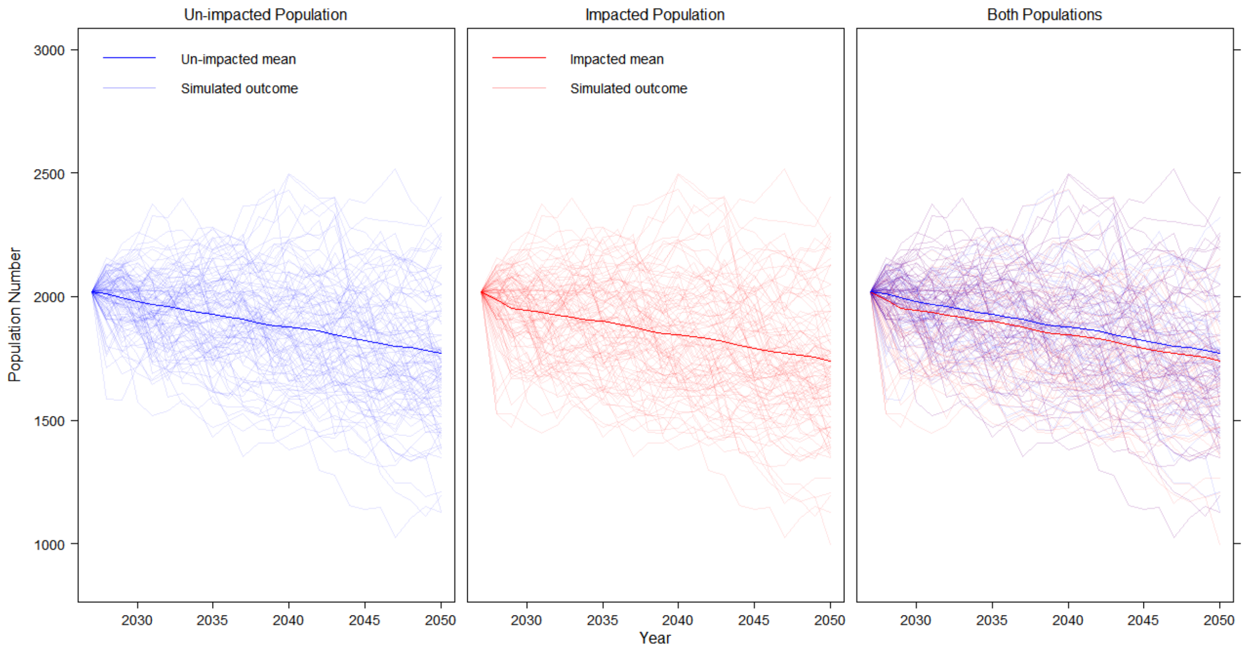

Plate 11-18 Simulated worst-case bottlenose dolphin population sizes for both the un-impacted and the impacted populations

11.7.3.1.1.2.2.3 Minke Whale

886. For the cumulative scenario assessed (see **Volume 7, Appendix 11-2 (application ref: 7.11.11.2)** section 7.1 for details of the schemes considered, and their parameters) within the Celtic and Greater North Sea MU, the iPCoD model predicts a slight decrease in minke whale population size over time (**Table 11-119** and **Plate 11-19**).

887. 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 2029 the median population size for the impacted population is predicted to be 99.93% of the un-impacted population size. The impacted population at the end of 2046 (20 years after piling commences) is expected to be 94.96% of un-impacted population, and at 2052, which is the end point of the modelling, the impacted population is predicted to be 94.82% of the unimpacted population.

888. For minke whale, the potential magnitude of the CEA for disturbance from underwater noise from piling is assessed as low, due to there being less than an annual 1% population level impact the modelled period (**Plate 11-19**).

Table 11-120 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the minke whale population (CGNS MU) 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 population mean	Impacted population mean	Median impacted as % of un-impacted
Start	20,120	20,120	100.00%
End 2028	20,091	20,088	100.00%
End 2029	20,125	20,104	99.93%
End 2032	20,031	19,653	98.45%
End 2037	20,072	19,222	96.22%
End 2047	20,002	18,886	94.96%
End 2052	20,014	18,864	94.82%

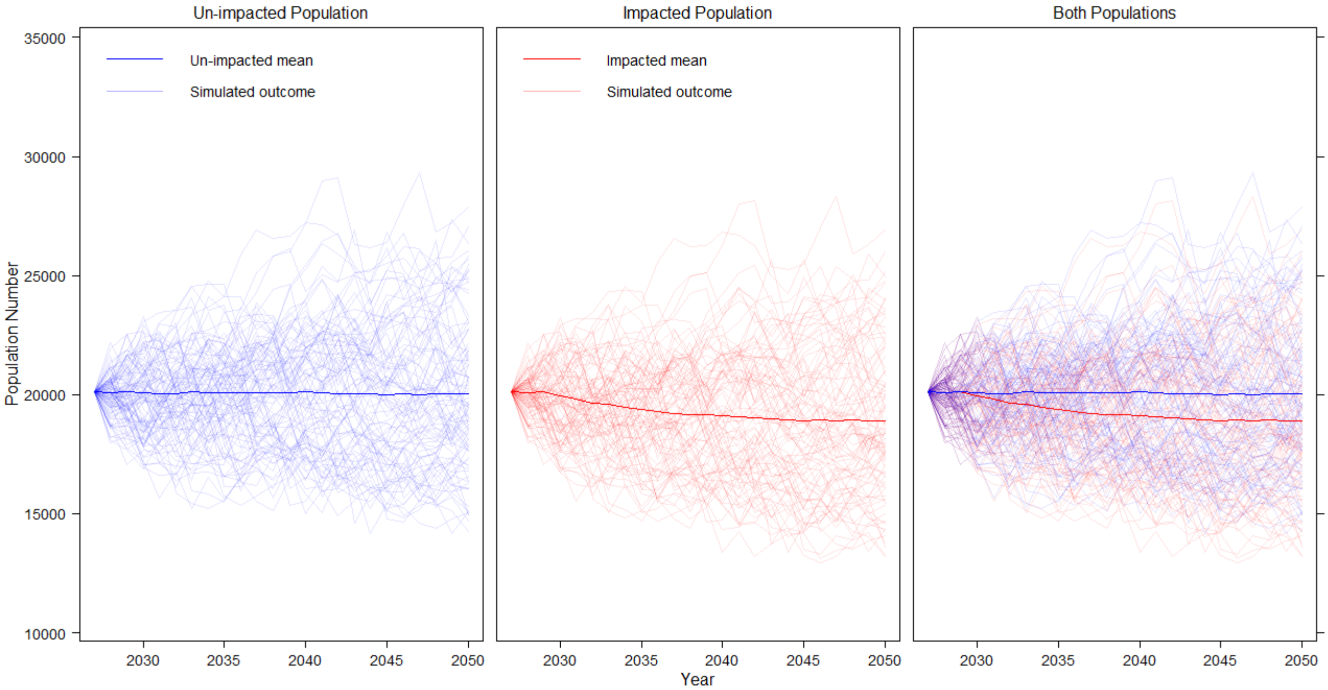

Plate 11-19 Simulated worst-case minke whale population sizes for both the un-impacted and the impacted populations

11.7.3.1.1.2.2.4 Grey Seal

889. For the cumulative scenario assessed (see **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)** section 7.1 for details of the schemes considered, and their parameters) within the wider MU (see section 11.5.8), the iPCoD model predicts no discernible decrease in grey seal population size over time for the SE England or wider grey seal MUs **(Plate 11-20** and **Plate 11-21**).

890. The median population size was predicted to be 100% of the un-impacted population size at the end of 2028 (1 year after piling has commenced) for both populations. This lack of discernible effect on the impacted population is maintained until 2052 for both the SE England or wider grey seal MUs, which is the end point of the modelling (**Table 11-121** and **Table 11-122**).

891. For grey seal, the potential magnitude of the CEA for disturbance from underwater noise from piling is assessed as negligible due to there being less than a 1% annual population level impact over the 25 year modelled periods.

Table 11-121 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the grey seal population (SE England MU (see section 11.5.8) 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 population mean	Impacted population mean	Median impacted as % of un-impacted
Start	30,594	30,594	100.00%
End 2028	30,818	30,818	100.00%
End 2029	31,061	31,061	100.00%
End 2032	31,548	31,550	100.01%
End 2037	32,436	32,438	100.01%
End 2047	34,477	34,480	100.01%
End 2052	35,683	35,685	100.01%

**Note that the marginal increase in the impacted population in comparison to the un-impacted population is a result of the environmental stochasticity built into the model*

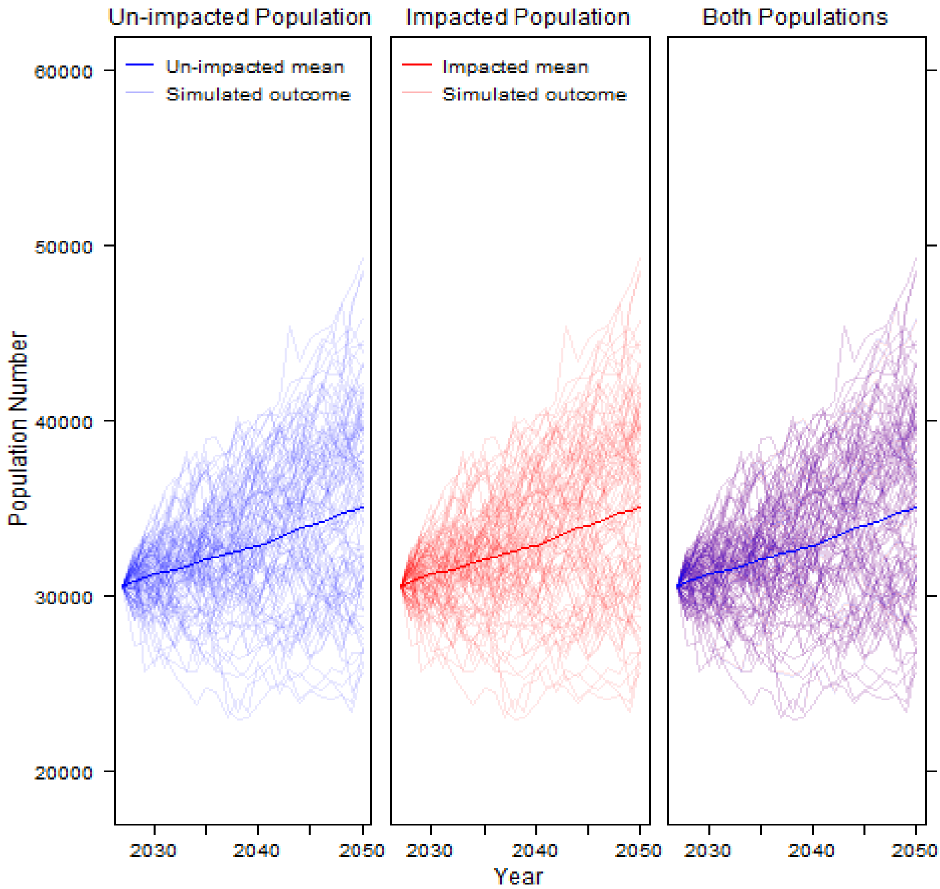

Plate 11-20 Simulated worst-case grey seal population sizes (SE England MU) for both the unimpacted and the impacted populations.

Table 11-122 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the grey seal population (Wider MU (see section 11.5.8) 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 population mean	Impacted population mean	Median impacted as % of un-impacted
Start	56,502	56,502	100.00%
End 2028	56,936	56,936	100.00%
End 2029	57,333	57,333	100.00%
End 2032	58,445	58,446	100.00%
End 2037	60,169	60,170	100.00%
End 2047	64,050	64,051	100.00%
End 2052	65,725	65,726	100.00%

**Note that the marginal increase in the impacted population in comparison to the un-impacted population is a result of the environmental stochasticity built into the model*

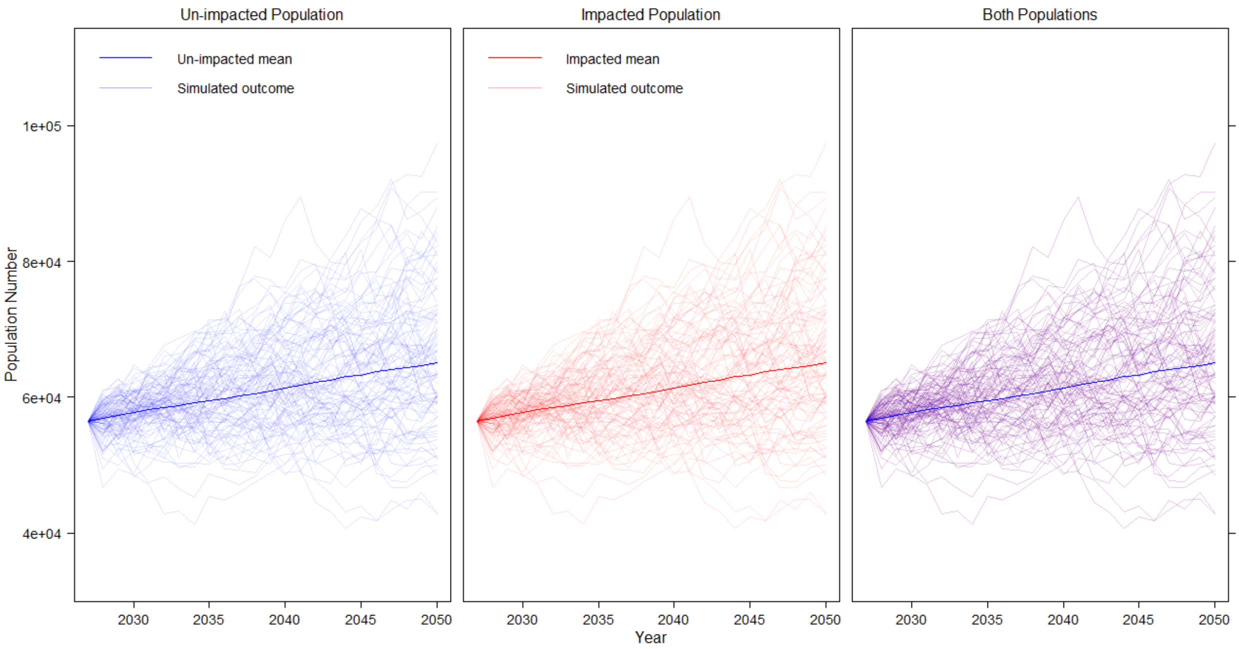

Plate 11-21 Simulated worst-case grey seal population sizes (Wider MU) for both the un-impacted and the impacted populations

11.7.3.1.1.2.2.5 Harbour Seal

892. For the cumulative scenario assessed (see **Volume 7, Appendix 11-4 (application ref: 7.11.11.4)** section 7.1 for details of the schemes considered, and their parameters) within the (North West MU and Northern Ireland MU, the iPCoD model predicts no discernible decrease in harbour seal population size over the 25 year modelled periods (**Table 11-123** and **Plate 11-22**).

893. 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). This lack of discernible effect on the impacted population is maintained until 2052, which is the end point of the modelling.

894. For harbour seal, the potential magnitude of the CEA for disturbance from underwater noise from piling is assessed as negligible due to there being less than a 1% annual population level impact over the 25 year modelled periods.

Table 11-123 Results of the iPCoD modelling for the cumulative assessment, giving the mean population size of the harbour seal population (SE England MU) 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 population mean	Impacted population mean	Median impacted as % of un-impacted
Start	4,868	4,868	100.00%
End 2028	4,368	4,368	100.00%
End 2029	3,907	3,907	100.00%
End 2032	2,802	2,806	100.00%
End 2037	1,624	1,627	100.00%
End 2047	542	544	100.00%
End 2052	313	314	100.00%

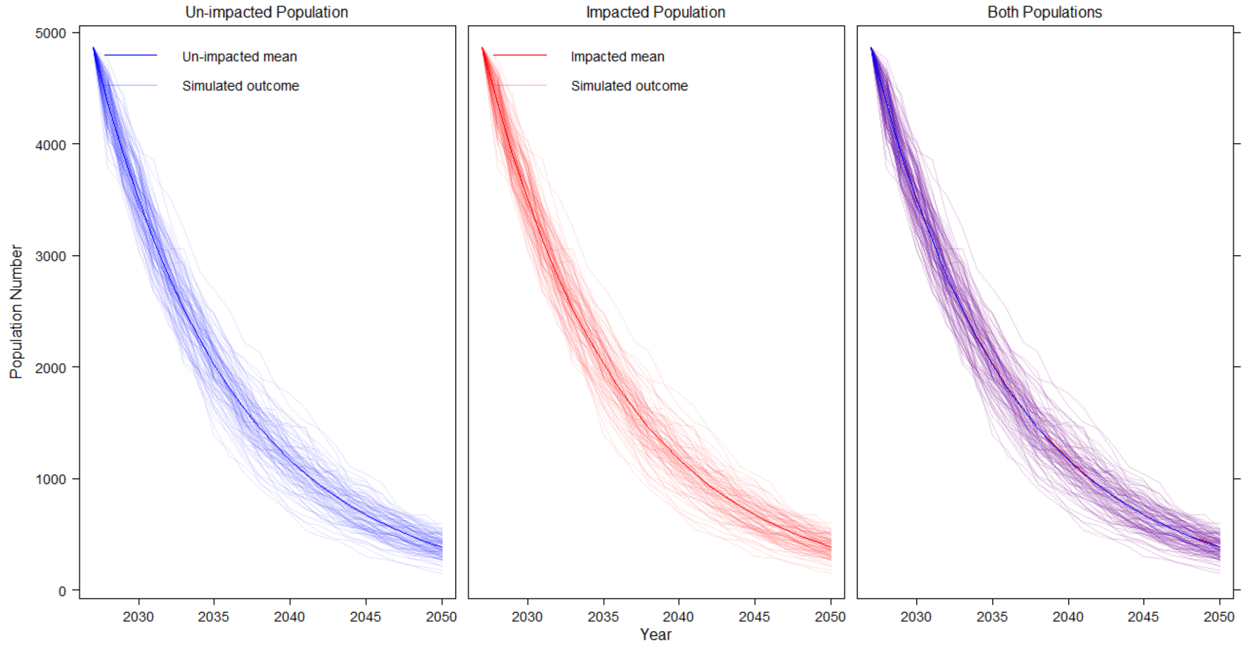

Plate 11-22 Simulated worst-case harbour seal population sizes for both the un-impacted and the impacted populations

11.7.3.1.1.2.3 Summary of Magnitude of Cumulative Population Level Consequences due to Disturbance

895. For all species assessed, the modelled impact of piling from the Projects falls below the threshold of a 1% annual decline in population which is considered insignificant. The greatest impact of cumulative disturbance occurs for minke whale, with a predicted 4.82% decline in population size over a 25-year period, but falls below the 1% annual decline mark. The population consequences of disturbance is therefore assessed as negligible for all species, with exception of minke whale with a magnitude impact of low.

11.7.3.1.1.3 Significance of Effect

896. If all included OWFs were single piling at the same time as DBS East and/or DBS West, there is the potential for a negligible to low magnitude of impact (dependent on species), however, as outlined above, it is highly unlikely that all OWFs could be concurrently piling at exactly the same time. In addition, the population modelling indicates there is no potential for a population level effect due to the cumulative disturbance.

897. Taking into account the sensitivity for marine mammal species, the cumulative effect assessment for disturbance to marine mammals from piling at other OWFs (based on the results of the population modelling wherever possible), is **minor adverse** (not significance in EIA terms) for harbour porpoise, white-beaked dolphin and minke whale, and **negligible adverse** (not significant in EIA terms) for bottlenose dolphin, grey seal and harbour seal. For common dolphin, no other OWF piling has been included as noted above, and therefore there is no cumulative impact due to piling for that species (**Table 11-124**).

Table 11-124 Assessment of effect of significance for the potential for cumulative disturbance due to other OWFs piling at the same time as DBS East and/or DBS West

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significance	Mitigation	Residual effect
Harbour porpoise	Medium	Negligible	Minor adverse	None required.	Minor adverse
Bottlenose dolphin	Low	Negligible	Negligible adverse		Negligible adverse
Common dolphin	Low	Negligible	Negligible adverse		Negligible adverse
White-beaked dolphin	Low	Medium	Minor adverse		Minor adverse
Minke whale	Medium	Low	Minor adverse		Minor adverse
Grey seal	Low	Negligible	Negligible adverse		Negligible adverse
Harbour seal	Low	Negligible	Negligible adverse		Negligible adverse

11.7.3.1.2 Mitigation and Residual Significance of Effect

898. No mitigation is required for disturbance from underwater noise from piling at cumulative projects with DBS East and/or DBS West. Therefore, the residual significance of effect for disturbance would be **negligible to minor adverse** (not significant in EIA terms) for all species.

11.7.3.2 Cumulative Impact 2: Assessment of Disturbance from Other Industries and Activities

899. 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:

900. Other construction activities at OWFs (vessels, cable installation works, dredging, seabed preparation and rock placement);

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

901. The magnitude of impact of each of these activities is considered and then an overall assessment of significance is provided.

902. For other construction activities at OWFs, the 11 screened in OWF projects have already been assessed as part of Cumulative Impact 1 (section 11.7.3.1); disturbance from piling. Piling is the worst-case impact from the construction of OWFs (in terms of underwater noise disturbance), and therefore any assessment of other construction activities has already been considered. The potential for underwater noise disturbance from other OWFs has therefore not been assessed further.

903. For the installation of oil and gas infrastructure, marine renewable projects, and disposal sites, all potential projects 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)**.

904. To assess the cumulative impacts of underwater noise from other industrial activities to marine mammals, wider densities have been used to represent a wider area rather than the project specific densities. As the location of the potential industrial activities is currently unknown, the following assessments are based on the SCANS-IV block NS-C density estimates for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin and minke whale (Gilles *et al*. 2023) to represent a wider area. For grey seal and harbour seal, the density estimates are based on average Carter *et al*. (2022) estimate for the whole of the relevant MU (**Table 11-125**).

Table 11-125 Marine mammal densities estimates used for CEA assessment of underwater noise of other activities.

Marine mammal species	Marine mammal density (km^2)	Source
Harbour porpoise	0.6027	SCANS-IV (Gilles *et al*, 2023)
Bottlenose dolphin	0.0491	SCANS-IV (Gilles *et al*, 2023)
Common dolphin	0.0032	SCANS-IV (Gilles *et al*, 2023)
White-beaked dolphin	0.0149	SCANS-IV (Gilles *et al*, 2023)
Minke whale	0.0068	SCANS-IV (Gilles *et al*, 2023)
Grey seal	0.2958	Total 2020 estimate (Carter *et al*, 2022)
Harbour seal	0.0647	Total 2021 estimate (Carter *et al*, 2022)

11.7.3.2.1 Sensitivity to Disturbance

905. As outlined in section 11.6.1.1.2, harbour porpoise and minke whale are assessed as having a medium sensitivity to disturbance from underwater noise sources, and bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal have a low sensitivity to disturbance.

11.7.3.2.2 Magnitude of Impact from Geophysical Surveys

906. 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 the Projects.

907. As outlined in **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**, geophysical surveys using Sub-Bottom Profilers (SBPs) and Ultra-Short Base Line (USBL) systems have the potential to disturb marine mammals and have therefore been screened into the CEA, as a precautionary approach.

908. The potential disturbance range used in the cumulative assessment is based on the SNCB guidance for assessment for harbour porpoise.

909. The assessments for the Review of Consents (RoC) HRA for the Southern North Sea SAC[3] (Department of Business, Energy and Industrial Strategy (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.

910. As a worst case, it has been assumed that all marine mammals within 5km of the survey source, a total area of 78.54km^2 could be disturbed.

911. For geophysical surveys with sub-bottom profilers, 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. Marine mammals 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.

912. However, as a precautionary approach, the assessment of the potential disturbance of harbour porpoise in the Southern North SAC in the RIAA will also include the possible disturbance from the Survey Area as assessed in the RoC HRA for the Southern North Sea SAC (BEIS, 2020[4]).

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[3] Record of the Habitats Regulations Assessment undertaken under Regulation 65 of the Conservation of Habitats and Species 2017, and Regulation 33 of the Conservation of Offshore Marine Habitats an

[4] Species Regulations 2017. Review of Consented Offshore Wind Farms in the Southern North Sea Harbour Porpoise SAC (BEIS, 2020).

913. 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 DBS East and/or DBS West. It is therefore assumed, as a worst-case scenario, that there could potentially be up to two geophysical surveys in the North Sea at any one time, during construction of DBS East and/or DBS West, with a total disturbance area of 157.1km^2.

914. For up to two geophysical surveys undertaken at the same time as construction of DBS East and/or DBS West, with no other cumulative activities, the magnitude of impact would be negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-126**).

915. It is less likely that any geophysical surveys would be undertaken within the bottlenose dolphin CES MU, however, on a precautionary basis, one geophysical survey within the CES MU has been assessed. The magnitude of impact for the bottlenose dolphin CES MU is low (**Table 11-126**).

Table 11-126 Quantitative assessment for cumulative disturbance of marine mammals due to up to two geophysical Surveys at OWF

Potential cumulative impact	Marine mammal species	Marine mammal; density (km^2)	Potential cumulative effect area (km^2)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
Up to two geophysical surveys	Harbour porpoise	0.6027	157.08	94.7 (0.03% of the NS MU)	Negligible
	Bottlenose dolphin	0.0491		7.7 (0.38% of the GNS MU)	Negligible
	Common dolphin	0.0032		0.5 (0.0004% of the CGNS MU)	Negligible
	White-beaked dolphin	0.0149		2.3 (0.005% of the CGNS MU)	Negligible
	Minke whale	0.0068		1.1 (0.005% of the CGNS MU)	Negligible
	Grey seal	0.2958		46.5 (0.08% of the SE & NE MU)	Negligible

Potential cumulative impact	Marine mammal species	Marine mammal; density (km^2)	Potential cumulative effect area (km^2)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
	Harbour seal	0.0647		10.2 (0.21% of the SE MU)	Negligible
Up to one geophysical survey	Bottlenose dolphin	0.0491	78.54	3.9 (1.72% of the CES MU)	Low

11.7.3.2.3 Magnitude of Impact from Aggregate Extraction and Dredging

916. Taking into account the small potential effect ranges, distances of the aggregate extraction and dredging projects from DBS East and/or DBS West, the potential for contribution to cumulative effects is very small. Therefore, risk of PTS or TTS for all marine mammal species from aggregate extraction and dredging has been screened out from further consideration in the CEA.

917. As a precautionary approach, a total of six aggregate extraction and dredging projects are included in the CEA for the potential for cumulative disturbance (see **Volume 7, Appendix 11-5 (application ref: 7.11.11.5)**).

918. As outlined in the Department for Business, Energy and Industrial Strategy (BEIS) (2020) RoC HRA for the Southern North Sea 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 projects at the same time as DBS East and/or DBS West 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 projects. Only five of those aggregate projects are within the relevant MUs for both seal species, and therefore for seals, the potential disturbance area is 5.7km^2. None of these aggregate projects are within the CES MU for bottlenose dolphins.

919. The densities for each marine mammal species are as outlined in section 11.7.3.2.1.

920. For the potential cumulative disturbance from aggregate and dredging projects undertaken at the same time as construction of DBS East and/or DBS West , the magnitude of impact would be negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-127**).

Table 11-127 Quantitative assessment for cumulative disturbance of marine mammals due to up to six aggregate extraction and dredging activities near the DBS Projects

Potential cumulative impact	Marine mammal species	Marine mammal; density (km²)	Potential cumulative effect area (km²)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
Up to six aggregate extraction and dredging projects	Harbour porpoise	0.6027	6.78	4.1 (0.001% of the NS MU)	Negligible
	Bottlenose dolphin	0.0491		0.3 (0.02% of the GNS MU)	Negligible
	Common dolphin	0.0032		0.02 (0.00002% of the CGNS MU)	Negligible
	White-beaked dolphin	0.0149		0.1 (0.0002% of the CGNS MU)	Negligible
	Minke whale	0.0068		0.05 (0.0002% of the CGNS MU)	Negligible
Up to five aggregate extraction and dredging projects	Grey seal	0.2958	5.70	1.7 (0.003% of the SE & NE MU)	Negligible
	Harbour seal	0.0647		0.4 (0.008% of the SE MU)	Negligible

11.7.3.2.4 Magnitude of Impact from Seismic Surveys

921. 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.

922. This assessment for the potential disturbance due to seismic surveys is based on the following for each marine mammal species:

- Harbour porpoise
  a. The potential impact area during seismic surveys, based on a radius of 12km (452.4km² per survey, or 904.8km² for two surveys), following the current SNCB guidance for the assessment of impact on harbour porpoise in the Southern North Sea SAC.
- Bottlenose dolphin, common dolphin and white-beaked dolphin
  b. Strong avoidance of bottlenose dolphin from a 2D seismic survey (with 470 cubic inch airguns, and a peak sound source level of 243 dB re 1 μPa @1m) was modelled at between 1.8km and 11km (based on site specific underwater noise modelling using the dB_{ht} method) (DECC, 2011d). This equates to an area of 380.13km², assuming the largest potential disturbance range of 11km. A potential disturbance range of 11km (disturbance area of 380.13km²) has therefore been used in the assessment for each seismic survey.
  c. The potential impact area for two seismic surveys is 760.3km².
- Minke whale
  d. There is little available information on the potential for disturbance from seismic surveys, however, as noted in section 11.6.1.2.3.1.3, observations of behavioural changes in other baleen whale species have shown avoidance reactions at up to 30km for a seismic survey (Richardson *et al.*, 1999). A potential disturbance range of 30km will therefore be applied to minke whale due to a lack of species-specific information (resulting in a disturbance area of 2,827.4km² for one survey, and up to 5,654.8km² for two seismic surveys).
- Grey seal and harbour seal
  e. As minke whale, there is little available information on the potential for disturbance from seismic surveys for either grey seal or harbour 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 source (BEIS, 2020). These ranges are based on modelled impact ranges, using the 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.

f. 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 both grey seal and harbour seal due to a lack of species-specific information.

923. The densities for each marine mammal species are as outlined in section 11.7.3.2.1.

924. For the potential cumulative disturbance from seismic surveys projects undertaken at the same time as construction of DBS East and/or DBS West , the magnitude of impact would be negligible for harbour porpoise, common dolphin, white-beaked dolphin, minke whale, and grey seal and low for bottlenose dolphin and harbour seal (**Table 11-128**).

925. It is unlikely that any seismic survey would be undertaken within the CES MU, or within 2km of the coastline, and therefore the CES bottlenose dolphin population has not been assessed.

Table 11-128 Quantitative assessment for cumulative disturbance of marine mammals due to up to two seismic surveys near the DBS Projects

Potential cumulative impact	Marine mammal species	Marine mammal; density (km^2)	Potential cumulative effect area (km^2)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
Up to two seismic surveys	Harbour porpoise	0.6027	904.8	545.3 (0.16% of the NS MU)	Negligible
	Bottlenose dolphin	0.0491	760.3	37.3 (1.8% of the GNS MU)	Low
	Common dolphin	0.0032		2.4 (0.002% of the CGNS MU)	Negligible
	White-beaked dolphin	0.0149		11.3 (0.03% of the CGNS MU)	Negligible

Potential cumulative impact	Marine mammal species	Marine mammal; density (km^2)	Potential cumulative effect area (km^2)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
	Minke whale	0.0068	5,654.8	38.5 (0.19% of the CGNS MU)	Negligible
	Grey seal	0.2958	1,815.8	537.1 (0.95% of the SE & NE MU)	Negligible
	Harbour seal	0.0647		117.5 (2.41% of the SE MU)	Low

11.7.3.2.5 Magnitude of Impact from Subsea Cables and Pipelines

926. Only one subsea pipeline has been screened into the cumulative assessment; Sea Link. This project is currently at scoping stage and therefore there is limited information available on potential effects and disturbance ranges for which to inform a cumulative assessment with DBS East and/or DBS West.

927. As described in section 11.6.1.3, 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 all marine mammal species. This has been used to inform the assessments for subsea cabling and pipeline projects, as activities would be similar, in the absence of any additional information for the project screened in for assessment.

928. The densities for each marine mammal species are as outlined in section 11.7.3.2.1.

929. Sea Link is not within the CES MU for bottlenose dolphin; therefore, this population has not been assessed.

930. For the potential cumulative disturbance from aggregate and dredging projects undertaken at the same time as construction of DBS East and/or DBS West, the magnitude of impact would be negligible for harbour porpoise, bottlenose dolphin common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal (**Table 11-129**).

Table 11-129 Quantitative assessment for cumulative disturbance of marine mammals due to subsea cabling and pipeline activities near the DBS Projects

Potential cumulative impact	Marine mammal species	Marine mammal; density (km^2)	Potential cumulative effect area (km^2)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
Sea Link	Harbour porpoise	0.6027	50.3	30.3 (0.008% of the NS MU)	Negligible
	Bottlenose dolphin	0.0491		2.5 (0.12% of the GNS MU)	Negligible
	Common dolphin	0.0032		0.2 (0.0002% of the CGNS MU)	Negligible
	White-beaked dolphin	0.0149		0.7 (0.002% of the CGNS MU)	Negligible
	Minke whale	0.0068		0.3 (0.002% of the CGNS MU)	Negligible
	Grey seal	0.2958		14.9 (0.03% of the SE & NE MU)	Negligible
	Harbour seal	0.0647		3.3 (0.07% of the SE MU)	Negligible

11.7.3.2.6 Magnitude of Impact from UXO

931. As for piling, the potential risk of PTS in marine mammals from cumulative effects has been screened out from further consideration in the CEA; if there is the potential for any PTS, suitable mitigation would be put in place to reduce any risk to marine mammals. Therefore, the CEA only considers potential disturbance effects.

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

933. 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.

934. The magnitude of the potential disturbance from UXO clearance has been estimated based on the following:

- Harbour porpoise
  a. 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 impact to harbour porpoise in the Southern North Sea SAC.
- Bottlenose dolphin, common dolphin and white-beaked dolphin
  b. The potential effect area during a single UXO clearance event, based on the modelled worst case effect range at DBS East and/or DBS West for TTS / fleeing response (weighted SEL) of 0.6km (1.09km²) for high-order clearance and 0.05km (0.0078km²) for low-order clearance.
- Minke whale
  c. The potential effect area during a single UXO clearance event, based on the modelled worst case effect range at DBS East and/or DBS West for TTS / fleeing response (weighted SEL) of 110.0km (38,013.3km²) for high-order clearance and 3.2km (32.17km²) for low-order clearance.
- Grey seal and harbour seal
  d. The potential effect area during a single UXO clearance event, based on the modelled worst case effect range at DBS East and/or DBS West for TTS / fleeing response (weighted SEL) of 22.0km (1,520.5km²) for high-order clearance and 0.57km (1.02km²) for low-order clearance.

935. 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).

936. 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 CEA 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.

937. The densities for each marine mammal species are as outlined in section 11.7.3.2.1.

938. For the potential cumulative disturbance from high-order UXO clearance projects undertaken at the same time as construction of DBS East and/or DBS West, the magnitude of impact for high-order UXO clearance would be negligible for harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, and grey seal and low for minke whale and harbour seal. For low order UXO clearance, the magnitude of impact would be negligible for all marine mammal species (**Table 11-130**).

Table 11-130 Quantitative assessment for cumulative disturbance of marine mammals due to UXO clearance activities near the DBS Projects

Potential cumulative impact	Marine mammal species	Marine mammal; density (km²)	Potential cumulative effect area (km²)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
	Harbour porpoise	0.6027	2,123.7	1,280.0 (0.37% of the NS MU)	Negligible

Potential cumulative impact	Marine mammal species	Marine mammal; density (km²)	Potential cumulative effect area (km²)	Maximum number of individuals potential disturbed (% of reference population)	Potential magnitude of cumulative effect
High-order UXO Clearance	Bottlenose dolphin	0.0491	1.09	0.05 (0.003% of the GNS MU; 0.02% of the CES MU)	Negligible
	Common dolphin	0.0032		0.003 (0.000003% of the CGNS MU)	Negligible
	White-beaked dolphin	0.0149		0.02 (0.00004% of the CGNS MU)	Negligible
	Minke whale	0.0068	38,013.3	258.5 (1.3% of the CGNS MU)	Low
	Grey seal	0.2958	1,520.5	449.8 (0.80% of the SE & NE MU)	Negligible
	Harbour seal	0.0647		98.4 (2.02% of the SE MU)	Low
Low-order UXO Clearance	Harbour porpoise	0.6027	78.5	47.3 (0.013% of the NS MU)	Negligible
	Bottlenose dolphin	0.0491	0.0078	0.0003 (0.00002% of the GNS MU; 0.0002% of the CES MU)	Negligible
	Common dolphin	0.0032		0.00003 (<0.0000002% of the CGNS MU)	Negligible
	White-beaked dolphin	0.0149		0.0001 (0.0000003% of the CGNS MU)	Negligible
	Minke whale	0.0068	32.17	0.2 (0.001% of the CGNS MU)	Negligible
	Grey seal	0.2958	1.02	0.3 (0.0005% of the SE & NE MU)	Negligible
	Harbour seal	0.0647		0.07 (0.001% of the SE MU)	Negligible

11.7.3.2.7 Magnitude of Disturbance from all Underwater Noise from Potential Noise Sources (other than OWF) DBS East and West In Isolation

939. Each of the above-described other noise sources are quantitively assessed together in **Table 11-131**.

940. For the potential impact for noisy activities (other than OWF) with the potential for cumulative disturbance effects together with piling at DBS East or DBS West, the magnitude of impact is negligible for common dolphin and white beaked dolphin, low for harbour porpoise, bottlenose dolphin, minke whale, and harbour seal and medium for grey seal (**Table 11-131**).

11.7.3.2.8 Magnitude of Disturbance from all Underwater Noise from Potential Noise Sources (other than OWF) DBS East and West Together

941. Each of the above-described other noise sources are quantitively assessed together in **Table 11-131**, together with DBS East and DBS West.

942. For the potential impact for noisy activities (other than OWF) with the potential for cumulative disturbance effects together with piling at DBS East and DBS West together, the magnitude of impact is negligible for common dolphin and white beaked dolphin, low for harbour porpoise, bottlenose dolphin, minke whale, and harbour seal, and high for grey seal (**Table 11-131**).

11.7.3.2.9 Mitigation and Residual Significance of Effect

943. The DBS Projects' SIP for the Southern North Sea SAC could manage and reduce the potential for significant disturbance of harbour porpoise from cumulative underwater noise during OWF piling. This could also reduce the potential for disturbance for all other marine mammal species.

Table 11-131 Quantitative assessment for all noisy activities with the potential for cumulative disturbance effects for marine mammals

Impact	Harbour porpoise	Bottlenose dolphin	Common dolphin	White-beaked dolphin	Minke whale	Grey seal	Harbour seal
Worse case disturbance at DBS East	iPCoD modelling undertaken, < 1% population level effect over both the first six years and 25 year modelled periods.	iPCoD modelling undertaken, < 1% population level effect of the GNS over both the first six years and 25 year modelled periods.	0.06	0.11	iPCoD modelling undertaken, < 1% population level effect over both the first six years and 25 year modelled periods.	iPCoD modelling undertaken, < 1% population level effect over both the first six years and 25 year modelled periods.	iPCoD modelling undertaken, < 1% population level effect over both the first six years and 25 year modelled periods.
Worse case disturbance at DBS West			0.04	0.09			
DBS East & DBS West concurrently			3.4	8.2			
Geophysical surveys	94.7	GNS: 7.7 CES: 3.9	0.5	2.3	1.1	46.5	10.2
Aggregates and dredging	4.1	GNS: 0.3	0.02	0.1	0.05	1.7	0.4
Seismic survey	545.3	GNS: 37.3	2.4	11.3	38.5	537.1	117.5
Sea Link	30.3	GNS: 2.5	0.2	0.7	0.3	14.9	3.3
UXO clearance (HO)	1,280.0	0.05	0.003	0.02	258.5	449.8	98.4
UXO clearance (LO)	47.3	0.0003	0.00003	0.0001	0.2	0.3	0.07
Total number with DBS East in isolation *Magnitude*	**< 1.58% of the NS MU** *Low*	**< 3.37% of the GNS MU** *Low*	**3.2 (003% of the CGNS MU)** *Negligible*	**14.5 (03% of the CGNS MU)** *Negligible*	**< 2.48% of the CGNS MU** *Low*	**< 4.43% of the SE England MU** *Low*	**< 5.72% of the SE England MU** *Medium*
Total number with DBS West in isolation *Magnitude*	**< 1.58% of the NS MU** *Low*	**< 3.37% of the GNS MU** **MU)** *Low*	**3.2 (003% of the CGNS MU)** *Negligible*	**14.5 (03% of the CGNS MU)** *Negligible*	**< 2.48% of the CGNS MU** *Low*	**< 4.43% of the SE England MU** *Low*	**< 5.72% of the SE England MU** *Medium*
Total number with DBS Projects together *Magnitude*	**< 1.58% of the NS MU** *Low*	**< 3.37% of the GNS MU** *Low*	**6.5 (006% of the CGNS MU)** *Negligible*	**22.6 (05% of the CGNS MU)** *Negligible*	**< 2.48% of the CGNS MU** *Low*	**< 4.43% of the SE England MU** *Low*	**< 5.72% of the SE England MU** *Medium*
Total number without DBS Projects together *Magnitude*	**0.58% of the NS MU (2,001.7 animals)** *Negligible*	**GNS: 2.37% of the GNS MU (47.9 animals)** *Low* **CES: 1.79% of the CES MU (4 animals)** *Low*	**3.1 (003% of the CGNS MU)** *Negligible*	**14.4 (03% of the CGNS MU)** *Negligible*	**1.48% of the CGNS MU (298.7 animals)** *Low*	**3.43% of the SE England MU (1,050.3 animals)** *Low*	**4.72% of the SE England MU (229.9 animals)** *Low*

11.7.3.2.10 Significance of Effect

944. If all included activities were undertaking activities at the same time as DBS East and/or DBS West, there is the potential for a low to high magnitude of impact (dependent on species), however, it is highly unlikely that all activities would be undertaken at the same time.

945. Taking into account the receptor sensitivity for all marine mammal species, the cumulative effect assessment for disturbance to marine mammals from all other noise sources is **minor adverse** (not significant in EIA terms) for harbour porpoise, bottlenose dolphin, minke whale, grey seal and harbour seal. Common dolphin and white-beaked dolphin both have a magnitude of **negligible adverse** (not significant in EIA terms) (**Table 11-132**).

Table 11-132 Assessment of effect of significance for the potential for cumulative disturbance due to other noisy activities at the same time as DBS East and/or DBS West

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significance	Mitigation	Residual effect
Harbour porpoise	Medium	Low	Minor adverse	None required	Minor adverse
Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse
Common dolphin		Negligible	Negligible adverse		Negligible adverse
White-beaked dolphin		Negligible	Negligible adverse		Negligible adverse
Minke whale	Medium	Low	Minor adverse		Minor adverse
Grey seal	Low	Low	Minor adverse		Minor adverse
Harbour seal		Medium	Minor adverse		Minor adverse

11.7.3.3 Cumulative Impact 3: Cumulative Barrier Effects from Disturbance of OWF

946. The sensitivity of harbour porpoise and minke whale is medium to barrier effects from underwater noise, while dolphin and seal species have a sensitivity of low (see section 11.6.1.5).

947. For the assessment of the potential for barrier effects due to underwater noise from projects undergoing construction, the effect to marine mammal species is based on the assessments provided in section 11.7.3.2.7, and 11.7.3.2.8 for cumulative disturbance effects due to all noisy activities, which have a residual effect of minor adverse for harbour porpoise, bottlenose dolphin, minke whale, and harbour seal, negligible to common dolphin and white-beaked dolphin, and minor to moderate adverse for grey seal (**Table 11-131**).

948. The potential for a barrier effect due to underwater noise during operation was assessed as having no effect (section 11.6.2.4), and therefore has not been considered within this CEA.

11.7.3.3.1 Magnitude of Impact at DBS East and DBS West In Isolation

949. It is important to note that the OWFs and other noise sources included in the CEA 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 or DBS West, the maximum underwater effect ranges for disturbance at other projects would not overlap with the maximum underwater effect ranges for disturbance at DBS East or DBS West during piling and construction. Therefore, there is no potential for underwater noise from DBS East or DBS West, other OWFs and noise sources to result in a barrier of movement to marine mammals. The potential magnitude of cumulative effect for a barrier to marine mammals, as a result of cumulative underwater noise effects, is low, due to the limited potential for any overlap in disturbance areas between projects.

11.7.3.3.2 Magnitude of Impact at DBS East and DBS West Together

950. The magnitude of impact for DBS East and DBS West together would be the same as for DBS West or DBS West in isolation. Therefore, the magnitude of cumulative barrier effect (from underwater noise), with the Projects together, is low for all species.

11.7.3.3.3 Significance of Effect

951. With the sensitivity of low to medium for all marine mammal species for barrier effects due to underwater noise, and the expected magnitude level of low (at worst), the effect significance for all marine mammal species would be **minor adverse** (not significant in EIA terms) (**Table 11-133**).

Table 11-133 Assessment of significance of the potential of a cumulative barrier effect for DBS East or DBS West Together

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significant	Mitigation	Residual affect
Harbour porpoise and minke whale	Medium	Low	Minor adverse	None required	Minor adverse
Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse		

11.7.3.3.4 Mitigation and Residual Significance of Effect

952. No mitigation is required for the potential for from cumulative underwater noise barrier effects. Therefore, the residual impact, taking into account good practice to reduce any risk of collisions with marine mammals, would be **minor adverse** (not significant in EIA terms) at DBS East and/or DBS West for all marine mammals.

11.7.3.4 Cumulative Impact 4: Increased Collision Risk with Vessels

953. As outlined in sections 11.6.1.6 and 11.6.2.5, the increased collision risk using a very precautionary approach, has an effect significance of **minor adverse** (with mitigation), with a low number of marine mammals at risk.

11.7.3.4.1 Magnitude of Impact at DBS East or DBS West In Isolation

954. There have been no known reported incidents of marine mammal collisions with OWF vessels. All OWFs vessels are expected to follow best practice measures to reduce the potential for collision with marine mammals, and therefore, with the low potential for collision, and the low to medium sensitivity of marine mammals to collision risk, all other projects are expected to have a low potential for increased vessel collision risk, with a similar effect significance to the Projects. Therefore, the magnitude of impact for cumulative vessel collision risk, with DBS East or DBS West in isolation, is low to medium.

11.7.3.4.2 Magnitude of Impact at DBS East and DBS West Together

955. The expected magnitude for collision risk would be low to medium for all species and the significance of effect for the Projects in isolation is seen as more representative. As such, the magnitude would be considered as low to medium for all species.

11.7.3.4.3 Significance of Effect

956. Taking into account the low to medium marine mammal sensitivity and the potential magnitude of impact, the significance of effect for any potential increased collision risk as a result of construction vessels without mitigation has been assessed as a precautionary **minor adverse** (not significant in EIA terms) for all marine mammals (**Table 11-134**).

957. However, as outlined above, this is precautionary, as it is unlikely that marine mammals would be at increased collision risk with vessels during construction, considering that vessels within the windfarms would be stationary for much of the time or very slow moving.

Table 11-134 Assessment of cumulative significance of effect for Increased Collision Risk with Vessels during Construction for DBS East and West In Isolation and Together

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significance
DBS East or DBS West			
Minke whale	Medium	Low	Minor adverse
Harbour porpoise, common dolphin, white-beaked dolphin and harbour seal	Low	Low	Minor adverse

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significance
Bottlenose dolphin and grey seal	Low	Low to medium	Minor adverse
DBS East and DBS West together			
Harbour porpoise, common dolphin and white-beaked dolphin	Low	Low	Minor adverse
Bottlenose dolphin and grey seal	Low	Low to medium	Minor adverse
Minke whale	Medium	Low	Minor adverse
Harbour seal	Low	Medium	Minor adverse

11.7.3.4.4 Mitigation and Residual Significance of Effect

958. No mitigation is required for the potential for increased collision risk due to cumulative projects. As outlined in section 11.6.1.4 and 11.6.2.5.6, vessel movements, where possible, would follow set vessel routes where available and hence areas where marine mammals are accustomed to vessels, in order to reduce any increased collision risk. These measures would be detailed within the PEMP as secured through a Deemed Marine Licence Condition.

959. The residual impact, taking into account good practice to reduce any risk of collisions with marine mammals, would be **minor adverse** (not significant in EIA terms) at either DBS East or DBS West Array Areas including the Offshore Export Cable Corridor for all marine mammals.

11.7.3.5 Cumulative Impact 5: Disturbance to Seal Haul-Outs

960. The sensitivity of grey seal and harbour seal to disturbance at haul-out sites is medium (see section 11.6.1.9.3 and 11.6.2.8.3).

961. As stated in section 11.6.1.9.3, the closest seal haul out site is 106km from the DBS East Array Area site and 25km from the Offshore Export Cable Corridor, there is therefore no potential for any direct disturbance as a result of construction activities from either DBS East or DBS West (including landfall and the export cable route).

11.7.3.5.1 Magnitude of Impact at DBS East or DBS West In Isolation

962. It is not expected that DBS East or DBS West would have any significant effect to seal at haul-out sites, with an effect significance of **minor adverse**. In addition, best practice measures would be implemented by DBS East or DBS West, such as reducing vessel transit speeds wherever practicable, and the avoidance of transiting within 1km of any seal haul-out site when outside official shipping channels.

963. It is assumed that all other projects 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. It is therefore considered that there would be limited potential for any cumulative disturbance effect at any seal haul-out site, and the cumulative effect magnitude would be negligible.

11.7.3.5.2 Magnitude of Impact at DBS East and DBS West together

964. For the Projects together, the same magnitude of impact would be expected as for DBS East or DBS West in isolation. Therefore, the cumulative magnitude for both the Projects with other projects, for the disturbance to seals at haul-out sites, is negligible.

11.7.3.5.3 Significance of Effect

965. With the sensitivity of medium for both seal species, and the expected magnitude level of negligible (at worst), the effect significance for cumulative disturbance at seal haul-out sites would be **minor adverse** (not significant in EIA terms), for DBS East and / or DBS West (**Table 11-135**).

Table 11-135 Assessment of effect significance for the potential for disturbance at seal haul-out sites

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significant	Mitigation	Residual effect
Grey seal and harbour seal	Medium	Negligible	Minor adverse	None required	Minor adverse

11.7.3.5.4 Mitigation and Residual Significance of Effect

966. No mitigation is required for the potential for cumulative disturbance at seal haul-out sites, over and above those that would be undertaken for the Project alone (see section 11.3.3). Therefore, the residual effect significance would be **minor adverse** (not significant in EIA terms).

11.7.3.6 Cumulative Impact 6: Changes to Prey Resources

967. For any potential changes to prey resources, it has been assumed that any potential effects on marine mammal prey species from underwater noise, including piling, would be the same or less than those for marine mammals. Therefore, there would be no additional cumulative effects other than those assessed for marine mammals, i.e., if prey is disturbed from an area as a result of underwater noise, marine mammals could be disturbed from the same or greater area. As a result, any changes to prey resources would not affect marine mammals as they would already be disturbed from the area.

968. Any effects to 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 for prey species in the surrounding area.

11.7.3.6.1 Magnitude of Impact for DBS East or DBS West In Isolation

969. Taking into account the assessment for DBS East or DBS West in isolation (sections 11.6.1.7.1.1 and 11.6.2.6.1), and assuming similar effects for other projects and activities, along with the range of prey species taken by marine mammals and the extent of their foraging ranges, there would be no potential for cumulative effect on marine mammal populations as a result of changes to prey resources. Therefore, the cumulative magnitude of impact is considered to be negligible (**Table 11-136**).

11.7.3.6.2 Magnitude of Impact for DBS East and DBS West Together

970. Taking into consideration the assessment for DBS East and DBS West together (sections 11.6.1.7.1.2 and 11.6.2.6.4), the significance of effect would be the same as DBS East and DBS West constructed individually, see section 11.7.3.5.1 and **Table 11-136**.

11.7.3.6.3 Significance of Effect

971. With the sensitivity of low to medium for harbour porpoise, minke whale, grey and harbour seal, and low for bottlenose dolphin, common dolphin and white-beaked dolphin and the expected magnitude level of negligible (at worst), the effect significance for all marine mammal species would be **negligible to minor adverse** (not significant in EIA terms) (**Table 11-136**).

Table 11-136 Assessment of effect significance for the potential changes to prey resources

Marine mammal species	Sensitivity	Magnitude of impact	Potential effect significant	Mitigation	Residual effect
Harbour porpoise, minke whale, grey seal and harbour seal	Low to Medium	Negligible	Negligible to minor adverse	None required	Negligible to minor adverse
Bottlenose dolphin, common dolphin and white-beaked dolphin	Low	Negligible	Negligible adverse		Negligible adverse

11.7.3.6.4 Mitigation and Residual significance of effect

972. No mitigation is required for the potential for cumulative effects on prey species; therefore, the residual effect for all marine mammal species would be **negligible to minor adverse** (not significant in EIA terms).

11.8 Potential Monitoring and Mitigation Requirements

973. Monitoring requirements are described in the **Volume 8, In-Principal Monitoring Plan (IPMP) (application ref: 8.23)** submitted alongside the DCO application, which will be further developed and agreed with stakeholders prior to construction, taking account of the final detailed design of the Projects.

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

- Piling
  - Following the Statutory nature conservation agency protocol for minimising the risk of injury to marine mammals from piling noise (JNCC 2010b).
  - Following the Statutory nature conservation agency guidance for the use of Passive Acoustic Monitoring in UK waters for minimising the risk of injury to marine mammals from offshore activities (JNCC 2023b)

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

976. Mitigation and monitoring will be secured through the following management plans (**Table 11-137**). **Volume 8, Outline MMMP (application ref: 8.25)** for both piling and UXO clearance and In-Principle Southern North Sea SAC **Volume 8, Site Integrity Plan (SIP) (application ref: 8.26)** are submitted with the DCO application.

Table 11-137 Additional Mitigation

Parameter	Additional mitigation measures
MMMP for Piling Activities	The MMMP for piling will be developed in the pre-construction period and be based upon best available information, methodologies, industry best practice, latest scientific understanding, current guidance and detailed project design as described in **Table 11-4**.
Southern North Sea SAC SIP	In addition to the MMMPs for piling and UXO clearance, a Southern North Sea SAC SIP will be developed as stated **Table 11-4**.

977. Mitigation will be required for any potential UXO clearance but a separate Marine Licence would be submitted following a detailed UXO survey prior to construction, and a detailed assessment based on that latest available information (including potential UXO locations, size, type, and number) has been undertaken. Mitigation will be required, and will use the relevant JNCC guidelines as standard (the relevant guidelines are noted below):

- Following the JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC 2010a).

978. A detailed MMMP will be prepared for UXO clearance during the pre-construction phase. The MMMP for UXO clearance will ensure there is adequate mitigation to minimise the risk of any physical or permanent auditory injury to marine mammals as a result of UXO clearance as much as is practicable. The MMMP for UXO clearance will be developed in the pre-construction period, when there is more detailed information on the UXO clearance which could be required and the most suitable mitigation, based upon best available information and methodologies at that time, in consultation with the MMO and relevant SNCBs.

979. 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.

11.9 Transboundary Effects

980. The highly mobile nature of marine mammals included within this assessment means that there is the potential for transboundary impacts. This has been taken into account throughout the assessment, as the study area for each species is based on their relevant MU (or area within which the same individuals are considered to part of one larger overall population). The MUs (and therefore reference populations) for each species covers an area wider than the UK (**Table 11-138**). This approach has been taken through all of the assessments.

Table 11-138 Other Countries Considered in the Marine Mammal Assessments Through the Relevant MU Reference Populations

Country	Marine mammal species	Inclusion within assessment
Germany	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Netherlands	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Belgium	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
France	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.

Country	Marine mammal species	Inclusion within assessment
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Denmark	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Sweden	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for common dolphin, white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.
Norway	Harbour Porpoise	Part of the North Sea MU for harbour porpoise.
	Bottlenose dolphin	Part of the Greater North Sea MU for bottlenose dolphin.

Country	Marine mammal species	Inclusion within assessment
	Common dolphin, White-beaked dolphin and minke whale	Part of the Celtic and Greater North Seas MU for both white-beaked dolphin and minke whale.
	Grey seal and harbour seal	Not part of the grey seal and harbour seal reference population area, and therefore no potential for transboundary impacts.

981. There is a substantial level of marine development being undertaken, and being planned, by other countries (including Belgium, the Netherlands, Germany and Denmark) in the southern North Sea. Each of these countries have their own independent environmental assessment requirements and controls. As noted above, marine mammals are highly mobile and there is therefore the potential for transboundary impacts, especially with regard to noise. In addition, if there is the potential for DBS East and/or DBS West to impact marine mammals from other designated sites; this has been assessed in the RIAA.

11.10 Interactions

982. The effects identified and assessed in this chapter have the potential to interact with each other. The areas of potential interaction between effects are presented in **Table 11-139**. This provides a screening tool for which effects have the potential to interact. **Table 11-139** provides an assessment for each receptor (or receptor group) as related to these impacts.

983. The worst-case impacts assessed within the chapter take these interactions into account, and therefore the impact assessments are considered conservative and robust. Synergistic impacts of potential disturbance from underwater noise during construction from all potential noise sources have been assessed as potential barrier effects in the following tables.

984. In **Table 11-139** the effects are assessed relative to each development phase to see if multiple effects could increase the significance of the effect upon a receptor. Following this a lifetime assessment is undertaken which considers the potential for an effect to affect receptors across all development phases; (assessment for construction, operation and maintenance or decommissioning) to determine if (for example) multiple construction impacts affecting the same receptor could increase the level of impact upon that receptor.

985. The significance of each individual impact is determined by the sensitivity of the receptor and the magnitude of impact; the sensitivity is constant whereas the magnitude may differ. Therefore, when considering the potential for impacts to be additive it is the magnitude of impact which is important – the magnitudes of the different effects are combined upon the same sensitivity receptor.

Table 11-139 Interactions Between Impacts - Screening

Potential Interactions between Impacts									
Construction									
	Impact 1	**Impact 2**	**Impact 3**	**Impact 4**	**Impact 5**	**Impact 6**	**Impact 7**	**Impact 8**	**Impact 9**
Impact 1: Permanent and Temporary Auditory Injury from Underwater Noise during Piling		Yes	Yes	Yes	Yes	No	No	No	No
Impact 2: Disturbance or Behavioural Effects from Underwater Noise during Piling	Yes		Yes	Yes	Yes	No	No	No	No
Impact 3: TTS and Disturbance from Underwater Noise during other construction activities	Yes	Yes		Yes	Yes	No	No	No	No
Impact 4: TTS and Disturbance from Underwear Noise and presence of vessels	Yes	Yes	Yes		Yes	No	No	No	Yes
Impact 5: Barrier Effects as a Result of Underwater noise	Yes	Yes	Yes	Yes		No	No	No	No
Impact 6: Increased Collision Risk with Vessels	No	No	No	No	No		No	No	No
Impact 7: Changes to Prey Resources	No	No	No	No	No	No		Yes	No
Impact 8: Changes to Water Quality	No	No	No	No	No	No	Yes		No
Impact 9: Disturbance of Seals at Haul-Out Sites	No	No	No	Yes	No	No	No	No	

Potential Interactions between Impacts									
Operation									
	Impact 1	**Impact 2**	**Impact 3**	**Impact 4**	**Impact 5**	**Impact 6**	**Impact 7**	**Impact 8**	
Impact 1: Impacts from Underwater Noise Associated with Operational Wind Turbines		Yes	Yes	Yes	No	No	No	No	N/A
Impact 2: Impacts from Underwater Noise Associated with Operation and Maintenance Activities	Yes		Yes	Yes	No	No	No	No	
Impact 3: Impacts from Underwear Noise due to the presence of vessels	Yes	Yes		Yes	No	No	No	Yes	
Impact 4: Barrier Effects as A Result of Underwater noise	Yes	Yes	Yes		No	No	No	No	
Impact 5: Increased Collision Risk with Vessels	No	No	No	No		No	No	No	
Impact 6: Changes to Prey Resources	No	No	No	No	No		Yes	No	
Impact 7: Changes to Water Quality	No	No	No	No	No	Yes		No	
Impact 8: Disturbance of Seals at Haul-Out Sites	No	No	Yes	No	No	No	No		
Decommissioning									
It is anticipated that the decommissioning impacts will be no greater than construction									

Table 11-140 Interaction Between Impacts - Phase and Lifetime Assessment

Receptor	Highest Significance Level				
	Construction	**Operation**	**Decommissioning**	**Phase Assessment**	**Lifetime Assessment**
Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Minor to moderate adverse	Minor adverse	Minor adverse	***Construction*** The MMMP (for piling) will reduce the risk of injury for marine mammals, and therefore during piling there will be no pathway for interaction of potential injury with disturbance effects (i.e. all individuals are assumed to be disturbed if within range and excluded from the disturbance footprint). Likewise, there is no pathway for vessel interaction or effects on prey resource to interact with noise impacts as it is assumed that individuals will be excluded from the disturbance footprint (i.e., there cannot be a vessel interaction if the individual is excluded from the vicinity of the construction works). Once noisy activities have ceased the footprint of disturbance and changes to prey resource will be highly localised. It is therefore considered that the interaction of these impacts would not represent an increase in the significance level. ***Operation*** Operational noise impacts from wind turbines will be highly localised to within 0.1km of each wind turbine, whilst the majority of change to habitat for prey species will also be confined to the immediate footprint of wind turbine. The magnitude of impact is negligible and relates to largely the same spatial footprint. Therefore, there is no greater impact as a result of any interaction of these impacts. There is potential for interaction with maintenance noise disturbance and vessel interaction but given the negligible magnitudes of effect and episodic nature of these impacts it is not considered that that the interaction of these impacts would represent an increase in the significance level.	No greater than individually assessed impact. The greatest magnitude of impact will be the spatial footprint of construction noise (i.e., piling). Once this disturbance impact has ceased all further impact during construction and operation will be small scale, highly localised and episodic. There is no evidence of long-term displacement of marine mammals from operational wind farms. It is therefore considered that over the Projects lifetime these impacts would not combine and represent an increase in the significance level.

11.11 Inter-relationships

986. For marine mammals, there are clear inter-relationships between other topics. The marine sediment and water quality topic, and several other topics, have already been considered within this EIA. For the potential inter-relationships between other topics assessed within this EIA, including underwater noise form vessels, collision risk form vessels, changes to prey availability and changes to water quality, a summary of the potential inter-relationships is provided in **Table 11-141**.

Table 11-141 Marine Mammal Inter-Relationships

Topic and Description	Related Chapter (Volume 7)	Where Addressed in this Chapter	Rationale
Construction			
Underwater noise from vessels	Chapter 14 Shipping and Navigation	Section 11.6.1.4	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
Increased risk of collision with vessels	Chapter 14 Shipping and Navigation	Section 11.6.1.6	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
Changes to water quality	Chapter 8 Marine Physical Environment	Section 11.6.1.8	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Changes to prey resources	Chapter 11 Fish and Shellfish Ecology	Section 11.6.1.7	Potential effects on fish species could affect the prey resource for marine mammals.
Operation			
Underwater noise from vessels	Chapter 14 Shipping and Navigation	Section 11.6.2.3	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.

Topic and Description	Related Chapter (Volume 7)	Where Addressed in this Chapter	Rationale
Increased risk of collision with vessels	Chapter 14 Shipping and Navigation	Section 11.6.2.5	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
Changes to water quality	Chapter 8 Marine Physical Environment	Section 11.6.2.7	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Changes to prey resources	Chapter 10 Fish and Shellfish Ecology	Section 11.6.2.6	Potential effects on fish species could affect the prey resource for marine mammals.
Decommissioning			
Underwater noise from vessels	Chapter 14 Shipping and Navigation	Section 11.6.3	Increased vessel traffic associated with the Projects could affect the level of disturbance for marine mammals.
Increased risk of collision with vessels	Chapter 14 Shipping and Navigation	Section 11.6.3	Increased vessel traffic associated with the Projects could affect the level of collision risk for marine mammals.
Changes to water quality	Chapter 8 Marine Physical Environment	Section 11.6.3	Potential changes to water quality, such as increased SSC, could affect marine mammals directly or indirectly as a result of impacts on prey species.
Changes to prey resources	Chapter 10 Fish and Shellfish Ecology	Section 11.6.3	Potential effects on fish species could affect the prey resource for marine mammals.

11.12 Marine Wildlife Licence Application

987. A Marine Wildlife Licence application would be made to the Marine Management Organisation (MMO) for all activities that have the potential for injury or disturbance on EPS (cetaceans). The activities that may require an EPS licence are:

- Piling;
- UXO clearance; and
- Geophysical surveys.

988. Prior to these activities taking place, an EPS risk assessment would be undertaken, following the staged approach as outlined in '*The protection of Marine European Protected Species from injury and disturbance*' (JNCC *et al.* 2010). If it is deemed that an EPS licence is required for any activity, an EPS Risk Assessment document would be produced, and a Marine Wildlife Licence application submitted.

989. Mitigation will be put in place for piling and any required UXO clearance as per the JNCC guidelines. Where ADDs are required, these will also be considered within the risk assessments.

11.13 Summary

990. This chapter has provided a characterisation of the existing environment for marine mammals based on both existing and site specific survey data which has established that, with the identified mitigation in place, the overall significance of effects will be **negligible to minor adverse** (not significant in EIA terms) for either DBS East or DBS West in isolation, or for the Projects together, as summarised in **Table 11-142**.

991. For the potential cumulative effects, there is the potential for a **negligible to minor adverse** effect (not significant in EIA terms) for all cumulative impacts and species, with the exception of grey seal, with a **minor to moderate adverse** effect (significant in EIA terms) as a result of disturbance from other noisy activities **(Table 11-142**).

Table 11-142 Summary of Potential Likely Significant Effects on Marine Mammals

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Construction						
Impact 1a: PTS from underwater noise during piling due to a single strike at maximum hammer energy at a single location or at both locations concurrently	All marine mammal species	High	Negligible	Minor adverse	MMMP for piling will significantly reduce any potential for marine mammals to be within the PTS effect area.	Minor adverse
Impact 1a: PTS from underwater noise from sequential monopiles at a single location	Harbour porpoise and minke whale	High	Medium	Major adverse		Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse		Minor adverse
	Grey seal		Medium	Major adverse		Minor adverse
Impact 1a: PTS from underwater noise from sequential jacket pin piles at a single location	Harbour porpoise and minke whale	High	Medium	Major adverse	MMMP for piling will significantly reduce any potential for marine mammals to be within the PTS effect area.	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse		Minor adverse
	Grey seal		Low to medium	Moderate to major adverse		Minor adverse
Impact 1a: PTS auditory injury from underwater noise from sequential monopiles (or jacket pin piles) at both locations concurrently	Harbour porpoise, minke whale and grey seal	High	Medium	Major adverse		Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin		Negligible	Minor adverse		Minor adverse
	Harbour seal		Low	Moderate adverse		
Impact 1b: TTS auditory injury from underwater noise during piling due to a single strike at maximum hammer energy at single location or at both locations concurrently	All marine mammals	Medium	Negligible	Minor adverse	MMMP for piling will minimise TTS effects	Minor adverse
Impact 1b: TTS auditory injury from underwater noise during exposure at multiple sequential	Harbour porpoise and minke whale	Medium	DBS East & DBS West: Negligible Offshore Export Cable Corridor: Low	Minor adverse	MMMP for piling will minimise TTS effects	Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
monopiles at a single location	Grey seal		Low to medium	Minor to moderate adverse		
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		Negligible	Minor adverse		Minor adverse
Impact 1b: TTS auditory injury from underwater noise during piling exposure at multiple sequential jacket pin piles at a single location	Harbour porpoise	Medium	Low	Minor adverse	MMMP for piling will minimise TTS effects	Minor adverse
	Grey seal		Low to medium	Minor to moderate adverse		
	Bottlenose dolphin, common dolphin, white-beaked dolphin, and harbour seal		Negligible	Minor adverse		
	Minke whale		Low	Minor adverse		Minor adverse
Impact 1b: TTS auditory injury from underwater noise from multiple sequential monopiles at both locations concurrently	Harbour porpoise, minke whale and grey seal	Medium	Low	Minor adverse	MMMP for piling will minimise TTS effects	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, minke whale and harbour seal		Negligible	Minor adverse		
Impact 1b: TTS auditory injury from underwater noise from multiple sequential jacket pin piles at both locations concurrently	Harbour porpoise and minke whale	Medium	Low	Minor adverse	MMMP for piling will minimise TTS effects	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse		Minor adverse
	Grey seal		High (High)	Major adverse		Minor adverse
Impact 2: Disturbance or behavioural effects from underwater noise during piling at a single location or a concurrently at two locations	Harbour porpoise	Medium	Negligible	Minor adverse	No Mitigation required	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse		Negligible adverse
	Minke whale	Medium	Low	Minor adverse		Minor adverse
Impact 2: Reduction in foraging due to noise disturbance for a single piling event and two concurrent piling events	Harbour porpoise and minke whale	Medium	Low	Minor adverse	No Mitigation required	Minor adverse
	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse		Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 2: Disturbance or behavioural effects from ADDs	Common dolphin and white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse	No Mitigation required	Negligible adverse
	Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse
Impact 3a: TTS from underwater noise during other construction activities in isolation and together	All marine mammal species	Medium	Negligible	Minor adverse	No Mitigation required	Minor adverse
Impact 3b: Disturbance from underwater noise during other construction activities in isolation and together	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	No Mitigation required	Negligible to Minor adverse
	Common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse		
	Bottlenose dolphin	Low	Low	Minor adverse		
Impact 4a: TTS from underwater noise and presence of vessels in Array Areas in isolation and together	All marine mammal species	Medium	Negligible	Minor adverse	No Mitigation required	Minor adverse
Impact 4b: Disturbance from underwater noise and presence of vessels in Array Areas in isolation and together	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	Best Practice Measures in PEMP.	Minor adverse
	Common dolphin, white-beaked dolphin and harbour seal	Low	Negligible	Negligible adverse		Negligible adverse
	Grey seal		Low	Negligible to minor adverse		Negligible to minor adverse
	Bottlenose dolphin		Low to medium	Minor adverse		Minor adverse
Impact 4c: Disturbance from underwater noise and presence of vessels during transit	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	Best Practice Measures in PEMP.	Minor adverse
	Common dolphin, white-beaked dolphin and harbour seal	Low	Negligible	Negligible adverse		Negligible adverse
	Bottlenose dolphin and grey seal		Low	Minor adverse		Minor adverse
Impact 5: Barrier effects as a result of underwater noise during construction in isolation and together	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	No mitigation required.	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Minor adverse		Minor adverse
	Minke whale	Medium	Low	Minor adverse		Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 6: Increased collision risk and vessels during construction at Array Areas in isolation	Harbour porpoise, common dolphin and white-beaked dolphin	Low	Low	Minor adverse	Best Practice Measures in PEMP.	Minor adverse
	Bottlenose dolphin and grey seal	Low	Low to medium	Minor adverse		Minor adverse
	Harbour seal	Low	Medium	Minor adverse		Minor adverse
Impact 7: Changes to prey resources	Bottlenose dolphin, common dolphin and white-beaked dolphin, harbour seal and grey seal	Low	Negligible to low	Negligible to minor adverse	MMMP and SIP to reduce the potential impacts of underwater noise for marine mammals would also reduce the potential impacts on prey species.	Negligible to minor adverse
	Harbour porpoise and minke whale	Low to medium	Negligible to low	Negligible to minor adverse		
Impact 8: Changes to water quality	All marine mammal species	Negligible	Low	Negligible adverse	No mitigation required.	Negligible adverse
Impact 9: Disturbance to seal at haul-out sites from construction activities and from vessel activity areas at Array Areas in isolation and together	Grey seal and harbour seal	Low to medium	Negligible to low	Negligible to minor adverse	Best Practice Measures in PEMP.	Negligible to minor adverse
Operation						
Impact 1a: TTS due to operational wind turbines, from either a single wind turbine or all wind turbines at Array Areas in isolation and together	All marine mammal species	Medium	Negligible	Minor adverse	No mitigation required	Minor adverse
Impact 1b: Disturbance due to operational wind	Harbour porpoise, bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse	No mitigation required.	Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
turbines, from either a single wind turbine or all wind turbines at Array Areas in isolation and together	Minke whale	Medium	Low	Minor adverse		Minor adverse
Impact 2a: TTS due to maintenance activities at Array Areas in isolation and together	All marine mammals	Medium	Negligible	Minor adverse	No mitigation required	Minor adverse
Impact 2b: Disturbance due to maintenance activities at Array Areas in isolation and together	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	No mitigation required	Minor adverse
	Bottlenose dolphin (CES MU)	Low	Low	Minor adverse		Minor adverse
	Bottlenose dolphin (GNS MU)	Low	DBS East or DBS West: Negligible DBS East & DBS West: Low	Negligible to minor adverse		Negligible to minor adverse
	Common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Low	Negligible	Negligible adverse		Negligible
Impact 3a: TTS from underwater noise and presence of vessels at Array Areas in isolation	Harbour porpoise, common dolphin, white-beaked dolphin, minke whale, grey seal and harbour seal	Medium	Negligible	Minor adverse	No mitigation required	Minor adverse
	Bottlenose dolphin	Medium	Negligible to low	Minor adverse		
Impact 3b: Disturbance from underwater noise and presence of vessels at Array Areas in isolation	Harbour porpoise and minke whale	Medium	Negligible to low	Minor adverse	Best Practice Measures in PEMP.	Minor adverse
	Bottlenose dolphin	Low	Low to medium	Minor adverse		Minor adverse
	Common dolphin and white-beaked dolphin		Negligible to low	Negligible to minor adverse		Negligible to minor adverse
	Grey seal		Medium	Minor adverse		Minor adverse
	Harbour seal		Negligible	Negligible		Negligible adverse
Impact 3c: Disturbance from underwater noise and presence of vessels during transit	Harbour porpoise and minke whale	Medium	Low	Minor adverse	Best Practice Measures in PEMP.	Minor adverse
	Common dolphin and white-beaked dolphin	Low	Low	Minor adverse		Minor adverse
	Bottlenose dolphin and grey seal		Medium	Minor adverse		Minor adverse
	Harbour seal		Negligible	Negligible adverse		Negligible adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
Impact 4: Barrier effects as a result of underwater noise during construction	Harbour porpoise, minke whale, bottlenose dolphin, common dolphin and white-beaked dolphin, harbour seal and grey seal	Low	No impact	No impact	No mitigation required	No impact
Impact 5: Increased collision risk and vessels during construction at Array Areas in isolation	Harbour porpoise and white-beaked dolphin	Low	Negligible	Negligible adverse	Best Practice Measures in PEMP.	Negligible adverse
	Bottlenose dolphin		Low to medium	Minor adverse		Minor adverse
	Common dolphin		Low	Negligible to minor adverse		Negligible to minor adverse
	Minke whale	Medium	Negligible	Minor adverse		Minor adverse
	Grey seal and harbour seal	Low	Low	Minor adverse		Minor adverse
Impact 6: Changes to prey resources	Harbour porpoise minke whale, grey seal and harbour seal	Low to Medium	Negligible to low	Negligible to minor adverse	No mitigation required	Negligible to minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low				
Impact 7: Changes to water quality	All marine mammal species	Negligible	Negligible	Negligible adverse	No mitigation required.	Negligible adverse
Impact 8: Disturbance to seal haul-out sites from O&M activities	Grey seal and harbour seal	Low to Medium	Negligible to low	Negligible to minor adverse	Best Practice Measures in PEMP.	Negligible to minor adverse
Decommissioning						
Impact 1a: PTS or TTS from underwater noise	Harbour porpoise, minke whale and grey seal	High	Negligible to medium	Minor to major adverse	MMMP as required.	To be determined prior to decommissioning
	Bottlenose dolphin, common dolphin and white-beaked dolphin		Negligible	Minor adverse		
	Harbour seal		Negligible to low	Moderate adverse		
Impact 1b: TTS from underwater noise	Harbour porpoise	Medium	Negligible to low	Minor adverse	MMMP for piling will minimise TTS effects.	To be determined prior to decommissioning
	Bottlenose dolphin, common dolphin, white-beaked dolphin and harbour seal		Negligible	Minor adverse		
	Minke whale		Negligible to low	Minor adverse		
	Grey seal		Negligible to High	Minor to major adverse		
Impact 2: Disturbance from underwater noise	Harbour porpoise	Medium	Negligible to low	Minor adverse	No mitigation required.	To be determined prior
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible to low	Negligible to minor adverse		

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
	Minke whale	Medium	Low	Minor adverse		to decommissioning
Impact 3: Disturbance from underwater noise, presence and movements of vessels	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	Best Practice Measures in PEMP.	To be determined prior to decommissioning
	Common dolphin, white-beaked dolphin and harbour seal	Low	Negligible	Negligible adverse		
	Grey seal		Low	Minor adverse		
	Bottlenose dolphin		Low to medium	Minor adverse		
Impact 4: Barrier effect from underwater noise	Harbour porpoise and minke whale	Medium	Negligible	Minor adverse	No mitigation required.	To be determined prior to decommissioning
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Negligible	Negligible adverse		
Impact 5: Increased collision risk with vessels	Minke whale	Medium	Low	Minor adverse	Best Practice Measures in PEMP.	To be determined prior to decommissioning
	Harbour porpoise, common dolphin and white-beaked dolphin	Low	Low	Minor adverse		
	Bottlenose dolphin and grey seal		Low to medium	Minor adverse		
Impact 6: Changes to prey resource	All marine mammal species	Low to Medium	Negligible to low	Negligible to minor adverse	No mitigation required.	To be determined prior to decommissioning
Impact 7: Changes to water quality	All marine mammal species	Negligible	Low	Negligible adverse	No mitigation required.	To be determined prior to decommissioning
Impact 8: Disturbance of seals at haul-out sites	Grey seal and harbour seal	Low to medium	Negligible to low	Negligible to minor adverse	Best Practice Measures in PEMP.	To be determined prior to decommissioning
Cumulative effects						
Cumulative Impact 1: Assessment of underwater noise from piling at other OWFs	Harbour porpoise	Medium	Negligible	Minor adverse	None required	Minor adverse
	Bottlenose dolphin	Low	Negligible	Negligible adverse		Negligible adverse
	Common dolphin	Low	No cumulative impact	No impact		No impact
	White-beaked dolphin	Low	Low	Minor adverse		Minor adverse
	Minke whale	Medium	Low	Minor adverse		Minor adverse

Potential Impact	Receptor	Sensitivity	Magnitude of Impact	Pre-mitigation Effect	Mitigation Measures Proposed	Residual Effect
	Grey seal and harbour seal	Low	Negligible	Negligible adverse		Negligible adverse
Cumulative Impact 2: Assessment of disturbance from other industries and activities	Harbour porpoise and minke whale	Medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin	Low	Low	Minor adverse		Minor adverse
	Common dolphin and white-beaked dolphin		Negligible	Negligible adverse		Negligible adverse
	Grey seal	Low	Low	Minor adverse		Minor adverse
	Harbour seal		Medium	Minor adverse		Minor adverse
Cumulative Impact 3: cumulative barrier effects from disturbance of OWF	Harbour porpoise and minke whale	Medium	Low	Minor adverse	None required	Minor adverse
	Bottlenose dolphin, common dolphin, white-beaked dolphin, grey seal and harbour seal	Low	Low	Minor adverse		Minor adverse
Cumulative Impact 4: Increased collision risk with vessels	Minke whale	Medium	Low	Minor adverse	None required	Minor adverse
	Harbour porpoise, common dolphin, white-beaked dolphin and harbour seal	Low	Low to medium	Minor adverse		Minor adverse
	Bottlenose dolphin and grey seal	Low	Low to medium	Minor adverse		Minor adverse
Cumulative Impact 5: Disturbance to seal haul-outs	Grey seal and harbour seal	Medium	Negligible	Minor adverse	None required	Minor adverse
Cumulative Impact 6: Changes to prey resources	Harbour porpoise, minke whale, grey seal and harbour seal	Low to Medium	Negligible	Negligible to minor adverse	None required	Negligible to minor adverse
	Bottlenose dolphin, common dolphin and white-beaked dolphin	Low	Negligible	Negligible adverse		Negligible adverse

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