MarineSpace

Making Sense of the Marine Environment ™

Habitats Regulations Assessment: Report to Inform Appropriate Assessment



Document Ref: J/5/24/20	Originator: Damien Kirby
Date: 06/12/2021	Circulation: Restricted - Commercial-in-confidence

Habitats Regulations Assessment: Report to Inform Appropriate Assessment

Prepared by:

MarineSpace Ltd

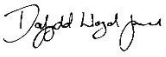
MarineSpace
Making Sense of the Marine Environment ™

MarineSpace Ltd
Ocean Village Innovation Centre
Ocean Way
Southampton
SO14 3JZ

Prepared for:

Blue Gem Wind

Blue Gem Wind Ltd
Bridge Innovation Centre
Pembrokeshire Science and Technology Park
Pembroke Dock
Wales
SA72 6UN

Date	Originator	Version	Action	Signature
26/10/2021	Liam Porter	0.1	Internal Draft	
08-14/11/2021	Ian Reach	0.2	Technical Review	
16/11/2021	Liam Porter	0.3	Internal Draft	
16/11/2021	Ian Reach	0.4	Technical Review	
17/11/2021	Dafydd Lloyd Jones	0.5	Editorial Review	
21/11/2021	Ian Reach	0.6	Technical Review	
03/12/2021	Liam Porter	0.7	Internal Draft - Addressing Client / Regulator Comments	
04/12/2021	Damien Kirby	0.8	Internal Draft - Addressing Client / Regulator Comments	
05/12/2021	Ian Reach	0.9	Technical Review / Editorial Review	
14/12/2021	Jonny Lewis	1.0	Director Sign-off / External Document	

Any reproduction must include acknowledgement of the source of the material. This report should be cited as:

MarineSpace Ltd, 2021. *Habitats Regulations Assessment: Report to Inform Appropriate Assessment.*

All advice or information presented in this report from MarineSpace Ltd is intended only for use in the UK by those who will evaluate the significance and limitations of its contents and take responsibility for its use and application. No liability (including that for negligence) for any loss resulting from such advice or information is accepted by MarineSpace Ltd, subcontractors, suppliers or advisors.

The cover image of a floating offshore wind unit sourced from Simply Blue Energy (2021) ©. All rights reserved.

Data Licenses

© Crown Copyright 2021. All rights reserved.

Charts NOT TO BE USED FOR NAVIGATION.

Executive Summary

The proposed Project is a demonstration scale Floating Offshore Wind (FLOW) development in the Celtic Sea region. The Applicant, Blue Gem Wind (BGW), is a joint venture between Simply Blue Energy (SBE) and TotalEnergies, set up to create a new low carbon offshore energy sector in the region that contributes to climate change mitigation targets, supply chain diversification and energy security.

As a test and demonstration development, the Erebus Project is the first in the Applicant's 'stepping-stone approach' for FLOW in the Celtic Sea. This stepping-stone approach is the best way to increase learning and to maximise the opportunities to the local economy for this technology, by starting with smaller demonstration projects, such as the Project, before moving incrementally to larger commercial scale projects in the 2030s. This will provide local, Welsh and UK supply chain companies with the greatest chance to grow with the sector as it expands globally; it will also maximise knowledge transfer and facilitate a sustainable transfer to a low carbon economy.

This Report to Inform Appropriate Assessment (RIAA) has been drafted to provide the information necessary to undertake an Appropriate Assessment (AA) as part of the determination process for the Section 36 consent with deemed planning permission under the Electricity Act 1989 from Welsh Ministers, administered by Planning and Environment Decisions Wales (PEDW), and a Marine Licence under the Marine and Coastal Access Act 2009 (MCAA) issued by Natural Resources Wales (NRW). As such, this RIAA (and associated technical appendices) presents the conclusions for the potential for the proposed Project to result in a Likely Significant Effect (LSE), and where LSE cannot be ruled out, whether or not an Adverse Effect on Site Integrity (AEOSI) can be ruled out for the Project, alone, and in-combination, with other reasonably foreseeable plans and projects.

The document covers both the marine and terrestrial elements of the Project, as follows:

- Background of the Project and overview of the HRA process (Section 1);
- Consultation and Scoping (Section 2);
- Detailed description of the project and maximum-case Project Design Envelope (PDE) (Section 3);
- Embedded mitigation specific to each receptor or receptor group (Section 4);
- Details outlining the approach taken to conduct the RIAA (Section 5);
- Assessment of potential pressures on Natura 2000 sites or Ramsar Sites with marine components alone or in-combination (Sections 6-9);
- Assessment of potential pressures on terrestrial Natura 2000 or Ramsar Sites either alone or in combination (Sections 10-12);
- Consideration of Marine Conservation Zone (MCZ) grey seal species Feature of Conservation Interest (FOCI) (Section 13).

Where there is credible evidence that there is no risk that the Project activities are 'likely to have a significant effect' on designated features of a Natura 2000, National Site or Ramsar site by undermining its conservation objective(s), these features have been screened out of assessment, and require no further assessment within the RIAA. Where such determination has been concluded, the justification is noted within the relevant receptor chapters.

If any credible impact pathway is identified, or there is reasonable doubt whether the Project will, or will not, result in LSE, in view of the conservation objectives, then the respective site and feature has been screened into the HRA Stage 2 Integrity Test, and assessed in the RIAA to enable the competent authorities to conduct the Appropriate Assessment (AA).

The assessment of the potential for an AEOSI is carried out in two parts, the first being an assessment of the potential for the Project alone to result in an adverse effect, drawing on the respective worst-case Project Design Envelope (PDE) Scenario for the designated feature or classified population being assessed (Section 3). The assessment alone (presented in the first component of Sections 6-12) concluded that, with the application of appropriate mitigation as detailed in Section 4, there would be no AEOSI as a result of the construction, operation and decommissioning of the Project.

Following the assessment of the project alone, the second component of Sections 6-12 presents the assessment of the potential for an AEOSI from the Project in-combination with other relevant and reasonably foreseeable plans and projects which may impact on each site being assessed. This assessment concluded that there would be no AEOSI as a result of the construction, operation and decommissioning of the Project in-combination with the relevant and reasonably foreseeable plans and projects.

Contents

1. Introduction 1-1
1.1. Project Background 1-1
1.2. Purpose of this Document 1-1
1.3. Habitats Regulations Process and the United Kingdom's Exit from the European Union 1-2
1.3.1. Habitats Regulations Site Designations 1-3
1.4. Habitats Regulations Assessment Legislation 1-3
2. Consultation and Scoping 2-1
3. Detailed Project Description 3-1
3.1. Introduction 3-1
3.2. Project Description 3-1
3.3. Consideration of Alternative Solutions 3-2
3.4. Construction Programme 3-3
3.4.1. Offshore Construction Activities 3-3
3.4.2. Onshore Construction Activities 3-10
3.5. Operation and Maintenance Programme 3-12
3.5.1. Offshore Operation and Maintenance 3-12
3.5.2. Cable Repairs/Remediation 3-13
3.5.3. Onshore Operation and Maintenance 3-16
3.6. Decommissioning Programme 3-17
4. Embedded Mitigation 4-1
4.1. Annex I Benthic Habitats 4-1
4.1.1. Standard Mitigation 4-1
4.1.2. Additional Mitigation 4-2
4.2. Annex II Migratory Fish 4-2
4.2.1. Standard Mitigation 4-2
4.2.2. Additional Mitigation 4-2
4.3. Annex II Marine Mammals 4-3
4.3.1. Standard Mitigation 4-3
4.3.2. Additional Mitigation 4-3
4.4. Annex I and Migratory Seabirds 4-4
4.4.1. Standard Mitigation 4-4
4.4.2. Additional Mitigation 4-4
4.5. Annex I Terrestrial Habitats 4-5

4.5.1. Standard Mitigation....4-5
4.5.2. Additional Mitigation....4-6
4.6. Annex II Terrestrial Mammals....4-7
4.6.1. Standard Mitigation....4-7
4.6.2. Additional Mitigation....4-8
4.7. Annex I Terrestrial Birds....4-9
4.7.1. Standard Mitigation....4-9
4.7.2. Additional Mitigation....4-9

5. Overview of Habitats Regulations Assessment Screening....5-1
5.1. Special Areas of Conservation and Features Screened In....5-4
5.2. Special Protection Areas and Features Screened In....5-8

6. Annex I Benthic Habitats Assessment....6-11
6.1. Introduction....6-11
6.1.1. Summary of Screening....6-11
6.1.2. Summary of Potential Pressure Pathways....6-12
6.2. Project Design Envelope Parameters Relevant to Annex I Benthic Habitats....6-14
6.3. Approach to Assessment....6-17
6.4. Offshore and Intertidal Surveys....6-18
6.4.1. Baseline Surveys....6-18
6.4.2. Annex I Habitat Assessment....6-20
6.5. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation....6-23
6.5.1. Site Details....6-23
6.5.2. Assessment of Adverse Effects Alone....6-31
6.5.3. Assessment of Adverse Effects In-combination....6-58
6.5.4. Summary....6-71
6.6. Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru Special Area of Conservation....6-71
6.6.1. Site Details....6-71
6.6.2. Assessment of Adverse Effects Alone and In-combination....6-73

7. Annex II Migratory Fish Assessment....7-1
7.1. Introduction....7-1
7.1.1. Summary of Screening....7-1
7.1.2. Summary of Potential Pressure Pathways....7-2
7.2. Project Design Envelope Parameters Relevant to Annex II Migratory Fish....7-4
7.3. Approach to Assessment....7-9
7.4. Underwater Noise Modelling....7-9
7.5. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation....7-11

7.5.1. Site Details 7-11
7.5.2. Assessment of Adverse Effects Alone 7-14
7.5.3. Assessment of Adverse Effects In-combination 7-29
7.5.4. Summary 7-39
7.6. Afonydd Cleddau/Cleddau Rivers Special Area of Conservation 7-40
7.6.1. Site Details 7-40
7.6.2. Assessment of Adverse Effects Alone and In-combination 7-43
7.7. Summary 7-43

8. Annex II Marine Mammals Assessment 8-1
8.1. Introduction 8-1
8.1.1. Summary of Screening 8-1
8.1.2. Summary of Potential Pressure Pathways 8-1
8.2. Project Design Envelope Parameters Relevant to Annex II Marine Mammals 8-2
8.3. Approach to Assessment 8-6
8.4. Digital Aerial Surveys and Modelling 8-8
8.4.1. Underwater Noise Modelling 8-8
8.5. Cetaceans 8-10
8.5.1. West Wales Marine/Gorllewin Cymru Forol Special Area of Conservation 8-10
8.5.2. Cardigan Bay/Bae Ceredigion Special Area of Conservation 8-50
8.5.3. Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau Special Area of Conservation 8-85
8.6. Pinnipeds 8-90
8.6.1. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation 8-90

9. Special Protection Areas with Marine Components Assessment 9-1
9.1. Introduction 9-1
9.1.1. Summary of Screening 9-1
9.1.2. Summary of Potential Pressure Pathways 9-7
9.2. Project Design Envelope Parameters Relevant to Offshore Ornithological Features 9-7
9.3. Approach to Assessment 9-10
9.4. Digital Aerial Surveys and Modelling 9-10
9.4.1. Digital Aerial Survey Data Collection 9-11
9.4.2. Additional Data 9-11
9.4.3. Apportioning and Seasonal Biologically Defined Minimum Population Scales 9-13
9.4.4. Displacement Analysis 9-16
9.4.5. Collision Risk Modelling 9-21
9.4.6. Population Viability Analysis 9-21

9.5. Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro Special Protection Area 9-22
9.5.1. European Storm-Petrel *Hydrobates pelagicus* 9-23
9.5.2. Lesser Black-Backed Gull *Larus fuscus* 9-23
9.5.3. Manx Shearwater *Puffinus puffinus* 9-24
9.5.4. Atlantic Puffin *Fratercula arctica* 9-25
9.5.5. Breeding Seabird Assemblage 9-26
9.5.6. Assessment of Adverse Effects Alone 9-27
9.5.7. Assessment of Adverse Effects In-combination 9-52
9.6. Grassholm Special Protection Area 9-69
9.6.1. Northern Gannet *Morus bassanus* 9-70
9.6.2. Assessment of Adverse Effects Alone 9-70
9.6.3. Assessment of Adverse Effects In-combination 9-79
9.7. Irish Sea Front Special Protection Area 9-82
9.7.1. Manx Shearwater *Puffinus puffinus* 9-83
9.7.2. Assessment of Adverse Effects Alone 9-84
9.7.3. Assessment of Adverse Effects In-combination 9-86
9.7.4. Summary 9-86
9.8. Balearic Shearwater 9-86
9.8.1. Displacement 9-86
9.9. Migratory Populations 9-87
9.9.1. Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro Special Protection Area 9-87
9.9.2. Special Protection Areas with Overwintering Qualifying Features 9-87

10. Annex I Onshore Habitats Assessment 10-1
10.1. Introduction 10-1
10.2. Project Details 10-1

11. Annex II Onshore Mammals Assessment 11-1
11.1. Introduction 11-1
11.2. Onshore Field Surveys 11-1
11.3. Project Details 11-1
11.4. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation 11-3
11.4.1. Site Details 11-3
11.4.2. Assessment of Adverse Effects Alone 11-6
11.4.3. Assessment of Adverse Effects In-combination 11-8
11.4.4. Summary 11-8

11.5. Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru Special Area of Conservation 11-9
11.5.1. Site Details 11-9
11.5.2. Assessment of Adverse Effects Alone 11-11
11.5.3. Assessment of Adverse Effects In-combination 11-14
11.5.4. Summary 11-15
11.6. Pembrokeshire Bat Sites and Bosherton Lakes/Safleoedd Ystlum Sir Benfro a Llynnoedd Bosherton Special Area of Conservation 11-16
11.6.1. Site Details 11-16
11.6.2. Assessment of Adverse Effects Alone 11-18
11.6.3. Assessment of Adverse Effects In-combination 11-21
11.6.4. Summary 11-22
12. Annex I Terrestrial Birds Assessment 12-1
12.1. Introduction 12-1
12.2. Onshore Field Surveys 12-1
12.3. External Data Consultation 12-1
12.4. Castlemartin Coast Special Protection Area 12-2
12.4.1. Site Details 12-2
12.4.2. Assessment of Adverse Effects Alone 12-3
12.4.3. Assessment of Adverse Effects In-combination 12-4
12.4.4. Summary 12-4
13. Consideration of MCZ Assessment Outcomes 13-1
14. References 14-1

List of Figures

Figure 3.1: Indicative development and installation programme for the Project 3-3
Figure 6.1: Location of Sites screened in for the next stage of the assessment for the Project in relation to Annex I Benthic Habitats 6-12
Figure 6.2: Project export cable corridor (intertidal area) with burial classification category and spatial extent of Annex I habitats 6-33
Figure 6.3: Project export cable corridor (KP0-KP6.5) with burial classification category and spatial extent of Annex I habitats 6-34
Figure 6.4: Project export cable corridor (KP6.5-KP10.5) with burial classification category and spatial extent of Annex I habitats 6-35

Figure 6.5: Daily average net sediment transport rate and direction over a representative mean spring-neap cycle as determined by numerical sediment transport modelling outputs. The crest lines of larger sandwave features are shown by white lines, and areas identified as exposed rock substrate are illustrated by black hatched areas (From: ABPmer, 2021).....6-53

Figure 7.1: Location of sites screened in for the next stage of the assessment for the Project in relation to Annex II migratory fish species. 7-3

Figure 8.1: Overlap between 5 dB SELss noise contours and the West Wales Marine SAC.....8-25

Figure 8.2: Spatial extent of 5 dB SEL_{ss} noise contours and the Cardigan Bay SAC. Note: there is no direct overlap with the SAC.....8-64

Figure 8.3: Overlap between 5 dB SELss noise contours and the Pembrokeshire Marine SAC.....8-103

Figure 9.1: Median population trajectory and 95% confidence intervals for the Skomer, Skokholm and Seas off Pembrokeshire classified population of common guillemot.....9-43

Figure 9.2: Median population trajectory and 95% confidence intervals for the Grassholm SPA classified population of northern gannet.....9-78

List of Tables

Table 2.1: Summary of consultation responses received on the Habitats Regulations Assessment screening report and actions taken in this report in order to address the comments 2-2

Table 3.1: Predicted duration of and vessel utilisation during offshore construction activities.....3-8

Table 3.2: Estimated dimension of onshore construction compounds.....3-10

Table 3.3: Key parameters with respect to the onshore construction activities.....3-12

Table 3.4: Summary of typical repairs and Project operating modes over time 3-13

Table 3.5: Summary of cable repair/remediation included in PDE.....3-15

Table 5.1: Criteria used for identification of Natura 2000 and Ramsar sites 5-1

Table 5.2: High level overview of potential broad pressure pathways identified via the Habitats Regulations Assessment screening exercise 5-2

Table 5.3: Special Areas of Conservation and relevant features screened into the assessment 5-4

Table 5.4: Special Protected Areas and relevant screened into the assessment 5-8

Table 6.1: Project realistic worst-case scenario parameters for use in assessment of potential for adverse effects on designated Annex I benthic habitats within Pembrokeshire Marine Special Area of Conservation 6-14

Table 6.2: Summary of site-specific surveys undertaken to characterise the baseline for benthic ecology 6-19

Table 6.3: Criteria for assessment of stony reef (Irving, 2009).....6-21

Table 6.4: Characteristics of *Sabellaria spinulosa* reef (Gubbay, 2007) 6-22

Table 6.5: Interaction between export cable corridor and Annex I habitats. Cells highlighted blue represent locations where rock protection may be required within sections where Annex I habitat has been identified 6-38

Table 6.6: Developments considered within the benthic Annex I Habitats in-combination Assessment. Project details included for reference 6-59

Table 7.1: Project realistic worst-case scenario parameters for use in assessment of potential for adverse effects on designated Annex II migratory fish populations.....7-4

Table 7.2: Summary of the impact ranges from Popper *et al.* (2014) for shipping and continuous noise, covering the different construction noise sources for fish (with a swim bladder involved in hearing).....7-18

Table 7.3: Developments considered within the Annex II Migratory fish in-combination assessment. Erebus Project details included for reference.....7-30

Table 8.1: Project realistic worst case scenario parameters for use in assessment of potential for adverse effects on designated Annex II marine mammal populations 8-2

Table 8.2: Potential pressures from the Project in relation to the conservation objectives of the West Wales Marine/Gorllewin Cymru Forol SAC.....8-13

Table 8.3: PTS-onset impact ranges and number of harbour porpoise predicted to experience PTS-onset for low order UXO detonation 8-15

Table 8.4: PTS-onset impact ranges and number of harbour porpoise predicted to experience PTS-onset for high order UXO detonation 8-16

Table 8.5: PTS-onset impact ranges for impact piling – worst-case (800 kJ).....8-18

Table 8.6: Summary of the source level (SEL_{cum} dB re 1 µPa @ 1 m RMS) and PTS-onset impact ranges (m) for the different construction noise sources using the non-impulsive criteria from Southall *et al.* (2019) for marine mammals assuming a stationary receptor or a fleeing receptor.....8-20

Table 8.7: Estimated area of West Wales Marine SAC that harbour porpoise could potentially be disturbed from during UXO clearance 8-22

Table 8.8: Interaction between 5 dB SEL_{ss} noise contours and West Wales Marine SAC; dose-response curve values provided to allow determination of area of the SAC impacted ..8-23

Table 8.9: Disturbance impact for impact piling using the dose-response approach 8-24

Table 8.10: Potential disturbance to harbour porpoise associated with other construction activities at Project Erebus 8-27

Table 8.11: Summary of the maximum areas of displacement of harbour porpoise due to pressures on prey resources resulting from temporary and long-term habitat loss 8-35

Table 8.12: Assessment of potential for pressure pathways to result in in-combination adverse effects 8-38

Table 8.13: Tiers for projects considered in the in-combination assessment 8-42

Table 8.14: Projects screened into the in-combination assessment for harbour porpoise 8-43

Table 8.15: In-combination assessment of disturbance to harbour porpoise feature of West Wales Marine/Gorllewin Cymru Forol SAC. 8-46

Table 8.16: In-combination assessment of increased collision for harbour porpoise feature of West Wales Marine/Gorllewin Cymru Forol SAC 8-48

Table 8.17: Operations which may cause deterioration or disturbance to the features of the Cardigan Bay SAC (Source: NRW, 2018d) 8-52

Table 8.18: PTS-onset impact ranges and number of bottlenose dolphin predicted to experience PTS-onset for low order UXO detonation 8-56

Table 8.19: PTS-onset impact ranges and number of bottlenose dolphin predicted to experience PTS-onset for high order UXO detonation 8-57

Table 8.20: PTS-onset impact ranges for bottlenose dolphin from impact piling – worst-case (800 kJ) 8-58

Table 8.21: Summary of the source level (SEL_{cum} dB re 1 µPa @ 1 m RMS) and PTS-onset impact ranges (m) for the different construction noise sources using the non-impulsive criteria from Southall *et al.* (2019) for HF cetaceans (dolphins) assuming a stationary receptor (S) 8-60

Table 8.22: Estimated area of Cardigan Bay SAC that bottlenose dolphin could potentially be disturbed from during UXO clearance 8-62

Table 8.23: Disturbance impact for impact piling using the dose-response approach 8-63

Table 8.24: Disturbance to bottlenose dolphin associated with the other construction activities at Project Erebus 8-66

Table 8.25: Summary of the maximum areas of displacement of bottlenose dolphin due to effects on prey resources resulting from temporary and long-term habitat loss 8-74

Table 8.26: Tiers for projects considered in the in-combination assessment 8-77

Table 8.27: Projects screened into the in-combination assessment of disturbance from construction activities for bottlenose dolphin 8-78

Table 8.28: In-combination assessment of disturbance from construction activities for bottlenose dolphin 8-79

Table 8.29: In-combination assessment for potential increased collision risk with vessels for bottlenose dolphin in the Cardigan Bay SAC....8-83

Table 8.30: Operations which may cause deterioration or disturbance to the features (Source: NRW, 2018f) 8-87

Table 8.31: Operations which may cause deterioration or disturbance to the features (Source: NRW, 2018a) 8-92

Table 8.32: PTS-onset impact ranges and number of animals predicted to experience PTS-onset for low order UXO detonation....8-96

Table 8.33: PTS-onset impact ranges and number of animals predicted to experience PTS-onset for high order UXO detonation....8-97

Table 8.34: PTS-onset impact ranges for grey seal from impact piling – worst-case (800 kJ)....8-98

Table 8.35: Summary of the source level (SEL_{cum} dB re 1 µPa @ 1 m RMS) and PTS-onset impact ranges (m) for the different construction noise sources using the non-impulsive criteria from Southall *et al.* (2019) for grey seal assuming a stationary receptor (S) 8-100

Table 8.36: Estimated area of Pembrokeshire Marine SAC that grey seal could potentially be disturbed from during UXO clearance 8-101

Table 8.37: Interaction between 5 dB SELss noise contours and Pembrokeshire Marine SAC; dose-response curve values provided to allow determination of area of the SAC impacted 8-102

Table 8.38: Disturbance impact for impact piling using the dose-response approach 8-104

Table 8.39: Disturbance to grey seal associated with the other construction activities at the Project 8-106

Table 8.40: Summary of the maximum areas of displacement of grey seal due to effects on prey resources resulting from temporary and long-term habitat loss 8-114

Table 8.41: Tiers for projects considered in the in-combination assessment 8-117

Table 8.42: Projects screened into the in-combination assessment for grey seal feature of the Pembrokeshire Marine SAC 8-118

Table 8.43: In-combination assessment of disturbance to grey seal feature of the Pembrokeshire Marine SAC....8-119

Table 9.1: Screening outcome for classified SPA breeding populations with foraging ranges that overlap with the Project array area or export cable corridor....9-2

Table 9.2: Project realistic worst case scenario parameters for use in assessment of potential for adverse effects on classified SPA seabird populations 9-8

Table 9.3: Apportionment of adult seabirds to SPA and non-SPA breeding colonies within foraging range which include this species as a feature.....9-13

Table 9.4: Apportionment of seabirds in the non-breeding season to SPA colonies assessed 9-15

Table 9.5: Defined seasons for use in assessment of species-specific displacement effects.....9-17

Table 9.6: Displacement ranking for ranking for species recorded at the Project site considered to be at risk of displacement.....9-19

Table 9.7: Parameters for Displacement Analysis within Project Footprint Plus 2 km Buffer 9-20

Table 9.8: Predicted mortality levels for Manx shearwater (no apportioning) due to displacement from the Project array area during the breeding season.....9-33

Table 9.9: Predicted mortality levels for Manx shearwater (no apportioning) due to displacement from the Project array area during the post-breeding migration.....9-34

Table 9.10: Predicted mortality levels for Manx shearwater (no apportioning) due to displacement from the Project array area during the pre-breeding migration 9-34

Table 9.11: Predicted mortality levels for black-legged kittiwake (no apportioning) due to displacement from the Project array area during the breeding season.....9-36

Table 9.12: Predicted mortality levels for black-legged kittiwake (no apportioning) due to displacement from the Project array area during the post-breeding migration 9-37

Table 9.13: Predicted mortality levels for black-legged kittiwake (no apportioning) due to displacement from the Project array area during the pre-breeding migration.....9-38

Table 9.14: Black-legged kittiwake seasonal collision mortalities 9-38

Table 9.15: Predicted mortality levels for common guillemot (no apportioning) due to displacement from the Project array area during the breeding season.....9-40

Table 9.16: Predicted mortality levels for common guillemot (no apportioning) due to displacement from the Project array area during the non-breeding season 9-41

Table 9.17: Common guillemot seasonal collision mortalities 9-42

Table 9.18: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the breeding season.....9-45

Table 9.19: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the post-breeding migration.....9-46

Table 9.20: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the non-breeding season 9-47

Table 9.21: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the pre-breeding migration 9-48

Table 9.22: Predicted mortality levels for Atlantic puffin (no apportioning) due to displacement from the Project array area during the breeding season 9-49

Table 9.23: Predicted mortality levels for Atlantic puffin (no apportioning) due to displacement from the Project array area during the non-breeding season.....9-50

Table 9.24: Lesser black-backed gull seasonal collision mortalities 9-52

Table 9.25: Description of tiers of other developments considered for in-combination assessment (adapted from PINS Advice Note 17) (PINS, 2019) 9-55

Table 9.26: Other projects screened in for assessment of potential in-combination effects on the Stockholm, Skomer and the Seas off Pembrokeshire SPA.....9-58

Table 9.27: Predicted in-combination displacement mortality for Manx shearwater *Puffinus puffinus* 9-61

Table 9.28: Predicted in-combination displacement mortality for black legged kittiwake *Rissa tridactyla* 9-62

Table 9.29: Predicted in-combination collision risk mortality for black-legged kittiwake *Rissa tridactyla* 9-63

Table 9.30: Predicted in-combination displacement mortality for common guillemot *Uria aalge* 9-64

Table 9.31: Predicted in-combination displacement mortality for razorbill *Alca torda*.....9-66

Table 9.32: Predicted in-combination displacement mortality for Atlantic puffin *Fratercula arctica* ..9-67

Table 9.33: Predicted in-combination collision risk mortality for lesser black-backed gull *Larus fuscus* 9-68

Table 9.34: Predicted mortality levels for northern gannet (no apportioning) SPA due to displacement from the Project array area during the breeding season.....9-75

Table 9.35: Predicted mortality levels for northern gannet (no apportioning) SPA due to displacement from the Project array area during the pre-breeding migration.....9-76

Table 9.36: Predicted mortality levels for northern gannet (no apportioning) due to displacement from the Project array area during the pre-breeding migration 9-76

Table 9.37: Gannet seasonal collision mortalities 9-77

Table 9.38: Predicted in-combination displacement mortality for northern gannet *Morus bassanus*.... 9-81

Table 9.39: Predicted in-combination collision risk mortality for northern gannet *Morus bassanus*..... 9-82

Table 9.40: Welsh coastal/estuarine Special Protection Areas with qualifying overwintering features (Source: CCW, 2008d; NRW, 2018g, 2021d) 9-89

1. Introduction

1.1. Project Background

The proposed Project is a demonstration scale Floating Offshore Wind (FLOW) development in the Celtic Sea region. The Applicant, Blue Gem Wind (BGW), is a joint venture between Simply Blue Energy (SBE) and TotalEnergies, set up to create a new low carbon offshore energy sector in the region that contributes to climate change mitigation targets, supply chain diversification and energy security.

Fixed bottom offshore wind technology can face significant challenges in deep waters, and is considered to be unfeasible in water depths greater than 60 m, as a result of installation, operation and maintenance (O&M) and costs associated with foundations. This, therefore, restricts fixed bottom offshore wind to waters close to the coast. However, FLOW has the potential to circumvent these challenges and unlock deeper offshore sites. The technology is still to be tested at large-scale, but the potential contribution FLOW can play in the energy mix is being recognised by UK Government, with a target set of up to 1 GW of FLOW to be installed by 2030 (BEIS, 2020).

FLOW demonstration projects have already been deployed in UK waters. Kincardine and Hywind, both fully operational FLOW developments located off the Scottish North Sea coast. At 50 MW Kincardine is the world's largest FLOW development (Pilot Renewables, 2019). Previously, Hywind (30 MW) was the world's largest operational FLOW project.

As a test and demonstration development, the Erebus Project is the first in the Applicant's 'stepping-stone approach' for FLOW in the Celtic Sea. This stepping-stone approach is the best way to increase learning and to maximise the opportunities to the local economy for this technology, by starting with smaller demonstration projects, such as the Project, before moving incrementally to larger commercial scale projects in the 2030s. This will provide local, Welsh and UK supply chain companies with the greatest chance to grow with the sector as it expands globally; it will also maximise knowledge transfer and facilitate a sustainable transfer to a low carbon economy.

1.2. Purpose of this Document

This Report to Inform Appropriate Assessment (RIAA) assesses the list of European designated sites and Ramsar sites that were screened into Habitats Regulations Assessment (HRA) Stage 2 Integrity Test, from the HRA Stage 1 Screening for Likely Significant Effects (see Volume 3, Technical Appendix 8.2: HRA Screening Report). The document covers both the marine and terrestrial elements of the Project.

The structure of this report is as follows:

- Background of the Project and overview of the HRA process (Section 0);
- Consultation and Scoping (Section 0);
- Detailed description of the project and maximum-case Project Design Envelope (PDE) (Section 0);
- Embedded mitigation specific to each receptor or receptor group (Section 0);
- Details outlining the approach taken to conduct the RIAA (Section 0);

- Assessment of potential pressures on Natura 2000 sites or Ramsar Sites with marine components alone or in-combination (Sections 0-9);
- Assessment of potential pressures on terrestrial Natura 2000 or Ramsar Sites either alone or in-combination (Sections 0-0);
- Consideration of Marine Conservation Zone (MCZ) grey seal species Feature of Conservation Interest (FOCI) (Section 0).

Where there is credible evidence that there is no risk that Project activities are 'likely to have a significant effect' on designated features of a Natura 2000 Site, National Site, or Ramsar Site by undermining its conservation objective(s), these features have been screened out of the assessment, and require no further assessment within the RIAA. Where such determination has been concluded, the justification is noted within the relevant receptor chapters.

If any credible impact pathway is identified, or there is reasonable doubt whether the Project will or will not result in Likely Significant Effect (LSE), in view of the conservation objectives, then the respective site and feature has been screened into the HRA Stage 2 Integrity Test, and assessed in the RIAA to enable the competent authorities to conduct the Appropriate Assessment (AA).

1.3. Habitats Regulations Process and the United Kingdom's Exit from the European Union

Following the United Kingdom's (UK's) exit from the European Union (EU), and the end of the transition period on the 31 December 2020, legislation has been passed to remove the domestic constitutional basis for EU law in the UK. Overall, the legislative changes do not result in a material change in how HRAs are undertaken in the UK.

The Conservation of Habitats and Species Regulations 2017[1] (as amended) and The Conservation of Offshore Marine Habitats and Species Regulations 2017[2] (as amended) transpose the EU Habitats Directive (Council Directive 92/43/EEC)[3] and certain elements of the Wild Birds Directive (Directive 2009/147/EC)[4] (known together as the Nature Directives) into UK law. Most functions of these Regulations have now been transferred from the European Commission (EC) to the appropriate authorities in England and Wales under the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019[5].

[1] https://www.legislation.gov.uk/uksi/2017/1012/contents/made

[2] https://www.legislation.gov.uk/uksi/2017/1013/contents/made

[3] Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A31992L0043

[4] Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32009L0147

[5] https://www.legislation.gov.uk/uksi/2019/579/contents/made

The 2019 amendments provide legal certainty and minimise disruption immediately following EU exit by maintaining, as closely as possible, the pre-existing regulatory regime. For example, references in an EU context throughout the legislation have been re-defined to a UK only context. Habitat and species protection and standards will be implemented in the same, or an equivalent way, maintaining existing protections for habitats and species. The environmental assessment regimes that inform planning decisions, including HRA, continue to apply post-EU exit.

1.3.1. Habitats Regulations Site Designations

All European protected sites and species retain the same level of protection now that the UK has left the EU. However, the 2019 Conservation Regulations now provide for the creation of a "*national site network*" within the UK territory. This is comprised of the European protected sites already designated under the Nature Directives (Natura 2000 network) and any further sites designated after exit day under the 2019 Regulations. Appropriate management objectives will be established for the national site network (the 'network objectives') (UK Gov. 2021).

References to "European sites" and "Natura 2000 sites" throughout this RIAA, are to be read as references to either European sites and Natura 2000 sites within the European Union, or "European sites within the UK national site network"[6] designated before the UK left the EU; or designated after the UK left the EU under the Conservation of Habitats and Species (Amendment) (EU Exit) Regulations 2019.

1.4. Habitats Regulations Assessment Legislation

This document has been produced to inform Stage 2: Appropriate Assessment of the HRA process for the Project. It provides information to enable the competent authorities (Natural Resources Wales (NRW) Licensing and Planning and Environment Decisions Wales (PEDW)) to conduct an appropriate assessment to inform decision making on consenting the Project; with respect to its potential to have adverse effect on the integrity of any European site screened into assessment.

Sites within the Natura 2000 network are defined as Special Areas of Conservation (SACs), Special Protection Areas (SPAs) and Sites of Community Importance (SCIs). UK Government policy (ODPM, 2005) states that internationally important wetlands designated under the Ramsar Convention 1971 (Ramsar sites and potential Ramsar sites) are afforded the same protection as SPAs and SACs, for the purpose of considering development proposals that may affect them. Therefore, Ramsar sites have also been considered within this RIAA.

HRA guidance (PINS, 2017; EC, 2018; UK Gov., 2019) sets out stages for assessment of the effects of projects or plans on designated sites. The HRA process comprises 4 main stages, which are:

[6] As defined by Regulation 3 of the Conservation of Habitats and Species Regulations 2017 and Regulation 2 of the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as Amended).

- **Stage 1: Screening** to identify the likely impacts of a project on a European site and consider whether the impacts are likely to be significant i.e. screening for LSE;
- **Stage 2: Appropriate Assessment** to determine whether the integrity of the European site, and the Natura 2000 network as a whole, will be adversely affected by the project;
- **Stage 3: Assessment of Alternative Solutions** to establish if there are any alternative ways that the project can be delivered which will result in a lesser effect on a European site, where it cannot be established that there will be no adverse effect on the integrity of that site;
- **Stage 4: Imperative Reasons of Overriding Public Interest (IROPI) and Compensatory Measures** to establish whether it is necessary for the project to proceed despite adverse effects on the integrity of a European site, and to confirm that necessary compensatory measures are in place to maintain the coherence of the Natura 2000 network.

All 4 stages of the process are referred to collectively as the HRA, to clearly distinguish the whole process from the step within it referred to as the 'Appropriate Assessment' (i.e., Stage 2: AA).

Stage 1: Screening is presented in Volume 3, Technical Appendix 8.2: HRA Screening Report. This includes identification of LSE (or where no LSE cannot be determined beyond reasonable scientific doubt) for sites and species, with LSE defined as:

"*any effect that may reasonably be predicted as a consequence of a plan or project that may significantly affect the conservation or management objectives of the features for which the site was designated, but excluding trivial or inconsequential effects [de minimis]*" (Hoskin and Tyldesley, 2006).

This document comprises the RIAA (to inform Stage 2: AA), where potential effects to the sites and features screened in at Stage 1 (i.e., those where no LSE could not be determined, or where LSE was determined) are assessed in detail. The aim of the AA is to determine whether the proposals will have an adverse effect on the integrity of any Natura 2000 site. Neither the UK Habitats Regulations nor the EU Directive legally define the term 'integrity', however within the '*Managing Natura 2000*' sites guidance, site integrity is defined as: "*the coherent sum of the site's ecological structure, function and ecological processes, across its whole area, which enables it to sustain the habitats, complex of habitats and/or populations of species for which the site is designated*" (EC, 2018).

The AA should answer the question "*can it be demonstrated that the proposals will not adversely affect the integrity of the site?*" focusing on the qualifying features for which the site is designated. In accordance with the Waddenzee judgement (ECJ Case 127/02[7]), the European Court of Justice ruled that a plan or project may be authorised only if a competent authority has made certain that the plan or project will not adversely affect the integrity of the site. "*That is the case where no reasonable scientific doubt remains as to the absence of such effects*". In terms of what is reasonable, guidance from Scottish Natural Heritage (SNH) states that "*to identify the potential risks,*

[7] Case C-127/02 *Landelijke Verening tot Behoud van de Waddenzee, Nederlandse Verening tot Bescherming van Vogels v Staatssecretaris van Landbouw, Natuurbeheer en Visserij* [2004] ECR 2004-I-07405 (https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A62002CJ0127&qid=1629443222613)

so far as they may be reasonably foreseeable in the light of such information as can be reasonably obtained" (SNH, 2001).

The '*Managing Natura 2000*' guidance document emphasises the conservation objectives of a site as the basis for defining adverse effect: "*the integrity of the site involves its constitutive characteristics and ecological functions. The decision as to whether it is adversely affected should focus on and be limited to the habitats and species for which the site has been designated and the site's conservation objectives*" (EC, 2018).

The conservation objectives set out what needs to be achieved for the Natura 2000 site to make the appropriate contribution to the conservation status of the features for which the site is designated, and thus deliver the aims of the Nature Directives (i.e. favourable conservation status for natural habitats and species of Community interest as described in Article 1 of the Habitats Directive).

The assessment also accounts for any avoidance or mitigation measures which will be implemented to avoid or reduce the level of impact from the activity. The competent authority may also consider the use of further/additional conditions or restrictions to help avoid adverse effect on site integrity.

If the AA concludes that the proposals will not adversely affect the integrity of sites within the European site network, either alone or in-combination with other reasonably foreseeable plans and projects, the permission may be granted. However, if the AA concludes that there will be an adverse effect on the integrity of the Natura 2000 site, or that there is uncertainty and a precautionary approach is taken, then consent can only be granted through a derogation process i.e. if there are no alternative solutions, but where IROPI exists, and appropriate compensatory measures have been secured.

MarineSpace and ITPE have undertaken a shadow HRA and produced this RIAA to allow the competent authority (NRW Licensing/PEDW) to complete their formal AA.

2. Consultation and Scoping

As part of the Habitats Regulations Assessment (HRA) process, consultation with key stakeholders has been undertaken at all stages of the HRA and will continue through the application and consenting process.

The approach to HRA assessment has been informed by consultation with stakeholders, with particular consideration of Natural Resources Wales (NRW) and the Joint Nature Conservation Committee (JNCC). Blue Gem Wind (BGW) initially set out the proposed approach to the HRA process in the 'Project Erebus Habitat Regulations Assessment Strategy' note (MarineSpace Ltd, 2020a). NRW and JNCC were consulted on this note in June 2020 and, following comments (NRW, 2020a), the note was subsequently updated, and a revised version provided in October 2020 (MarineSpace Ltd, 2020b). This document outlined key principles and methodology for the HRA process, and was intended to provide the basis of an accepted approach concerning the HRA for the Project. This included details of specific screening thresholds that would be used to identify Natura 2000 and Ramsar sites which could potentially be affected by construction, operation or decommissioning activities associated with the Project.

These thresholds were updated in accordance with consultation feedback from NRW and JNCC and the screening rationale was taken forward to produce a subsequent HRA Screening Output Note (MarineSpace Ltd, 2019). This output was submitted to NRW and JNCC for consultation in October 2020 with a view to confirm that no sites were missing from the 'long-list' that should be considered within the HRA Stage 1 screening assessment. Following NRW/JNCC consultation feedback (JNCC and NRW, 2019a), the HRA Screening Output Note was updated and re-issued to NRW/JNCC in January 2020 (MarineSpace Ltd, 2020c).

Consultee feedback on these documents (JNCC and NRW, 2021) was used to inform the subsequent HRA Stage 1 screening report, which was submitted to the regulators, who consulted with the statutory bodies and key stakeholders upon the contents. A number of comments were received, predominantly from NRW, JNCC, and The Wildlife Trust. The full list of all comments and responses/actions taken can be found in Table 2.1, and all comments have been taken on board and addressed throughout this report.

Table 2.1: Summary of consultation responses received on the Habitats Regulations Assessment screening report and actions taken in this report in order to address the comments

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	1	Benthic Ecology	JNCC note the potential for sandwave levelling at seven proposed locations along the export cable corridor. JNCC request the specific location of these proposed operations when known. We suggest that the developer considers the documents created by Ørsted, Natural England and JNCC concerning sandwave levelling in Hornsea 3. These are available on the PINS website.	Sandwave levelling is not proposed within the Pembrokeshire Marine SAC or any other designated nature conservation site, only cable installation via conventional plough/trenching tool.
JNCC	2	Benthic Ecology	We agree with the potential pressure pathway: 'Accidental Pollution', to be screened out at this stage.	This point is noted. However, NRW has advised that accidental pollution is screened into assessment. The applicant recognises that part of the justification for screening this pressure out of Stage 2 assessment was based on proposed mitigation. Mitigation measures cannot be considered within HRA screening (in accordance with People Over Wind and Sweetman v Coillte Teoranta) and therefore this pressure is screened into Stage 2 assessment. (Sections 6.5 and 6.6).
JNCC	3	Benthic Ecology	Given JNCC's offshore remit ([beyond] the territorial limit [12 nautical miles]) we are content that no further Special Areas of Conservation (SAC) designated for the presence of Annex I habitats need to be screened into the assessment within the Stage 2 Report to Inform Appropriate Assessment (RIAA). Where the Erebus project export cable corridor traverses inshore sites designated for Annex I habitats we defer to NRW.	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	4	Benthic Ecology	JNCC acknowledges that Table 3.2. contains a limited number of sites, however, we would recommend that when producing such tables a column be included to indicate which sites are inshore and which are offshore (beyond the territorial limit) to allow for quick distinction between those within or outside of each Statutory Nature Conservation Body's remit. This may be more applicable to Table 11.1: Summary of Natura 2000 sites and Ramsar sites screened into the Project Erebus Habitats Regulations Assessment (HRA) Screening Report.	Noted. The HRA screening report has been updated accordingly.
NRW	5	Benthic Ecology	Accidental pollution should be screened in and taken through to Stage 2 appropriate assessment.	Noted, the screening report has been updated to reflect this comment.
NRW	6	Benthic Ecology	Consider potential direct impacts from the project to the "*Large Shallow Inlets and Bays*" and "*Mudflats and Sandflats not covered by low tide*" features of the Pembrokeshire Marine SAC.	Noted, the screening report has been updated to reflect this comment.
NRW	7	Benthic Ecology	The Limestone Coast of South West Wales SAC should be screened in for potential impacts from the project to the "*Submerged or partially submerged sea caves*" feature.	Noted, the screening report has been updated to reflect this comment.

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	8	Benthic Ecology	We agree with the potential pressures that have been identified from the project to Annex I benthic habitats: • Temporary/permanent habitat loss/disturbance; • Temporary increases in suspended sediments/smothering; • Accidental pollution; • Colonisation of hard structures by invasive non-native species (INNS); • Changes to physical processes.	Noted.
NRW	9	Benthic Ecology	Colonisation of hard structures by INNS - There is also the potential for INNS to be introduced via vessel traffic to the site during construction, operation and decommissioning activities. We advise this is assessed under the potential impacts from the introduction of INNS in the HRA and that the assessment is not limited to potential impacts of INNS colonising hard structures.	Report updated to address this comment (Sections 6.5.2.1, 6.5.2.2, and 6.5.3.3).
NRW	10	Benthic Ecology	Accidental pollution – no potential likely significant effect (LSE). We disagree with accidental pollution being screened out as there is the potential for accidental pollution events to occur during construction, operation & maintenance and decommissioning phases as noted in Table 3.1 and for pollution incidents to potentially impact benthic communities. We advise this is screened in and taken through to stage 2 appropriate assessment where the relevant mitigation strategy could then be applied e.g. production of a Project Environmental Management Plan (PEMP).	Noted. Report amended to screen accidental pollution into Stage 2 assessment (Sections 6.5.2.1, 6.5.2.2, and 6.5.3.4).

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	11	Benthic Ecology	We agree with the following pressure pathways that will be screened in with respect to Annex I benthic habitats: • Temporary/permanent habitat loss/disturbance; • Temporary increases in suspended sediments/smothering; • Colonisation of hard structures by INNS; • Changes to physical processes.	Noted.
NRW	12	Benthic	Whilst we acknowledge these are the 2 main Annex I habitat types present within the Project footprint, there are 2 further Annex I habitats designated under the Pembrokeshire Marine SAC that directly overlap with the project footprint: • Large shallow Inlets and Bays. The proposed export cable route interacts directly with this feature. We advise that potential direct impacts to this feature are also considered in the HRA assessment as there may be some biotopes within the Large Shallow Inlets and Bays feature that might not be covered under the Annex I Reef feature and would therefore need to be assessed separately. • Mudflats and Sandflats not covered by seawater at low tide. There is the potential for the export cable route to interact directly with this feature as detailed by Figure 3.1. Table 3.2 Sites screened in for the next stage of the assessment for the Erebus Project in relation for Annex I Benthic Habitats	Noted, the screening report has been updated to reflect this comment.

Consultee	Ref. No.	Topic	Comment	Action/Response
			We agree with the following site and features of interest that will be screened in for the next stage of assessment for the Erebus Project in relation to Annex I benthic habitats: • Pembrokeshire Marine SAC.	
NRW	13	Benthic	We also advise that the Limestone Coast of South West Wales SAC is screened in for potential impacts from the project to the "*Submerged or partially submerged sea caves*" feature. Whilst we acknowledge the sensitivity of this feature to project secondary effects may be lower than for other habitat features, some biotopes within this feature may still be sensitive to project secondary effects. Furthermore, "*Submerged or partially submerged sea caves*" are cross-boundary features between the Limestone Coast SAC and the Pembrokeshire Marine SAC and the feature has already been screened in for the Pembrokeshire Marine SAC.	Noted, the screening report has been updated to reflect this comment.
The Wildlife Trust	14	Benthic	We agree that Pembrokeshire Marine SAC should be screened in for further assessment. At this early stage, we would like further information as to why open cut trenching is being considered alongside HDD nearshore. Open cut trenching would result in permanent loss of habitats for which compensation would be required, and therefore must be avoided.	HDD is the Applicant's preferred methodology and will be implemented if possible (Sections 3.4.1.5 and 4.1.1). However open cut trenching is included in the PDE as a contingency option and thus considered within the RIAA to cover the worst-case scenario, should HDD prove unfeasible, or fail. Additional survey work was undertaken to inform the EIA and RIAA (see Volume 3, Technical Appendix 9.1, Annex 1 West Angle Shallow Subtidal Snorkel Survey Report) and did not identify any particularly sensitive habitats in the area associated with OCT.
The Wildlife	15	Benthic	To reduce in-combination impacts, we encourage Project Erebus and Project Valorous to work together to develop	Comments are noted and as part of future Valorous studies effort are being made by BGW to explore such

Consultee	Ref. No.	Topic	Comment	Action/Response
Trust			a shared cable route. This should be explored with BEIS as part of the Offshore Transmission Network Review.	opportunities, where technically and commercially feasible.
The Wildlife Trust	16	Benthic	At this stage, TWT cannot rule out no adverse effect on the SAC from cable protection and open trench cable installation. Detailed assessment for all features using the conservation objectives and advice for the SAC will be required. Please note that the subtidal sandbank and reef feature is in unfavourable condition.	The Project has continued to refine the PDE where possible to avoid, minimise, and mitigate adverse effects on site integrity on the Pembrokeshire Marine SAC. Alongside this the Project has continued engagement with NRW, JNCC and TWT to understand the effects and their significance. The RIAA has been produced to inform the HRA, which will be undertaken by NRW who will assess potential for AEOSI.
The Wildlife Trust	17	Benthic	It will be important to consider the outcomes of the Hornsea Three planning decision in relation to cable protection. This states that habitats subjected to cable protection: a. will experience the effects of habitat loss, habitat modification and changes in epifauna communities, b. will be impacted in the long-term, c. will impede the restoration of the Annex 1 habitats for the duration that cable protection is in place, and d. will not meet the Conservation Objectives for the protected site. TWT would like to discuss all options and alternatives available to reduce impacts on the SAC.	Noted, and, where relevant, findings from this project have been considered.
JNCC	18	Ornithology	JNCC suggest an additional reason to consider Manx shearwater at this stage is due to the lack of understanding of extent to which timings of digital aerial survey (DAS) may limit the extent to which Manx shearwater use of the area (e.g. in lower light conditions outside of DAS) is fully captured within DAS. The ongoing collation of complementary data sources including Manx shearwater tracking data should help to improve our assessment of this.	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Section 9.7). Additional apportioning data have been derived based on population estimates. These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. Additional external data sourced for the Project have also been considered and used to inform the assessments of collision risk and displacement for Manx shearwater

Consultee	Ref. No.	Topic	Comment	Action/Response
				(Section 9.4.2).
JNCC	19	Ornithology	"*A site-specific foraging range of 62 km is reported for a razorbill from the Skomer, Skokholm and the seas off Pembrokeshire SPA (Woodward* et al.*, 2019). This distance is considered more appropriate when considering birds present at the Project array area than the more general mean maximum foraging range reported for the species as a whole.*" This needs to be justified: Is there evidence of colony segregation in foraging areas for this species? If not, then there may be razorbills from other colonies within foraging range using this area. Numbers of each species observed are provided but given only a proportion of the footprint was surveyed, these numbers do not represent numbers using the array footprint across the year.	This point is noted. The Screening Report has been updated to apply the more general mean-maximum foraging range.
JNCC	20	Ornithology	JNCC recommend that northern gannet are considered under displacement given emerging (largely unpublished as yet) evidence that they may be displaced in some instances. This can be considered further in next steps as information on gannet displacement may become available.	SPA sites with classified populations of northern gannet have been included in assessment (Section 9.6), specifically with regards to displacement. Additional apportioning data have also been derived based on population estimates (Section 9.4.3). These outcomes have been reviewed and used to reassess potential LSE for any site within the species-specific foraging range, no LSE could be concluded for all SPAs excluding Grassholm SPA, which has been screened into Stage 2 assessment.
JNCC	21	Ornithology	Irish Sea Front: This site has a conservation objective to ensure access to the site from linked breeding colonies. Therefore, it should be screened in until available tracking data has been reviewed to establish whether or not the array footprint is within flight paths between breeding colonies and the Irish Sea Front SPA.	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Sections 9.5 and 9.9), and the Irish Sea Front SPA has been included in assessment (Section 9.7). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes

Consultee	Ref. No.	Topic	Comment	Action/Response
				have been used to reassess if it is appropriate to determine no LSE for this site. Assessment includes full consideration of whether or not the array footprint is within flight paths between breeding colonies and the Irish Sea Front SPA. The Irish Sea Front SPA has been screened into Stage 2 assessment due to links with the colony at Lundy (Section 9.7).
JNCC	22	Ornithology	Outer Firth of Forth and St Andrews Bay Complex: This should be considered as it is within the foraging range for Manx shearwater. However, the conservation objectives for this site do not require consideration of the foraging range of Manx shearwater from the site (it is not a breeding colony but rather a foraging area) and therefore this site should be considered and screened out.	Noted.
JNCC	23	Ornithology	Copeland Islands: Please see comments above. It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. In addition, given the ongoing work by Erebus to make use of available tracking data, it would be premature at this stage to assume no LSE for a Manx shearwater SPA based on distance from colony. Tracking from Copeland has shown a maximum foraging distance of 1970km bringing it within range of array footprint. This data should be explored further to establish where these longer trips were focused, and if they demonstrate linkage with the array footprint.	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Sections 9.5, 9.7 and 9.9. Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Copeland Islands SPA.
JNCC	24	Ornithology	Isles of Scilly: This site contains a breeding seabird assemblage feature and component species such as Manx shearwater, kittiwake, puffin and possibly others may need to be considered within this site, all of which are within theoretical foraging range of the array	Approach for assemblages only considers sites within 10 km. Isles of Scilly are 172.5 km away. Natural England were consulted, and full list of species

Consultee	Ref. No.	Topic	Comment	Action/Response
			footprint. Please check with Natural England for the full list of species to consider as part of the assemblage for this site.	considered. For Natural England, the main colony to consider is Lundy SSSI seabird colony. Connectivity between the Lundy SSSI colony and the Irish Sea Front SPA is considered in Section 9.7.
JNCC	25	Ornithology	St Kilda: Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. In addition, given the ongoing work by Erebus to make use of available tracking data, it would be premature at this stage to assume no LSE for a Manx shearwater SPA based on distance from colony (although we are not aware of data from St Kilda SPA).	SPA sites with classified populations of Manx shearwater and other non-classified colonies has been included in assessment (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the St Kilda SPA.
JNCC	26	Ornithology	Rum: Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. In addition, given the ongoing work by Erebus to make use of available tracking data, it would be premature at this stage to assume no LSE for a Manx shearwater SPA based on distance from colony. Tracking from Rum has shown a maximum foraging distance of 2890km bringing it within range of array footprint. This data should be explored further to establish where these longer trips were focused, and if they demonstrate linkage with the array footprint.	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Rum SPA.
JNCC	27	Ornithology	Ailsa Craig: JNCC are content that this has been screened out given site specific evidence of foraging ranges for gannet from this colony show a maximum of 296km, whilst Erebus is 393km away.	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	28	Ornithology	Forth Islands: This should have been considered for Northern gannet; the SPA is potentially within foraging range for this species (should be checked within GIS software). Noting that there is a good sample of tracked birds from this SPA showing a mean foraging range of 207km and a max of 590km, this data should be explored further to establish where these longer trips were focused, and if they demonstrate linkage with the array footprint.	SPA sites with classified populations of northern gannet have been included in assessment (Section 9.6). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Forth Islands SPA.
JNCC	29	Ornithology	Glannau Aberdaron ac Ynys Enlli/Aberdaron Coast and Bardsey Island: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. In addition, given the ongoing work by Erebus to make use of available tracking data, it would be premature at this stage to assume no LSE for a Manx shearwater SPA based on distance from colony.	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Glannau Aberdaron ac Ynys Enlli/Aberdaron Coast and Bardsey Island SPA.
JNCC	30	Ornithology	Grassholm: We agree this should be screened in at this stage with potential LSE.	Noted.
JNCC	31	Ornithology	Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro: We agree this should screened in at this stage with potential LSE. Listed species for potential LSE should include guillemot, razorbill and puffin due to potential for displacement effects.	Noted.
JNCC	32	Ornithology	Castlemartin Coast: We defer to NRW given the onshore location.	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	33	Ornithology	Tacumshin Lake: JNCC are content that this has been screened in.	Noted.
JNCC	34	Ornithology	Saltee Islands: We are content that this has been screened in. Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks.	Noted.
JNCC	35	Ornithology	Helvick Head to Ballyquin: We are content that this has been screened in.	Noted.
JNCC	36	Ornithology	Wicklow Head: We are content that this has been screened in.	Noted.
JNCC	37	Ornithology	Old Head of Kinsale: We are content that this has been screened in.	Noted.
JNCC	38	Ornithology	Howth Head Coast: We are content that this has been screened in.	Noted.
JNCC	39	Ornithology	Irelands Eye: We are content that this has been screened in.	Noted.
JNCC	40	Ornithology	Lambay Island: We are content that this has been screened in. Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks.	Noted.
JNCC	41	Ornithology	Rockabill: We are content that this has been screened in	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	42	Ornithology	Nord Bretagne DO: We are content that this has been screened in. Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. We are not clear why northern gannet have been excluded at this stage.	SPA sites with classified populations of Manx shearwater (Sections 9.5 and 9.7) and northern gannet (Section 9.6), and any non-classified colonies (Section 9.9) have been included in assessment. Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. Mers Celtiques - Talus du golfe de Gascogne Nord Bretagne DO SPA.
JNCC	43	Ornithology	Mers Celtiques - Talus du golfe de Gascogne: We are content that this has been screened in. Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. We are not clear why northern gannet have been excluded at this stage.	SPA sites with classified populations of Manx shearwater (Sections 9.5 and 9.7) and northern gannet (Section 9.6), and any non-classified colonies (Section 9.9) have been included in assessment. Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Mers Celtiques - Talus du golfe de Gascogne SPA.
JNCC	44	Ornithology	Côte de Granit Rose-Sept Iles: We are content that this has been screened in. Please see comments above: It is inappropriate to exclude Manx shearwater at this stage given potential collision risks. We are not clear why northern gannet have been excluded at this stage.	SPA sites with classified populations of Manx shearwater (Sections 9.5 and 9.7) and northern gannet (Section 9.6), and any non-classified colonies (Section 9.9) hvae been included in assessment. Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Côte de Granit Rose-Sept Iles SPA.
JNCC	45	Ornithology	JNCC did not go through non-UK SPAs in Table 6.5 individually but suggest that these should be reviewed in light of comments above for UK SPAs. For example, some	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
			non-UK sites for Manx shearwater and northern gannet seem to have been screened out but are within foraging range. Given known risks to gannet of both collision and displacement, and uncertainty around risks to Manx shearwater, without further exploration it is not possible at this stage to rule out LSE.	
NRW	46	Ornithology	The applicant will require the full 24 months of Digital Aerial Surveys before assessment of LSE for birds observed in the DAS, and the screening of sites, is possible.	Data from subsequent surveys have been included in the assessments. Inclusion of this data resulted in no substantial changes to be made to the HRA screening results.
NRW	47	Ornithology	The figures presented do not appear to be worked up densities but just the number of birds counted from the DAS surveys. As only 10% of the area is surveyed, this needs to be increased to the absolute density to calculate how many birds are there for assessment.	Information on absolute densities has been worked up following completion of 24 months of surveys (refer to Volume 3, Technical Appendices 11.1-11.6), and used for assessment within the RIAA.
NRW	48	Ornithology	Manx Shearwater should be screened in for all sites if within range (mean max +1SD) as per Woodward *et al.* (2019) and taken through to Appropriate Assessment (AA).	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites.
NRW	49	Ornithology	Displacement and Collision Risk Modelling needs to be considered.	Noted.
NRW	50	Ornithology	Accidental pollution should be screened in.	Noted, the screening report has been updated to reflect this comment. Accidental pollution has been considered for the screened in sites in Section 9.1,

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	51	Ornithology	The applicant needs to consider impacts on migratory seabirds and what they refer to as 'small populations' so that cumulative impacts can be assessed.	It is accepted that some of the values in Table 6.2 are close to the 1% threshold and consideration of combined effects from this and other projects may produce values in excess of this value. However, it should be noted that these values only provide an estimated number of birds that may pass the site. They do not take into account any avoidance behaviour that would influence risk of adverse effect. The SOSSMAT approach calculates the proportion of bird populations that may interact with the Project site. The Statutory Nature Conservation Body (SNCB) review of how avoidance rates should be applied in determination of collision risk from offshore wind developments (SNCB, 2014) recommends a minimum 98% avoidance rate to be applied. Similarly, displacement and disturbance rates are variable between species. However, mortality rates within displaced birds are not expected to exceed 1% (value informed by the rates used for Hornsea Project Three offshore wind farm, for Moray West offshore wind farm in Scotland and from the modelling work undertaken by the Centre for Hydrology and Ecology (CEH) for the Forth and Tay offshore wind farms in Scotland). As such, taking account of likely avoidance and mortality rates, the number of individual birds affected by the Project and other developments in-combination is also likely to be considerably below the 1% threshold and therefore **no LSE** was concluded for the proposed Project in-combination on all migratory bird species considered.
NRW	52	Ornithology	Additional species (named features and/or assemblage features) for some SPAs appear to have been missed out and should be screened in.	Noted, the screening report has been updated to address this.

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	53	Ornithology	SPAs designated for wintering species need to be assessed and should be included in this screening report due to the potential for collision and/or barrier effects.	SPAs designated for wintering features have been screened into Stage 2 assessment if located within 10 km of the Project array area or cable corridor footprint, or if there are migratory routes that interact with the Project (Section 9.9.2).
NRW	54	Ornithology	NRW only comments on impacts to Welsh SPAs and features. The relevant SNCBs should be consulted regarding SPAs outside Wales and whether they should be screened out.	Noted.
NRW	55	Ornithology	This screening report has been produced without the full two years' worth of agreed aerial surveys and therefore there isn't the adequate survey data to screen out sites and or species.	Any data from subsequent surveys have been assessed and used to inform the RIAA. Inclusion of this data resulted in no substantial changes to the screening report.
NRW	56	Ornithology	"*During all phases of the construction, O&M, and decommissioning there is a risk of accidental pollution from construction, operational and maintenance equipment and activities. Pollution incidents may impact birds through chemical contamination. This may adversely affect breeding and, in some cases, can be fatal. However, pollution events are likely to be rare and the associated impacts would be highly localised and small scale. As such, it is considered there is no potential LSE from this pressure.*" We disagree with accidental pollution being screened out as there is the potential for accidental pollution events to occur and therefore for pollution incidents to potentially impact bird communities. We advise this is screened in and taken through to stage 2 AA where the relevant mitigation strategies can then be applied.	Noted, the screening report has been updated to reflect this comment.

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	57	Ornithology	"*A site specific foraging range of 62 km is reported for a razorbill from the Skomer, Skokholm and the seas off Pembrokeshire SPA (Woodward* et al.*, 2019). This distance is considered more appropriate when considering birds present at the Project array area than the more general mean maximum foraging range reported for the species as a whole.*" Screening should be done using the mean max + 1SD. If there is a potential effect, then this should be screened in and looked at in detail during the HRA where information on local movements of birds can be used. Razorbills from other colonies within foraging range could be feeding within the project footprint. Unless these birds can be proven to forage elsewhere then all razorbills should be screened in if within mean max +1SD range.	This point is noted. The Screening Report has been updated to apply the more general species level mean-maximum foraging range.
NRW	58	Ornithology	As the applicant has confirmed, the SOSSMAT approach has identified that the postbreeding range of Balearic shearwater now consistently includes the Celtic Sea front area. Moreover, as the applicant has also stated, the foraging range and migration patterns of this species is still unknown. We disagree that the applicant can reach the conclusion that "*it is considered unlikely that the species visits the Project array area*" based on just one year of DAS and without further evidence of absence, particularly at the time of year when the species moves into UK waters. We advise that this species be considered in more detail due to its IUCN Critically Endangered status. We do not agree that the applicant can be confident that there will be no LSE for this species. Refer to, for example, Ilhas Berlengas SPA, Tête de Canyon du Cap Ferret SPA, and the Mers Celtiques - Talus du golfe	Although not identified, based on the Project screening criteria, and not recorded in 24 months' Digital Aerial Survey (DAS) data, Balearic shearwater has been taken forward for Stage 2 assessment (Section 9.8). This species has recently been recorded in waters approximately 25 km south of the Project (Philips *et al.*, 2021) and as such it is possible that its range may extend further northwards and overlap with the site of the Proposed Development. Given its status as Europe's only globally critically endangered seabird this species has been included in assessment and addressed qualitatively (Section 9.8).

Consultee	Ref. No.	Topic	Comment	Action/Response
			de Gascogne SPA.	
NRW	59	Ornithology	Risk calculations from Furness *et al.* (2013) may not be precautionary enough. For instance, Manx shearwaters have been shown to avoid the windfarm at North Hoyle in Liverpool Bay, and there is very little known about European Storm petrels' response to arrays (Dierschke *et al.*, 2016). Therefore, we advise that these features should be screened in for potential displacement.	SPA sites with classified populations of Manx shearwater and other non-classified colonies have been included in assessment (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No European storm-petrel have been observed in 24 months of DAS data (refer to Volume 3, Technical Appendix 11.1: Baseline, and Technical Appendix 11.6: 2 Year Bird Survey Report), however, it has been observed at other project sites using the same DAS equipment and methodology. It is therefore considered that this species is not present at this site. However, based on the concerns raised in this response, this receptor will be screened into Stage 2 assessment and considered therein (Section 9.5).
NRW	60	Ornithology	We will only be commenting on Welsh sites, however the applicant is encouraged to look at sites across Europe which could be affected, especially with reference to species such as Balearic shearwater (this will also need to be considered under Section 6.5.2).	Noted.
NRW	61	Ornithology	There are no wintering SPAs in this report. Welsh wintering estuarine SPAs need to be assessed as there is the potential for collision and/or potential barrier effects during migration. This would need to include an assessment of all Welsh wintering estuarine SPAs including Traeth Lafan SPA, The Dyfi SPA, Burry Inlet SPA	SPAs designated for wintering features have been screened into Stage 2 assessment (Section 9.9.2).

Consultee	Ref. No.	Topic	Comment	Action/Response
			and Severn Estuary SPA.	
NRW	62	Ornithology	Glannau Aberdaron ac Ynys Enlli/Aberdaron Coast and Bardsey Island We recommend that Manx shearwater should not be screened out at this stage given the potential collision risk/displacement and the need for tracking data to assess colony site fidelity as mentioned above.	SPA sites with classified populations of Manx shearwater have been included in assessment (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites. No LSE could be determined for the Glannau Aberdaron ac Ynys Enlli/Aberdaron Coast and Bardsey Island SPA.
NRW	63	Ornithology	Grassholm We agree that Grassholm SPA should be screened in at this stage with potential LSE.	Noted.
NRW	64	Ornithology	Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro We agree that Skomer, Skokholm and the Seas off Pembrokeshire SPA should be screened in at this stage with potential LSE. However, guillemot, razorbill and puffin should also be included as species for potential LSE due to the potential for displacement effects, as should the assemblage feature. NB guillemot and razorbill are not features in their own right but are part of the assemblage.	All species both present as discrete classified populations, or, where contributing to assemblage feature i.e. common guillemot, razorbill and Atlantic puffin, from the Skomer, Skokholm and the Seas off Pembrokeshire SPA, have been screened into Stage 2 assessment (Section 9.5).
JNCC and NRW	65	Marine Mammals	JNCC and NRW note that the final sentence within Section 6.4.4. appears to be incomplete and should be rewritten. "*However, should the AA for the sites screened in conclude an adverse effect on the integrity, an iterative approach may be applied whereby an AA may be conducted for the next closest harbour porpoise site within the*"	Noted. HRA Screening Report amended to address this error.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC and NRW	66	Ornithology	JNCC and NRW question whether cumulative impacts on migratory seabirds have been considered, given the proximity of some of the values in Table 6.2 to the 1% UK population threshold for the proportion of bird populations whose migratory routes interact with the project array area. In addition, NRW note that calculations will need to be made for smaller populations on migration and during the breeding period as these will need to be added together cumulatively. So far it appears that this assessment has been done on birds counted, rather than absolute densities, and only on one year's worth of data. The applicant will require the full 24 months of Digital Aerial Surveys before assessment of LSE is possible.	It is accepted that some of the values in Table 6.2 are close to the 1% threshold and consideration of combined effects from this and other projects may produce values in excess of this value. However, it should be noted that these values only provide an estimated number of birds that may pass the site. They do not take into account any avoidance behaviour that would influence risk of adverse effect. The SOSSMAT approach calculates the proportion of bird populations that may interact with the Project site. The Statutory Nature Conservation Body (SNCB) review of how avoidance rates should be applied in determination of collision risk from offshore wind developments (SNCB, 2014) recommends a minimum 98% avoidance rate to be applied. Similarly, displacement and disturbance rates are variable between species. However, mortality rates within displaced birds are not expected to exceed 1% (value informed by the rates used for Hornsea Project Three offshore wind farm, for Moray West offshore wind farm in Scotland and from the modelling work undertaken by the Centre for Hydrology and Ecology (CEH) for the Forth and Tay offshore wind farms in Scotland). As such, taking account of likely avoidance and mortality rates, the number of individual birds affected by the Project and other developments in-combination is also likely to be considerably below the 1% threshold and therefore **no LSE** was concluded for the proposed Project in-combination on all migratory bird species considered.
JNCC and NRW	67	Ornithology	JNCC and NRW advise that despite scoring 0 in Table 6.4, Manx shearwater are screened in given the uncertainty as to flight height distributions for this species (see	SPA sites with classified populations of Manx shearwater have been included in assessment where no LSE could not be determined (Sections 9.5, 9.7, and 9.9). Additional

Consultee	Ref. No.	Topic	Comment	Action/Response
			previous discussions regarding tracking data showing some flights potentially at collision risk height but required further analysis).	apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites.
JNCC and NRW	68	Ornithology	Although titled 'summary' it provides new information on screening thresholds not described in Section 6 and is therefore quite confusing. "*Although a local site-specific foraging range is assigned to Manx shearwater, at 1,250 km, the screening assessment has proceeded on a precautionary basis and included all sites within the mean maximum foraging +1 SD of 2,356.5 km for connectivity, but the majority screened out as No LSE.*" This requires clarification as the applicant appears to contradict themselves. Will Manx shearwaters within 2,356.5km of the array footprint been screened in or out? If, as stated, a precautionary approach is being adopted, then all Manx shearwater colonies within 2,356.5km of the project footprint should be screened in based on their foraging range.	SPA sites with classified populations of Manx shearwater located within the species-specific foraging range have been included in assessment where no LSE could not be determined (Sections 9.5, 9.7, and 9.9). Additional apportioning data have been derived based on population estimates (Section 9.4.3). These outcomes have been used to reassess if it is appropriate to determine no LSE for each of these sites.
JNCC and NRW	69	Ornithology	"*No LSE is also concluded for species that were observed in the DAS in numbers corresponding with ≤0.01% of the UK population (Error! Reference source not found.).*" How will the numbers of birds observed in the DAS be considered in the context of bird population within the array footprint? Two years of data with absolute densities are required before an assessment of birds observed in the DAS can be conducted. Will an analysis be undertaken to estimate array footprint numbers based on those seen within the DAS (which represents only a proportion of the array footprint area)? It is important for the applicant to do this analysis so we are	Following completion of the full 24 months DAS, values have been worked up into absolute densities (Section 9.4). These values have been incorporated into the RIAA where appropriate (Sections 9.5-9.9).

Consultee	Ref. No.	Topic	Comment	Action/Response
			able to understand if these numbers are being used to directly compare against national populations.	
The Wildlife Trust	70	Ornithology	Barrier Effects - The degree of additional energy expenditure required for flight deviations will relate to the frequency of use for the respective flight path, the size of the development and its proximity to designated sites. This is hugely important – particularly for species with high flight costs like auks and gannets. These could be much more serious than collision risks because these may be offset by compensatory recruitment. It is disingenuous to evaluate the barrier effects of Erebus as a stand-alone development when Valorous is proposed for a site alongside it and within the early lifespan of Erebus. The barrier effects to seabirds will be the combined result of both the demonstration and commercial scale FLOW projects. We do not support the development of any further FLOW projects until a robust data set of evidence exists to rule out any negative impacts and to test mitigation measures of any negative interactions observed.	Noted. Project Valorous was determined to be a Tier 5 project within the in-combination assessment screening process (refer to Chapter 30: Cumulative Effects Assessment, and Volume 3, Technical Appendix 30.1: Cumulative Long List). This recognises that the project has not yet submitted an application, there is low certainty associated with any information that has been provided, and there is risk that the project may not proceed. Valorous has not yet received a lease from The Crown Estate and is still subject to the outcomes of a forthcoming plan level HRA. It was considered that the level of uncertainty associated with these factors precluded delivery of a robust in-combination assessment of potential adverse effects from the Proposed Development and Project Valorous, and therefore Valorous was screened out of in-combination assessment. It is understood that should sufficient detail for this project become available post-submission, the Project may be requested to provide additional information during the determination period.
The Wildlife Trust	71	Ornithology	Collison Risk – We would question why attraction to light has not be included in this section. FLOW devices will need to be lit for navigational safety, the greatest concern is with attraction of fledging Manx Shearwaters to the lighting on the devices and subsequent increased collision risk. There is concern about the amount of permanent lighting and transient lighting on service and maintenance vessels associated with the windfarm. Of	It is acknowledged that fledgling Manx shearwaters can be attracted to artificial light however assessment is undertaken in the context of local conditions. It is important to note that any additional lighting required for the Proposed Development must be considered in the context of the baseline high levels of shipping activity and heavily illuminated tanker waiting areas for vessels entering Milford Haven. Manx shearwaters are at low risk

Consultee	Ref. No.	Topic	Comment	Action/Response
			particular concern would be lighting associated with and the timing of the installation and decommissioning of this project, which should avoid periods of higher attraction risk (Manx shearwater fledging period Aug - October). Fledging Manx Shearwaters are particularly vulnerable to lights and collision, since they are genetically pre-programmed to orientate in a certain direction from the colony. They are known to be attracted to lights and known to ground/collide with structures. They are also found grounded on ships, so are often flying sufficiently high for that to be an issue. SW is the first migration direction which is likely to be innately driven in young shearwaters, which places them at risk of interaction with Erebus. Fledglings may have no experience of the site during the day.	of collision due to their flight height, therefore it is not appropriate to assert that artificial lighting will be associated with an increased risk of collision with Project infrastructure. Pressures associated with artificial lighting have been screened out of assessment within Stage 2 of the HRA, but are assessed within the ES (see Chapter 11: Offshore Ornithology).
The Wildlife Trust	72	Ornithology	The first year of DAS from the Project array area was completed from September 2019 - October 2020. Whilst we welcome the presentation of the Year 1 results, we have serious concerns about the use of DAS alone to evaluate seabird usage of the site and the behaviour of different species within the proposed site and subsequently Collision Risk. DAS are conducted by day only, between 1000 and 1500, the time when foraging seabirds are least active. We question how much can this industry standard method capture the variability of activity and behaviour of the species in this area? DAS are a snapshot once a month for little more than an hour, flown only during the middle part of the day and may only cover 10% of site. Whilst this may have been acceptable in other UK EIA processes, this area is unique with such a large number of Manx shearwater present.	24 months of digital aerial survey work has been supplemented by tagging and tracking data and analysis specific to the Erebus site. The analysis was commissioned by the Applicant and undertaken by academic researchers associated with long-term tagging and tracking projects from Skomer and Grassholm. Further details are presented in Section 9.4.2 and provide additional data regarding the behaviour, connectivity and activity associated with Northern gannet and Manx shearwaters within the array area and a 4 km buffer.

Consultee	Ref. No.	Topic	Comment	Action/Response
The Wildlife Trust	73	Ornithology	The limited daytime flight period of these surveys makes it a wholly unsatisfactory way of surveying the diurnal and seasonal activity peaks we know are associated with Gannets, Manx Shearwaters and Kittiwakes, but also auks – who roost on the sea and travel to and from their roost sites to the colony at dawn and dusk. Although unlikely that another approach is adopted at this stage, it is essential that the DAS data is integrated with other data in order to calibrate and validate, allowing an understanding of how well DAS will reflect variability. The BTO has recently undertaken work on behalf of Marine Scotland Science utilising tracking data for a range of species to understand whether seabird distributions at sea might differ at times when DAS are not feasible, i.e. at night and during poor weather conditions. This work will be relevant, although the key difference will be the species involved in the Celtic Sea and our need to understand dawn/dusk movements.	As above. Data from the 24 months of digital aerial surveys has been supplemented by tagging and tracking data, specific to the Erebus site. This includes data during diurnal and seasonal activity peaks.
The Wildlife Trust	74	Ornithology	Survey flights can proceed only in wind conditions under 35 knots, so are not representative of the conditions experienced in this area of sea, in fact, the reason for the chosen Erebus site is the regular and reliable occurrence of high wind speeds.	As above. Data from the 24 months of digital aerial surveys has been supplemented by tagging and tracking data, specific to the Erebus site. This includes data collected during all wind speeds.
The Wildlife Trust	75	Ornithology	DAS analysis will calculate this from a proportional size method using the digital stills. This method has not been properly validated. We have serious doubts about the data from the DAS to allow accurate estimation of bird flight heights and the use of mean altitude rather than max.	The methodology for the ornithological surveys, specifically 24 months of digital aerial surveys was agreed in consultation with NRW. Data from the 24 months of digital aerial surveys has been supplemented by tagging and tracking data, specific to the Erebus site (Section 9.4.2).

Consultee	Ref. No.	Topic	Comment	Action/Response
The Wildlife Trust	76	Ornithology	A critical point is that if surveys can take place only in low wind speeds, the change of flight behavior, including height, of many species in high winds will not be detected, leading to incorrect assessment of collision risk.	As above. Data from the 24 months of digital aerial surveys has been supplemented by tagging and tracking data, specific to the Erebus site. This includes data collected during all wind speeds.
The Wildlife Trust	77	Ornithology	Despite assurances by HiDef at the Year 1 ornithology review that the survey imagery and expert analysis can identify birds to species, there are still concerns. No bird smaller than an auk (i.e. storm petrels) was identified in the first year of survey and can the methodology really differentiate between a Manx and Balearic Shearwater? We appreciate that DAS has been accepted as an appropriate tool across the industry, but in the Celtic Sea region this is fundamental, not just to this project but all wind farm developments around our coasts. As with any scientific investigation, the technique must be verified in a robust manner.	The methodology for the ornithological surveys, specifically 24 months of digital aerial surveys was agreed in consultation with NRW. Data from the 24 months of digital aerial surveys has been supplemented by tagging and tracking data, specific to the Erebus site. European storm-petrel have regularly been identified during HiDef digital aerial surveys in other regions, however none were recorded within the Erebus survey area during the 24 months of digital aerial surveys. HiDef have recorded >400 Balearic shearwater during historical surveys. None of these have been within UK waters, HiDef have on occasion recorded this species in Irish waters. However, the majority of sightings have been in French waters. As such, it is considered that the DAS would identify Balearic shearwater if it were present at the Project site.

Consultee	Ref. No.	Topic	Comment	Action/Response
The Wildlife Trust	78	Ornithology	'*Movements away from puffin breeding colonies are poorly understood and are thought to be dispersive rather than following a specific path*' – This may be true but Puffins on Skomer have been the subject of tracking studies by Oxford University since 2009. Ref.: Within-pair similarity in migration route and female winter foraging effort predict pair breeding performance in a monogamous seabird Annette L. Fayet, Akiko Shoji , Robin Freeman, Chris M. Perrins, Tim Guilford, Mar Ecol Prog Ser. Vol. 569: 243–252, 2017 April 2017 Ref: Guilford T, Freeman R, Boyle D, Dean B, Kirk H, *et al.* (2011) A Dispersive Migration in the Atlantic Puffin and Its Implications for Migratory Navigation. PLoS ONE 6(7): e21336. Doi:10.1371/journal.pone.0021336	Tagging and tracking data and analysis, specific to the Erebus site, was commissioned by the Applicant and undertaken by academic researchers associated with long-term tagging and tracking projects from Skomer and Grassholm. Further details are presented in Section 9.4.2 and provide additional data regarding the behaviour, connectivity and activity associated with Northern gannet and Manx shearwaters within the array area and a 4 km buffer.
The Wildlife Trust	79	Ornithology	'*The range for this species is not well understood, however the birds are thought to migrate from Iceland to the UK. Breeding sites have been identified in Scotland (7), Wales (1) and the southwest coast of England (1).*' This text needs updating and correcting. We know of 5 distinct island nesting sites for European Storm Petrel in Pembrokeshire alone, across two different SPA's. Whilst there may have been ringing recoveries from Iceland, Welsh breeders spend the Northern Hemisphere winter mainly off the coasts of South Africa and Namibia, with some birds stopping in the seas adjoining West Africa, some remaining in the Mediterranean.	European storm-petrel have regularly been identified during HiDef digital aerial surveys in other regions, however none were recorded within the Erebus survey area during the 24 months of digital aerial surveys. However, in response to concerns raised by NRW, JNCC, RSPB and TWT European storm-petrel have been screened into Stage 2 assessment and considered therein (Section 9.5).

Consultee	Ref. No.	Topic	Comment	Action/Response
The Wildlife Trust	80	Ornithology	Please revise figures – this is clearly wrong '*There are 281,319,499 breeding pairs within the UK, which is around 72-91% of the international population*' Please see - Perrins et al. - A census of breeding Manx Shearwaters *Puffinus puffinus* on the Pembrokeshire Islands of Skomer, Skokholm and Midland in 2018. SEABIRD 32 (2019): 106–118 Population estimates Scotland 100,000, Ireland 200,000, Wales 500,000 and outside UK 50,000; some 850,000 breeding pairs. These figures emphasise the central importance of Wales to the Manx Shearwater; well over half of the world population breed in Wales. The population estimate of Manx shearwater from the DAS of the Project array area ranged from 0-2,693 individuals per month, with the maximum number seen in July. But we know that this number is disputed by a scale of magnitude by the substantial OxNav tracking dataset.	The Project commissioned the University of Oxford to deliver shearwater tracking data analysis including: connectivity between the Erebus site and Skomer and Skokholm and other important colonies using existing GPS tracking data; analysis of diurnal activity patterns of shearwaters, including nocturnal and crepuscular, activity within the Erebus site using GPS tracking data (Section 9.4.2); provide an expert opinion on flight heights using currently unpublished on-board video-tracking data; and provide an assessment as to the important of Erebus for Balearic shearwaters and connectivity with Spanish SACs. The report was received from the University of Oxford and directly informed the ornithological impact assessment (Sections 9.5-9.9).
The Wildlife Trust	81	Ornithology	Erebus is likely to be on the commuting route to the Celtic sea front and other foraging areas, and Manx Shearwaters are likely to be transiting most early and late in the day. There is no assessment of nocturnal activity. GPS data can provide this for breeding birds.	As above. Tagging and tracking data and analysis, specific to the Erebus site, was commissioned by the Applicant and undertaken by academic researchers associated with long term tagging and tracking projects from Skomer and Grassholm. Further details are presented in Section 9.4.2 and provide additional data regarding the behaviour, connectivity and activity associated with Manx shearwaters within the array area and a 4 km buffer.
The Wildlife Trust	82	Ornithology	There is no assessment of flight behaviour (speed, altitude and shear soaring) in windy conditions	There is insufficient data available on flight behaviour in windy conditions for these parameters to be incorporated into collision risk assessment with any degree of certainty. As such, this is recognised as a limitation of assessment. However, the assessment provided within the Appropriate Assessment is based on

<table>
<tr><th>Consultee</th><th>Ref. No.</th><th>Topic</th><th>Comment</th><th>Action/Response</th></tr>
<tr><td></td><td></td><td></td><td></td><td>the best available methodologies, as agreed with the SNCBs.</td></tr>
<tr><td>The Wildlife Trust</td><td>83</td><td>Ornithology</td><td>This paragraph on page 6-7 requires clarification and the last sentence (highlighted in bold) is not complete or relevant to Manx Shearwater at all… ‘Although the number of Manx shearwater recorded within the End of Year 1 DAS were low, the approach to screening Manx shearwater will proceed on precautionary basis. This is due to the Project being the first floating offshore wind development in the region and data on interactions with offshore wind (both fixed and floating) and Manx shearwater is limited. Therefore, all sites within the 2,365.5 km mean maximum + 1SD for Manx shearwater are included in Table 6.5 as there may be connectivity between the sites. The closest SPA designated for Manx shearwater, Skomer Skokholm and the Seas off Pembrokeshire, is screened in to the next stage of the HRA. However, should the AA for the sites screened in conclude an adverse effect on the integrity, an iterative approach may be applied whereby an AA may be conducted for the next closest harbour porpoise site within the’</td><td>Noted. Report text updated accordingly.</td></tr>
<tr><td>The Wildlife Trust</td><td>84</td><td>Ornithology</td><td>Table 6.2: Total risk score from collision page 6-13 Can you confirm if these figures are correct for Manx Shearwater?<table><tr><td>Manx shearwater</td><td>0</td><td>0</td><td>2</td></tr></table></td><td>These scores are correct and in accordance with Furness et al. (2013).</td></tr>
</table>

Consultee	Ref. No.	Topic	Comment	Action/Response
The Wildlife Trust	85	Ornithology	Can you please advise if Common Scoter were included in the SOSSMAT assessment? The importance of the region to Common scoter *Melanitta nigra* on post breeding passage should receive more attention. Between July – October tens of thousands of birds move south through the region, in the most part to their over-wintering grounds in Carmarthen Bay.	The omission of common scoter from the HRA screening report was made in error. This species is included in the SOSSMAT assessment; reference has been updated accordingly within the RIAA (Section 9.9.2).
The Wildlife Trust	86	Ornithology	We welcome the inclusion of this critically endangered species in the HRA screening report following its omission from the EIA report. However, our concerns over the correct identification from similar Manx shearwater by the DAS means we seek further reassurances from HiDef about them not being recorded to date. At this stage we cannot agree with your assessment that '*it is considered unlikely that the species visits the Project array area*'.	As part of the analysis undertaken by the University of Oxford (OxNav) for the Project, an assessment was undertaken as to the importance of the Erebus site for Balearic shearwaters and connectivity with Spanish SACs. This information has informed the ornithological impact assessment (Section 9.8). In addition, it should be noted that HiDef have recorded >400 Balearic shearwater during historical surveys. None of these have been within UK waters, HiDef have on occasion recorded this species in Irish waters. However, the majority of sightings have been in French waters. As such, it is considered that the DAS would identify Balearic shearwater if it were present at the Project site.
NRW	87	Marine and Estuarine Fish	We agree with the overall outcome of the screening process, however, please note comments below regarding rationale for the screening distance and the omission of allis and twaite shad from listed sites/species.	Noted.
NRW	88	Marine and Estuarine Fish	In this table under Item 3 it says: The habitat site hosts a mobile population of a qualifying interest feature (e.g. Annex I birds, Annex II or IV marine mammals, or Annex II Migratory Fish populations) that may interact directly	This comment is noted and accordingly the threshold for screening SAC sites has been amended from 10 km to being in line with the maximum extent of potential impacts as determined by the Project specific noise

Consultee	Ref. No.	Topic	Comment	Action/Response
			with the spatial area of the Project footprint. The asterisk text clarifies further the spatial area has defines [sic] for foraging ranges presumably for birds (and marine mammals?) but not how it will be interpreted for migratory fish.	modelling. The modelled worst case impact range for piling effects, based on criteria from Popper *et al.* (2014) is 20 km. As such, the screening threshold is amended to 20 km from turbine structures. The maximum level of disturbance associated with the Export Cable Corridor (ECC) is likely to result from unexploded ordnance (UXO) clearance. Acoustic emissions caused by UXO clearance will be emitted as a single pulse; Popper *et al.* (2014) provide specific criteria for explosions, and these are used in the determination of potential impact range. The maximum range for mortality and potentially mortal injury from Project UXO clearance, based on criteria provided by Popper *et al.* (2014), was modelled to be 930 m. In accordance with the information provided above, the threshold for screening SAC sites has been set as 20 km from the array area and 930 m from the ECC. However, although the Cleddau Rivers SAC is located 13.6 km from the Project ECC and >65 km from array area, this site has been screened into Stage 2 (Section 7.6) as the river drains directly into Milford Haven. It is therefore considered that there is a high probability that individuals would pass through/close to the Project footprint during seasonal migration.
NRW	89	Marine and Estuarine Fish	In this section a Zone of Influence (ZoI) has been set as 10km from the project and cable corridor. No rationale for the use of the 10km range has been provided, and in Table 4.1 it states that 'Acoustic impacts on fish are not expected at distances greater than 1 km from the noise source (Popper et al., 2014; Subacoustech, 2018).' NRW have been in consultation with the applicant on their	This comment is noted and accordingly the threshold for screening SAC sites has been amended from 20 km to being in line with the maximum extent of potential impacts as determined by the Project specific noise modelling. The modelled worst case impact range for piling effects, based on criteria from Popper *et al.* (2014) is 20 km. As

Consultee	Ref. No.	Topic	Comment	Action/Response
			noise modelling report and would advise that the potential ZoI is informed through the noise modelling presented in this report once finalised, and that a rationale for the 10km range for other impact pathways is provided. We note that in particular twaite and allis shad are a receptor and known to be sensitive to noise disturbance. We further note that on page 13-5, Table 13.1 a regional sea-scale screening approach is recommended as the screening distance for Annex II migratory fish species.	such, the screening threshold is amended to 20 km from turbine structures. The maximum level of disturbance associated with the ECC is likely to result from UXO clearance. Acoustic emissions caused by UXO clearance will be emitted as a single pulse; Popper *et al.* (2014) provide specific criteria for explosions, and these are used in the determination of potential impact range. The maximum range for mortality and potentially mortal injury from Project UXO clearance, based on criteria provided by Popper *et al.* (2014) was modelled to be 930 m. In accordance with the information provided above, the threshold for screening SAC sites has been set as 20 km from the array area and 930 m from the ECC. However, although the Cleddau Rivers SAC is located 13.6 km from the Project ECC and >65 km from array area, this site has been screened into Stage 2 (Section 7.6) as the river drains directly into Milford Haven. It is therefore considered that there is a high probability that individuals would pass through/close to the Project footprint during seasonal migration. In order to provide a further precautionary level to assessment, and in recognition of levels of uncertainty associated with migratory fish behaviour and noise sensitivity of species such as shad, a stepwise approach is also applied. If the outcome of Stage 2 assessment for any migratory fish species determines AEOSI, then a further screening exercise will be undertaken to determine potential for LSE for the next closest SAC population to the Project site.
NRW	90	Marine and	Regarding river lamprey, please note that although river	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
		Estuarine Fish	lampreys are primarily found in coastal waters, trawl data from Cefas has recorded them up to 40km from shore, and as river lamprey are parasitic on a range of fish species, their distribution at sea is likely to depend on the host species.	
NRW	91	Marine and Estuarine Fish	While we do not disagree with the outcome of the screening process for fish, we do agree with the rationale provided. Migration corridors and feeding areas for life stages of Annex II Migratory Fish species are generally poorly understood and there is no evidence base for the suggestion that the Project Area and Cable Corridor is or is not, important for migratory fish. However, given that the area is small and that NRW agree with the low risk to Annex II fish features from the impact pathways we agree with the overall conclusions of the HRA screening.	Noted.
NRW	92	Marine and Estuarine Fish	Please note that Carmarthen Bay and Estuaries SAC is also designated for allis and twaite shad, information which is omitted in Table 4.2. As shad species are particularly sensitive to noise we advise a stepwise approach where if the outcome of Stage two assessment of allis and twaite shad in Pembrokeshire Marine SAC determines AEOSI for either species, then a further screening exercise to determine potential for LSE for the more distant Carmarthen Bay and Estuaries SAC shad populations should be carried out.	This comment is noted, and this iterative approach has been applied within the RIAA. As the assessment for the Pembrokeshire Marine SAC determined no AEOSI (Section 7.5), the Carmarthen Bay and Estuaries SAC is not screened into Stage 2 assessment.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	93	Marine Mammals	The HRA screening has focussed on the wind farm area with no reference to the export cable. The proposed export cable route may pass through one of two SACs designated for harbour porpoise. The HRA will need to consider potential impacts from the installation of the export cable in addition to those at the wind farm area. We anticipate the key activity associated with installation of the export cable that may impact these sites would be UXO clearance however potential impacts should be assessed against all conservation objectives, including habitat loss and Conservation Objective 3.	Noted.
JNCC	94	Marine Mammals	JNCC agree with the approach of screening harbour porpoise sites into the HRA based on overlapping impact pathways. However, we note that an update to the Cumulative Effects Assessment stage 1 document (received May 2021) commits to using the marine mammal management units to screen sites into the assessment. While it is acceptable to have different screening approaches for different types of assessment, providing a justification for the differences in all relevant documents will avoid confusion.	This point is noted. All sites within the appropriate harbour porpoise MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined, then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	95	Marine Mammals	JNCC agree that the greatest impact to marine mammals is likely to occur as a result of UXO clearance. We assume the 26km distance for screening is based on the EDRs described in the noise management approach published for the harbour porpoise sites. If an impact pathway approach is employed, we recommend a 50km buffer is used for screening purposes, as the full impacts to marine mammals are still unclear and impacts to porpoise from piling have been recorded at this distance (MEG 2015).	This point is noted and has been considered within the RIAA. As mentioned in the response to comment 94, all sites within the appropriate harbour porpoise MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined, then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2. A 26 km EDR has been used for the assessment of UXO detonation as per current advice (JNCC, 2020).
JNCC	96	Marine Mammals	We note the assessment has considered Ramsar sites and has screened the Les Pierres de Lecq (the Paternosterers) site into the AA for common dolphins. This site is 334km away from the proposed wind farm area and inclusion of this site into an AA is contrary to the method used to screen the other cetacean sites, which are screened based on impact pathways. This is confusing and a consistent approach should be applied to all sites. Given the distance of this site to the proposed works, we do not agree with the conclusion of LSE for this site. We also note that Section 5.1.1 states that eight Ramsar sites are designated for marine mammals within French waters however the above site has been designated by Jersey	The screening report has been updated to amend the reference to French waters, and update screening approach to be in line with that for other marine mammal receptors.
JNCC	97	Marine Mammals	We agree that a separate assessment will be required for these species within the EIA (Section 5.2) however it is unclear why Annex IV is repeatedly referred to within this	This comment is noted. Only Annex II species have been referenced in the RIAA (Section 0).

Consultee	Ref. No.	Topic	Comment	Action/Response
			section. Only those species listed on Annex II of the Habitats Directive should be considered in an HRA process, which for cetaceans is limited to harbour porpoise and bottlenose dolphin	
JNCC	98	Marine Mammals	JNCC agree that habitat loss as a result of the proposed works will be minimal, however the potential for in combination effects are unclear. Subsequently we do not agree with the conclusion to rule this pressure pathway out of the assessment for the harbour porpoise sites, which include a conservation objective protecting the habitat and processes of porpoise and their prey. This will be of relevance when assessing the installation of the cable route which may pass through a porpoise site. We anticipate operations such as trenching, pre-sweeping and disposal activities as having the potential to impact the achievement of this conservation objective. We also note that presence of operating turbines and associated infrastructure has not been discussed when considering disturbance/displacement; only disturbance because of vessel/construction noise has been considered.	This comment is noted. Assessment of in-combination habitat loss has been considered within the RIAA. The RIAA has also considered displacement due to the presence of operating turbines and associated infrastructure. (See Section 8.1.2.)
JNCC	99	Marine Mammals	This table provides indicative data of marine mammals likely present in the project area based on one year of digital aerial surveys. We again advise that when assessing impacts on marine mammals, a range of density estimates from existing data and project survey effort alongside their associated assumptions and limitations should be presented, and the most suitable estimate for use in assessment should be agreed with SNCBs.	This point is noted, and the RIAA provides densities as agreed with SNCBs. A technical note setting out the approach to developing marine mammal density estimate to be assessed in the EIA was submitted to NRW and JNCC in August 2021. Additional sources of data were identified by NRW and JNCC and these were considered in the density estimates as set out in Chapter 12: Marine Mammals.

Consultee	Ref. No.	Topic	Comment	Action/Response
JNCC	100	Marine Mammals	This table groups potential effects during construction, operation and decommissioning together however the justification for each effect only focusses on construction activities. Recommend commentary is included as to how these effects may differ during the different stages of the project	This comment is noted and assessment within the RIAA has been carried out accordingly (Section 0).
JNCC	101	Marine Mammals	This section only provides text for harbour seal with no discussion or conclusions for grey seal, despite the majority of sites listed in Table 5.3 being designated for grey seals.	The HRA Screening Report has been updated to note that grey seal are screened in for Stage 2 assessment (Section 8.6).
JNCC	102	Marine Mammals	Table 5.3 only provides distances from the wind farm area with no reference to how far the sites listed are from the export cable route.	This table has been updated accordingly.
JNCC	103	Marine Mammals	This section states that '*no LSE has been concluded for all cetacean species other than …*'. Suggest rewording this sentence to make it clear what has been assessed as the assessment should not have considered 'all' cetaceans, only those listed on Annex II and as features of Ramsar sites.	HRA Screening Report updated accordingly.
JNCC	104	Marine Mammals	There are several sweeping statements in this chapter with no justification or reference as to where this information has come from. For example: marine mammals commonly occur in turbid environments and the foraging ranges quoted for seals.	The HRA Screening Report has been updated to provide references for the specified foraging ranges.

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	105	Marine Mammals	Our position on the use of MMMUs in HRA is that when a credible impact pathway is identified, all sites with that feature within the relevant MMMU for that species should be screened in for AA. As such, we do not agree with the conclusion of no LSE for SACs within the relevant MMMU where an impact pathway has been identified to the feature	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined, then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	106	Marine Mammals	We do not consider the 26km radius appropriate to use for screening for impacts from UXO, and cannot agree to this being the radius of impact from UXO without the underwater noise assessment to corroborate this position	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined, then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	107	Marine Mammals	The applicant should present a range of density estimates for marine mammals from the digital aerial survey results and other sources, and the most suitable estimate for use in assessment should be agreed with SNCBs	This point is noted, and the RIAA provides densities as agreed with SNCBs A technical note setting out the approach to developing marine mammal density estimate to be assessed in the EIA was submitted to NRW and JNCC in August 2021. Additional sources of data were identified by NRW and JNCC and these were considered in the density estimates

Consultee	Ref. No.	Topic	Comment	Action/Response
				as set out in Chapter 12: Marine Mammals.
NRW	108	Marine Mammals	The document presents inconsistencies and could be simplified to present a clearer approach, particularly in relation to functionally linked land. It would also benefit from some additional QA, including correcting the spelling of "*Phoca vituline*" (*Phoca vitulina*) and "*Tursiops truncates*" (*Tursiops truncatus*)	The typos identified have been amended within the HRA Screening Report.
NRW	109	Marine Mammals	When considering impacts on the marine mammal features of Special Areas of Conservation (SAC), we consider that as mobile species they have the potential to be impacted outside the boundaries of the SAC. We therefore use the relevant Marine Mammal Management Unit as the scale at which to assess potential impact. If credible impact pathways are identified, or there is reasonable doubt as to absence of an effect from the relevant impact to a marine mammal Annex II feature, in view of the conservation objectives, then all sites with that feature within the relevant MMMU for that species should be screened in for AA (NRW, 2020).	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined, then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	110	Marine Mammals	Screening criteria '3' described in Table 2.1 state that sites will be screened "where the Project overlaps with the foraging range of any Natura 2000 or Ramsar site qualifying species". We support this approach in that we consider MMMUs to represent the range of marine mammals - however, this principle has not been applied in the case of UXO where an impact range of 26km has been assumed, and sites beyond that range have been screened out.	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined, then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional,

Consultee	Ref. No.	Topic	Comment	Action/Response
				more distant sites were considered at Stage 2.
NRW	111	Marine Mammals	We note the low sighting numbers for some species recorded from year 1 survey results, and as per our previous comments to the applicant and the minutes of the Project Erebus Underwater Noise Meeting on 6th May, NRW advise that when assessing impacts on marine mammals a range of density estimates from existing data and project survey effort alongside their associated assumptions and limitations should be presented, and the most suitable estimate for use in assessment should be agreed with SNCBs.	This point is noted, and the RIAA provides densities as agreed with SNCBs A technical note setting out the approach to developing marine mammal density estimate to be assessed in the EIA was submitted to NRW and JNCC in August 2021. Additional sources of data were identified by NRW and JNCC and these were considered in the density estimates as set out in Chapter 12: Marine Mammals.
NRW	112	Marine Mammals	It is not clear what is meant by "*The following marine mammals have been assessed*" – clarity should be provided if this refers to what will be assessed within the HRA specifically. We note that bottlenose dolphin and harbour porpoise are also species for which an EPS licence should be sought if appropriate. We also note that distances used in discussing the extent of temporary increases in suspended sediments/smothering are not consistent with those used in the Annexe I Benthic Habitats section (see Physical Processes comments).	Text has been amended to specify that "*The following marine mammals have been considered within the HRA screening report*". It is accepted that the suspended sediment plumes noted are not in accordance with more recent modelling data that have been produced since the report was drafted. The relevant sections have been updated accordingly.
NRW	113	Marine Mammals	The list of potential noise sources is not exhaustive, and for completeness should be noted as such. Other sources include operational noise from project infrastructure and noise sources associated with maintenance activity, including vessels and works.	HRA Screening Report updated accordingly.

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	114	Marine Mammals	As above, we recommend the applicant follow our suggested approach on the use of MMMUs in HRA (NRW 2020).	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	115	Marine Mammals	We cannot confirm that the impact range for UXO is 26km without a full underwater noise assessment to support this approach. We do not believe that the use of 26km is suitable as a screening approach for marine mammals for this pathway.	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	116	Marine Mammals	We cannot confirm that a 26km radius represents the impact radius from disturbance without a full underwater noise assessment to support this approach.	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been

Consultee	Ref. No.	Topic	Comment	Action/Response
				considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	117	Marine Mammals	We advise that the risk of collision applies to project infrastructure alongside works vessels. In order to conduct a precautionary assessment, we recommend that any collisions should be considered fatal unless there is evidence to support an alternate approach.	Project infrastructure will not comprise any moving parts. As such, the associated collision risk is considered to be very low. However, this point has been considered within the RIAA (Table 8.1).
NRW	118	Marine Mammals	There is no section detailing the screening approach for grey seal, as for 5.5.1 harbour seal and each cetacean species in 5.5.2. Table 5.3 indicates screening results based on foraging distance, but a comparable section should be included for grey seal.	HRA Screening Report updated to address this comment.
NRW	119	Marine Mammals	As noted previously, we cannot agree that the impact range for UXO is 26km without a full underwater noise assessment to provide evidence to support this approach.	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.

Consultee	Ref. No.	Topic	Comment	Action/Response
NRW	120	Marine Mammals	We note the applicant's assertion that; "*It is considered that the HRA approach for harbour porpoise is in accordance with the 2020 NRW Position Statement NRW's position on the use of Marine Mammal Management Units for screening and assessment in Habitats Regulations Assessments for Special Areas of Conservation with marine mammal features (NRW, 2020) and provides a precautionary and proportionate approach*" on page 5-23. However, our position on the use of MMMUs in HRA, as described above, is "*If credible impact pathways are identified, or there is reasonable doubt as to absence of an effect from the relevant impact to a marine mammal Annex II feature, in view of the conservation objectives, then all sites with that feature within the relevant MMMU for that species should be screened in for AA*" (NRW 2020), so we advise that additional sites should be screened in to the applicant's AA. A sequential approach can then be applied to the AA of SACs within the management unit.	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.
NRW	121	Marine Mammals	We do not agree with the conclusion of no LSE for SACs within the relevant MMMU where an impact pathway has been identified to the feature. We recommend the applicant follow our position on the use of MMMUs in HRA to conclude LSE on all sites within a MMMU and then iteratively assess sites in the AA as outlined in our position (NRW 2020).	This point is noted. All sites within the appropriate MMMU have been screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If AEOSI is determined then assessment has been carried out for the next closest site. If no AEOSI is determined, more distant sites have not been considered further. As no AEOSI is determined for all sites assessed (Sections 8.5.1, 8.5.2, 8.5.3, and 8.6.1), no additional, more distant sites were considered at Stage 2.

Consultee	Ref. No.	Topic	Comment	Action/Response
The Wildlife Trust	122	Marine Mammals	We question if habitat loss should be screened in for the in-combination assessment.	This point is noted and this pressure is screened in with specific consideration of in-combination effects (Table 8.1).
The Wildlife Trust	123	Marine Mammals	We would like to discuss the how displacement, entanglement and barrier effects will be assessed at a future Expert Topic Group meeting.	Noted.
The Wildlife Trust	124	Marine Mammals	I have consulted one of our marine mammal specialists and we have both had a look at the document that you provided. We recommend that you include the Isles of Scilly Complex SAC (Grey Seal is listed as a qualifying feature) as, although it is far away, you should demonstrate that you have considered it, even if you then screen it out of further assessment. Also the Bristol Channel Approaches is a joint English/Welsh site.	Potential for impact on grey seal has been assessed for the Pembrokeshire Marine/Sir Benfro Forol SAC (Section 8.6.1). However, an iterative approach has been adopted, where if assessment for this site determined AEOSI, then assessment would be extended to include the next closest site. However, as no AEOSI was determined, more distant sites have not be considered further.
NRW	125	Physical Processes	*"A zone of influence is used to account for indirect effects on Annex I Habitats. This is set to corresponding with one tidal excursion distance the approximate distance over which water (or a section of plume with elevated SSC) is advected during one flood or ebb tide. Under mean spring conditions, this is approximately:* • *10 km around the array area;* • *14-15 km around the middle of the ECC (approximately KP20);* • *18-19 km in the nearshore approaches to Milford Haven (approximately KP10);* • *4 km within Milford Haven."* We welcome the approach outlined above but note that it has not been applied consistently throughout the	Noted.

Consultee	Ref. No.	Topic	Comment	Action/Response
			document.	
NRW	126	Onshore Protected Species	We have reviewed the screening report and are in agreement with the sites set out in Section 8 that have been screened in for appropriate assessment in relation to terrestrial protected mammal species.	Noted.
NRW	127	Onshore Protected Species	We agree with the list of sites screened in, the impact pathways identified and those that remain in.	Noted.
NRW	128	Onshore Protected Species	We note and appreciate the precautionary approach taken in screening in features. We have no suggested alterations.	Noted.
JNCC and NRW	129	Onshore Protected Species	The document would benefit from the inclusion of figures illustrating where the Project Erebus array boundary and cable corridor route will be located relative to the MPAs being discussed. As the document has been ordered by receptor, we would recommend a separate figure in each section illustrating the sites relevant to that section.	The text throughout the assessment has been updated to include relevant distances to sites and/or receptors.
JNCC and NRW	130	Onshore Protected Species	We also request shape files for the wind farm area and proposed cable route are provided to help inform future responses.	Data will be submitted with the submission of the application and supporting documentation.

3. Detailed Project Description

3.1. Introduction

This section presents the proposed development description of the Erebus Floating Offshore Wind Project (the Project), covering both the offshore and onshore elements of the Project.

At this stage in the development process for the Project, the proposed description is indicative, and a Project Design Envelope (PDE) approach has been adopted, see Chapter 4: Proposed Development Description. Further details of the use of a PDE or "*Rochdale Envelope*" are provided in detail within Chapter 2: Overview of EIA Methodology and summarised below. This approach has been set out and agreed with Planning and Environment Decision Wales (PEDW), formerly the Planning Inspectorate (PINS) and NRW through the consultation process; furthermore, this approach has been adopted on all UK offshore wind farm projects to date, and is widely accepted by all stakeholders.

3.2. Project Description

The proposed Project is a demonstration scale Floating Offshore Wind (FLOW) development in the Celtic Sea region. The array area is located approximately 35 km southwest of the Pembrokeshire coastline, covering an area of 43.5 km^2 in water depths of between 65-85 m. The array area is located outside of the 12 nm limit, but all elements of the Project, array area, offshore export cable corridor and landfall, fall within Welsh territorial waters or the Welsh Zone.

The Project comprises six to ten Wind Turbine Generators (WTG) with a total generating capacity up to 100 MW. Each WTG is housed on a semi-submersible floating platform with a mooring system comprising a maximum of five catenary mooring lines, up to 870 m in length, and a range of foundation options including drag embedment anchors, driven piles, drilled piles and/or suction piles. Up to 10 dynamic array cables are proposed, with a lazy wave configuration from the semi-submersible floating platform to the seabed. The offshore export cable, up to 49 km in length, links the array area to landfall at West Angle Bay, Pembrokeshire. The key project components of this Project are summarised below:

- Generating capacity up to a total of 100 MW;
- 6-10 WTGs ranging in capacity from 9.5-18 MW;
- 6-10 semi-submersible floating platforms;
- Associated subsea catenary mooring lines;
- A range of potential anchoring solutions (drag embedment anchors; suction piles; drilled piles; driven piles);
- Up to 10 dynamic array cables;
- Marine export cables, cable joints, associated external cable protection;
- Onshore export cable(s);
- Onshore substation;
- Main construction compound and temporary construction compounds;

- Onshore cable corridor, underground cables, transition bay, joint bays/inspection chambers, access points and haul roads; and
- Other associated infrastructure, such as navigational markers.

3.3. Consideration of Alternative Solutions

The Project has been through a detailed multi-stage process for site selection and for consideration of alternatives. The process began with identification of the need for the Project, specifically that the Project will play a key role in helping the UK reach its goal of net zero by 2050.

The selection and consideration of alternatives process involved a total of 13 stages:

- **Stage 1**: Defining the initial area of search (March 2019-April 2019);
- **Stage 2a**: Preliminary offshore array site selection (May 2019-June 2019);
- **Stage 2b**: Refined offshore array site selection (July 2019-August 2019);
- **Stage 3**: Grid investigation and grid application (May 2019-October 2019);
- **Stage 4**: The Crown Estate agreement for lease (June 2019-October 2019);
- **Stage 5**: Preliminary landfall assessment and offshore cable corridor development (March 2019-December 2019);
- **Stage 6**: Environmental Impact Assessment scoping (October 2019-January 2020);
- **Stage 7**: Export cable route and landfall surveys (September 2020-November 2020);
- **Stage 8**: Landfall selection (January 2021-April 2021);
- **Stage 9**: Onshore project substation location (March 2020-May 2021);
- **Stage 10**: Offshore cable route refinement and burial assessment (January 2021-April 2021);
- **Stage 11**: Onshore cable corridor and route (January 2021-May 2021);
- **Stage 12**: Final offshore export cable route refinement (April 2021-July 2021);
- **Stage 13**: Final project details and locations for consent applications.

Once the need for the Project had been determined, the site selection process started with the initial area of search, the Celtic Sea region. This was followed by individual steps to identify the most feasible option for each stage of the project – the offshore array area, export cable corridor, landfall, onshore cable corridor, and onshore substation. Each stage took several factors and constraints, including those related to engineering, environmental, and consenting, into consideration to identify the Best Practicable Environmental Option (BPEO) for the Project. The interaction between each stage of the Project was key to this process, for example, the landfall and onshore and offshore export cable corridor could not be considered in isolation, as they are all linked.

A detailed overview of the full process can be found in ES Volume 1, Chapter 3: Site Selection and Alternatives. A summary of the final selection is provided below:

- An array area located approximately 35 km southwest of the Pembrokeshire coastline in the Celtic Sea. The offshore array area measures approximately 43.5 km^2;
- Array cables and an offshore export cable, up to 49 km in length to landfall at West Angle Bay;
- Approximately 10.8 km of onshore cabling from West Angle Bay to the grid connection at Pembroke Power Station;

- An onshore substation located approximately 850 m south of Pembroke Power Station and cable into the grid connection point.

3.4. Construction Programme

The current indicative construction programme outlines key activities and when these are proposed to take place (Figure 3.1). The programme does not include expected time on site – this information is covered in the following subsections. The final installation and full generation date are proposed to be 2026.

Figure 3.1: Indicative development and installation programme for the Project

Tasks Milestones	2021	2022				2023				2024				2025				2026				2027 -> 2052
	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
Submission of the ES																						
FEED																						
Detailed Design																						
Fabrication																						
Construction (onshore and Offshore)																						
Final commissionning of WTG Units																						
Start-Up of Erebus																						
Operation of Erebus																						

3.4.1. Offshore Construction Activities

3.4.1.1. Wind Turbine Generators and Semi-submersible Floating Platform

The delivery of WTG and semi-submersible floating platform components will be straight to port and it is intended the integration will be undertaken at quayside. Works are still underway to establish which port will has capacity and is of a scale to accommodate the following stages.

The works at port are anticipated to involve delivery and unloading of WTG and semi-submersible platform components; wet store/moor of semi-submersible platforms at quayside; preparation and sequential installation of WTG components onto semi-submersible platforms; and pre-commissioning of fully assembled semi-submersible floating platform and WTG unit at quayside.

A preinstallation survey of the array area where mooring lines and anchors are to be installed will beF conducted.

Anchor Handling and Tug Supply vessels will be utilised, along with specialist Remote Operated Vehicles (ROVs), to lay the anchors and mooring lines, one after another, for each WTG unit. All vessels will be Dynamically Positioned (DP Class) with no vessel anchor deployment required. After deployment, anchors will be proof load tested and, except for the anchor and chain, no other part of the permanent mooring system will be connected during proof load testing. Anchors may be equipped with transponders or similar systems, in order to verify correct positioning after load testing.

Each structure will be subject to full mooring analysis and the pre-tensioned mooring system will be completed for each structure in accordance with the outcome of the analyses. The pre-installed mooring system cable ends will be temporarily buoyed off in preparation for later attachment to the WTG/substructure assembly, following its arrival on site.

Offshore tow and mooring hook up will be timed according to when weather forecasts indicate a suitable window for the planned works. In terms of duration, it is predicted that the installation of the moorings/anchors will take up to 44 days, and the subsequent tow out and hook up of the maximum number (10) semi-submersible floating platforms is predicted to take up to an additional 46 days. These values are inclusive of transit times to and from local ports, and include a 50% weather downtime. Therefore, the main works in the array area are expected to take up to 90 days.

3.4.1.2. Offshore Export Cable and Array Cables

Offshore electrical infrastructure includes the array cables and the export cable.

It is anticipated that the array cables will be installed following deployment of the semi-submersible floating platforms. It is anticipated that the cables will be manufactured in a single length, with no external connectors, in order to optimise efficiency and reduce cost. An alternative method is to manufacture the static and dynamic sections of cable separately, with a permanent mate-able transition joint connecting them. Once cables and associated hardware (bend stiffeners, buoyancy modules, and touchdown point protection) have been installed, the array cables will likely be stabilised using rock bags.

Based on installation of the maximum length of array cable, the duration of the installation works is expected to take up to 63 days, inclusive of cable protection works, operational contingency, and 50% downtime due to adverse weather.

Substantial investigative work has been undertaken in order to select an appropriate export cable corridor (ECC) that avoids several constraints and seabed features (refer to Volume 1, Chapter 3: Site Selection and Alternatives of the main ES). Installation of the offshore export cable will undergo detailed design work and several activities prior to installation. These are summarised in the following subsections.

Pre-construction Surveys

Prior to installation, further geophysical and geotechnical surveys of the ECC are likely to be undertaken in order to obtain detailed and up to date information on debris, boulders, presence of unexploded ordnance (UXO), seabed features, and water depth along the route. These data will be reviewed to inform the finalised export cable route within the ECC, the target burial depth, exact installation methods, and requirement for cable protection works.

Unexploded Ordnance Clearance

The Project is seeking consent for a single (1) UXO detonation via low order detonation (deflagration). Deflagration represents the preferred method for UXO clearance and is based on current industry knowledge and precedence set by other OWF projects. As such, this constitutes the realistic worst-case scenario and is used to inform this RIAA. The approach, informed by the UXO

Threat and Risk Assessment (6-Alpha Associates, 2020), provides an assessment of potential threat sources and the likelihood of contamination across the Project array area and ECC.

A pre-installation geophysical survey, including use of a magnetometer, will be conducted in order to identify any UXO targets along the cable route. Should UXO be identified, the intention is to route the cable around the UXO to avoid interaction. A more detailed assessment of the specific target will be undertaken, should re-routing of the cable not be possible.

Should more than 1 UXO target require clearance, the Project will engage with regulators and apply for a Marine Licence variation to allow additional UXO clearance via deflagration.

Boulder Clearance

Approximately 3-6 months before the pre-lay grapnel run (PLGR), boulder clearance may be required, depending on the density of boulders identified in the pre-installation survey. Clearance may be undertaken by the following methods:

- SCAR plough (15 m wide footprint, 0.5 m penetration);
- Sub-sea grab.

Should a SCAR plough be used, the total footprint is estimated to be: 15 m (7.5 m either side of the centre line), along up to 12 km of the export cable route, equating to a total of 180,000 m^2.

Based on current knowledge of the density and distribution of boulders within the ECC, and inclusive of operational contingency and a 50% downtime due to weather, the boulder clearance operation is expected to take up to 30 days.

Pre-lay Grapnel Run

Following pre-installation surveys, UXO clearance, and boulder clearance, a PLGR will be undertaken. This is designed to clear the export cable corridor of debris prior to installation and involves use of a series of grapnels and chains being pulled along the export cable corridor, affecting an area up to 15 m wide (where multiple passes are required), with penetration up to 0.5 m.

Based on current understanding of the offshore cable corridor, and taking operational contingency and 50% weather downtime into consideration, the PLGR operation is expected to take up to 24 days.

Sandwave Levelling

Where mobile bedforms are unavoidable, sandwave levelling will take place, preferably using a Mass Flow Excavator (MFE) or jetting; however, Trailing Suction Hopper Dredging (TSHD) remains an option to ensure a worst-case scenario is assessed.

A total volume of 403,000 m^3 is proposed to be levelled from within the ECC, with an additional 160,600 m^3 from within the array area.

Several disposal sites have been allocated within the offshore consent boundary to ensure that if TSHD is required, the sediment dredged remains within the local system. The disposal sites range

from 900-5,600 m in length and are positioned at KPs 7.8, 12.6, 14.7, and 28.8, and within the northern part of the array area.

Sandwave levelling is expected to occur at a rate of 500 m/day, with a current estimate of approximately 3,900 m of sandwave levelling required for the ECC. Inclusive of operational contingency and 50% weather downtime, this is expected to take up to 15 days. Levelling may also be required within the array area, for the array cables (3 sections totalling 550 m), mooring lines (2 sections totalling 120 m), and anchor locations (5 sections totalling 250 m). The levelling rate remains at 500 m/day, however, due to distance from shore, transit times are increased and weather conditions may limit levelling to 1 location per 2 days and, therefore, the activity may occur over 20 days (inclusive of transit times, operational contingency, and weather downtime).

Pre-Lay Trenching

Pre-lay trenching will take place prior to laying the offshore export cable at required sections of the route. A pre-trench plough will be used, creating a trench up to 3 m depth and running on skids extending 2 m either side (total width/footprint: 7 m). Multiple passes may be required to reach appropriate depth in places. Multiple passes are predicted to be required over approximately 13.5 km of the route, with up to 3 passes required. The rate of pre-lay trenching is an average of 500 m/hour. Based on the length of operations, and including operational contingency and 50% weather downtime, the multiple pass/pre-lay trenching works are expected to take up to 8 days.

Main Installation

Installation of the actual export cable is proposed to be undertaken via conventional cable plough, in order to minimise seabed disturbance. The plough runs on skids up to 5 m contact width, with the trench itself generally <1 m width, although up to 5 m in places, and up to 3 m in depth. The exact depth of offshore export cable will be defined in a post-consent cable burial risk assessment, taking ground conditions and external aggressors (trawling and vessel anchors) into consideration. The cable plough installation rate is typically 2 km/day, which, including operational contingency and 50% weather downtime, equates to up to 49 days for full installation.

Post-Lay Burial

Post-lay burial is understood to be required at joint locations along the export cable corridor. Mass Flow Excavator (MFE) will be used to bury the joints (150 m in length) and 250 m of offshore export cable either side, and will take up to 3 days per joint (including weather and operational contingency), i.e. 6 days in total.

3.4.1.3. Cable Protection

Where burial is not possible due to ground conditions, it is proposed that the array cable and offshore export cable will be partially buried or surface laid and then protected to the required depth using various solutions, including concrete mattresses, rock bags, or rock dumping. Based on the predicted amount of protection needed along the offshore export cable, and inclusive of operational contingency and 50% weather downtime, the activity is expected to take up to 20 days.

The total footprint of external cable protection proposed within the ECC (inclusive of a potential rock berm at the HDD exit point in the shallow sub-tidal section of West Angle Bay), is 83,380 m^2. This protection will be located at discreet locations along the export cable route and will comprise a rock berm with a 11 m base width and 2 m height above seabed level.

The total footprint of external cable protection proposed within the array area is 67,250 m^2, which comprises 11,000 m^2 of array cable protection and 56,250 m^2 of array cable stabilisation (rock bags).

3.4.1.4. Offshore Export Cable Joints

A total of 2 cable joints are proposed for the offshore export cable, at approximately KP15.0 and KP32.0. The jointing operation requires a window of good (calm) weather in order to minimise risk to vessel and crew. Jointing typically takes 1-10 days after both cable ends are secured on-board the vessel. Additional time will be required to recover the offshore export cables pre-jointing, and to re-bury the offshore export cables post-jointing. Including pre- and post- jointing operations, the joining itself, and allowing for operational contingency and weather downtime, the predicted length of operations is up to 24 days.

3.4.1.5. Offshore Export Cable Landfall (Marine)

Horizontal Directional Drilling (Marine Operations)

Where possible, HDD will be utilised at the cable landfall at West Angle Bay, in order to minimise disturbance impacts on the beach, intertidal, and nearshore environments.

A shallow draft Cable Lay Vessel (CLV) with a flat keel will be deployed to install the shore end section of the export cable from the HDD exit point in the subtidal area. Flat-bottomed barges can be self-propelled or reliant on support vessels for towage and assistance. They also tend to operate with an anchor spread up to 200-300 m either side of the export cable corridor, depending on water depth.

HDD boreholes will be required at West Angle Bay to install the High Density Poly Ethylene (HDPE) conduits through which the offshore export cable will be pulled in. The depth and length of these will be determined based on the outcome of the HDD feasibility study.

The offshore and onshore export cable circuits will be jointed at landfall, in the vicinity of the HDD entry point. The transition joint bay (TJB) will be backfilled following cable pulling operations and completion of the jointing works.

Open Cut Trenching (Intertidal Operations)

As a contingency measure if the primary landfall solution of HDD is unsuccessful, open-cut trenching is included in the consent application. If trenching at landfall is required, the trench will be divided into 2 sections: the nearshore, intertidal section, which can be excavated by land-based equipment; and the offshore, subtidal section, which will require excavation by marine plant/vessels.

For the intertidal section, a conventional track-based excavator will be used to open a trench from the TJB towards the subtidal region (approximately 500-600 m in length and 3 m wide). Removed material will be temporarily stored alongside the trench. Activities will be undertaken at low tide, in

order to maximise the extent of excavation using land-based equipment. A temporary trench support system, such as piling or cofferdams, may be required to provide support and stability and to reduce trench flooding. A service crane and ancillary lifting/loading vehicles will be required to install and remove trench support in the intertidal area.

For the subtidal section, a similarly sized trench will be excavated via barge mounted backhoe excavator or a 'walking spider' excavator (the preferred option in the proximity of mean low water due to its greater manoeuvrability). Excavated material will be stored within a hopper on a nearshore barge.

The CLV will be anchored at approximately 700 m from mean high water, assisted by Rigid Inflatable Boats (RIBs) to assist in maintaining cable alignment during shore pull operations. Once the offshore export cable is installed in the open-cut trench, the excavated material will be re-instated to the trench and, where required, the original beach profile will be restored via manual reprofiling.

3.4.1.6. Summary of Offshore Construction Activities

A summary of the maximum expected duration and vessel utilisation is provided in Table 3.1.

Table 3.1: Predicted duration of and vessel utilisation during offshore construction activities

Offshore Construction Activity	Maximum Predicted Duration of Works (days)	Maximum Predicted Vessels on Site (no.)	Type(s) of Vessel on Site
Offshore Array			
Pre-installation survey	10	1	Survey vessel
Pre-installation unexploded ordnance (UXO) clearance	5	2	Survey vessel; Dive support vessel
Installation of site boundary navigation aid and markers	2	1	Multi-purpose work vessel
Installation of mooring lines and anchors	44	2	Anchor handling vessel; Feeder barge
Tow-out and hook-up of semi-submersible floating platform to mooring lines	46	4	Two vessels (2); Crew boat; Platform installation vessel
Inter-array cable installation (inclusive of cable protection)	91	2	Cable lay vessel (CLV); Support vessel
Export Cable Corridor			

Offshore Construction Activity	Maximum Predicted Duration of Works (days)	Maximum Predicted Vessels on Site (no.)	Type(s) of Vessel on Site
Pre-construction survey	10	1	Survey vessel
UXO clearance	5	2	Survey vessel; Dive support vessel
Boulder clearance	30	1	*Vessel to be confirmed*
Pre-lay grapnel run (PLGR)	24	1	PLGR vessel
Pre-trenching	8	1	*Vessel to be confirmed*
Sandwave levelling	15	2	Trailing Suction Hopper Dredger; Support vessel
Export cable installation	49	3	CLV; Guard vessel (2)
Export cable protection and cable crossings	20	2	Rock dumping vessel or multipurpose vessel; Support vessel
Landfall			
Option 1: horizontal directional drilling	147	6	CLV; Guard vessel; Anchor handling tug (AHT) (2); Rigid inflatable boat (RIB) (2)
Option 2: open-cut trenching	105	13	Shallow draught barge with backhoe excavator; CLV; Guard vessel; AHT (2); RIB (8)

3.4.2. Onshore Construction Activities

3.4.2.1. Construction Compounds

Temporary construction compounds will be established in order to facilitate the construction of onshore Project infrastructure. The location and requirements for the construction compounds are currently under consideration. Several compounds are proposed:

- 1 main compound located at the onshore substation;
- 1 landfall construction compound at the cable landing point;
- Up to 4 satellite compounds along the onshore cable corridor.

Indicative locations of the satellite compounds, and a strategy for their use, have been proposed for the purpose of Project planning, and assessment of potential maximum footprint for construction parameters. However, final satellite compound locations and exact dimensions have not been confirmed.

Construction compounds will be required to accommodate material for construction (e.g. cable drums), personnel facilities, vehicles and machinery, and suitable storage and working areas.

The estimated dimensions and total footprints are provided in Table 3.2.

Table 3.2: Estimated dimension of onshore construction compounds

Compound	Length (m)	Width (m)	Footprint (m^2)
Main compound (1)	100	50	5,000
Landfall (1)	70	50	3,500
Satellite (4)	50	50	(4 × 2,500) = 10,000
Total		18,500	

3.4.2.2. Open Cut Trenching

Open cut trenching is the proposed method for installation of the majority of the onshore export cable, this includes through areas of arable land, along roads, and crossing over small roads and waterways. Trenching through arable land requires less preparation, however paved roads and road crossings require removal of the road surface, and trenching through small waterways may require damming and overpumping or temporary flume pipes.

The trenches will typically be made by digging an up to 1 m wide trench along the route with a large excavator, requiring a 5 m wide access corridor. Another 5 m wide corridor for lay-down of equipment and extracted material is also required. Additionally, 1.5 m is required along either side of the trench for safety and support, as well as 3-5 m on the far side of the trench for access, storage, or working, as required. A total width of 30 m along the onshore cable corridor is expected as a worst-case, allowing for double trenching and contingency.

The onshore export cable will be buried at a depth of 0.8-1.0 m, except where it passes through agricultural land, where a minimum thickness of 1.1 m of earth is required above the onshore export cable. After installation, the onshore export cable is covered with 300 mm of stabilising material (e.g., sand), followed by native (previously excavated) material, and topped with at least 300 mm of topsoil.

Protective tiles may be installed in the trench above the onshore export cable in places, notably where the onshore export cable crosses roads. Where the onshore export cable passes watercourses, there should be a minimum of 2 m (rivers) or 1.7 m (ditches) of clearance between the bed of the river and top of the onshore export cable.

Other notable obstacles the onshore export cable may be required to pass include:

- Trees and hedgerows;
- Existing major utilities (such as pipelines and cables);
- Environmentally sensitive areas.

Ecological and hydrogeology pre-construction surveys will be undertaken along the onshore cable corridor, in order to identify any sensitivities that should be avoided.

Horizontal Directional Drilling (Terrestrial Operations)

Significant obstacles, such as large watercourses, may be crossed through use of HDD in order to avoid disturbance and obstruction. This will involve boring a pipeline underneath the obstacle, emerging at a target point on the opposite side, using an electronic transmitter to ensure positional accuracy.

3.4.2.3. Onshore Substation Construction

The onshore substation construction compound is likely to be required to accommodate the following:

- Cable drum laydown area for the drums for part of the cable route;
- Site offices and welfare facilities;
- Vehicles and heavy machinery required for construction of the substation and possibly for part of the cable route installation;
- Sustainable drainage systems/drainage provisions;
- A suitable construction material store and tool lock-ups for equipment;
- Working area and access space.

All components will be brought in on flatbed trucks, except the transformers and reactors, which may be treated as abnormal loads. These will be stored on-site and assembled when required.

Construction of the onshore substation is expected to take approximately 18 months. The substation dimensions will be 35 × 25 m (L × W), covering an area of 875 m^2, and 15 m in height.

3.4.2.4. Summary of Onshore Construction Activities

Table 3.3 outlines the key parameters associated with onshore construction. Parameters are subject to further refinement based on site surveys, however, the values below a considered to represent a worst case and have been used for the assessment.

Table 3.3: Key parameters with respect to the onshore construction activities

Parameter	Maximum
Overall	
Size of onshore site boundary (footprint (km^2))	TBC
Overall onshore construction duration (month)	18
Onshore Export Cable	
Length of onshore export cable (km)	14.5
Width of export cable corridor (m)	60
Number of onshore cable joints	TBC
Number of cable crossings	TBC
Target depth of cable burial (m)	1.5
Overall duration of onshore export cable works (month)	9
Onshore Substation	
Length (m)	35
Width (m)	25
Height (m)	15
Overall duration of onshore substation construction works (month)	18

3.5. Operation and Maintenance Programme

3.5.1. Offshore Operation and Maintenance

It is anticipated that Operation and Maintenance (O&M) activities will be required throughout the Project's lifespan. Maintenance and inspection activities will be performed after the WTG Unit in question has been shut down. Boarding of the Units will most likely be undertaken by Crew Transfer Vessel (CTV), but helicopter could potentially be an option. The CTV will dock with the floating platform, and access will be via ladders on the substructure, while the use of helicopter will hoist personnel directly onto the nacelle of the WTG.

The WTG Units are expected to be serviced on an annual basis using CTV and standard tools, this may increase to up to 2 visits per year, anticipated to be from Milford Haven. It is assumed that the duration of servicing activities will be up to 240 hours per year (based on the worst-case of 2 x 12 hour per WTG/year with 10 WTGs). Oil change will be performed at planned intervals for different systems (typical interval is 2-5 years).

Inspections of array cables and offshore export cables, moorings and substructure will normally be performed at intervals of 1-4 years using vessels with remotely operated vehicles (ROVs). To allow for adequate inspection, biofouling may also have to be removed from substructure, cables and mooring lines.

In addition to scheduled services, it is assumed that the WTG Units will, on average, require 10 unforeseen visits per Unit per year for corrective actions. Frequency of these corrective services will vary over the lifetime of the Project but, in total for up to 10 turbines, this could range from 50-200 days per year.

Exchange of large components could occur, and equipment failures may (in extreme events) require a new nacelle, blade or rotor. The WTG Units can be disconnected and towed to shore to allow more efficient working in sheltered waters, if offshore lifts are hindered by waiting on weather. Offshore lifts would require a crane vessel, while the tow-in solution is foreseen to require tug boat(s), anchor handling vessel(s) and a crane vessel/barge. The remaining WTGs will continue to operate in the situation where a WTG Unit has been removed.

Table 3.4: Summary of typical repairs and Project operating modes over time

Parameter	Minimum	Maximum
Vessel visits per year	1 x 12 hr day	2 x 12 hr day of CTV
Minor maintenance (in line with WTG Manufacturer maintenance recommendations)	1	7
Major maintenance (asset return to port)	1	3
Mooring line replacement	0	2

3.5.2. Cable Repairs/Remediation

An assumption has been made that a number of cable repairs and/or remediation events (cable re-burial via jetting and/or MFE) will be required over the lifetime of the Project. These activities have, therefore, been included in the PDE for the Project and form part of the relevant consent applications.

For a cable repair along the export cable, a section of cable will be recovered, either side of the fault, of sufficient length to enable a repair. The repair would comprise 2 new joints connecting a new section of cable with the ends of the original cable.

Recovery of the cable will be performed by means of a suitable DP vessel, or anchor barge if in nearshore region. A suitable dive spread/platform may also be needed, dependent upon operation. The exact length of cable exposed and recovered to a cable handling vessel will be proportional to 1.5 times the deepest tidal water depth at the location of the fault.

This ensures sufficient slack in the cable system to prevent unnecessary strain on the component parts during repair and reburial. The total length of cable exposed and replaced in any one repair event is unlikely to exceed 1,000 m. All recovered and redundant cable will be disposed of and recycled onshore, as appropriate .

Cut and exposed cable ends will be sheathed and buoyed to the surface in preparation for the repair operation. The buoyed ends will be recovered onto the cable handling vessel and cable jointing will commence.

The new section of cable will be jointed aboard a cable-handling vessel before being re-laid back to the seabed, via lowering from the repair vessel deck. Upon completion of repair works and the surface cable lowering operation from the repair vessel, the resting cable will be assessed to ensure it is in the correct position and sufficient slack is available.

This operation will either take place from the flat-back or cable handling vessel during recovery. The newly repaired array cable or offshore export cable will be placed on, or as close to the original cable/trench as practicably possible.

If mechanical re-burial of the cable section is required, jetting with a MFE suspended approximately 1-2 m above the seabed will be conducted. These techniques do not permanently add or remove any material from the seabed and take place along the existing offshore cable corridor where the sediment has previously been disturbed. This operation is expected to disturb no more than 2 m width of seabed sediment (maximum 7 m, if the array cable or offshore export cable cannot be reburied in the original trench from where it was recovered initially).

Where jetting is not technically feasible, trenching could be undertaken with the use of a backhoe dredger as a last resort. Both jetting and trenching by these methods would occupy a similar seabed footprint. Trenching is assumed, however, to represent the worst-case scenario due to the potential for more seabed sediment to be suspended into the water column. Re-burial via ploughing methods will not be technically feasible in this instance, due to the offshore export cables already being *in situ*.

Exact rates of re-burial will vary depending on ground conditions and the final tool used, with a range of 100-250 m/hr. Re-burial of the average length of cable repair assumed in this application (1,000 m) is expected to take approximately 5 days.

Upon completion of re-burial, a post-burial survey will be carried out in order to assess whether the array cable or offshore export cable is at the correct position and required burial depth. Where re-burial, via jetting is not successful, cable protection will be installed over the newly repaired cable.

For any repairs required of the array cables, the entire length of the damaged array cable will be removed and replaced with a new cable. The maximum length of a single array cable is 6,021 m and

an indicative width of 50 m disturbance has been assumed to de-bury and recover the cable. This equates to a footprint of temporary disturbance of up to 301,050 m^2 per array cable repair and 1,505,250 m^2 for all 5 array cable repairs.

For cable remediation, any previous as-laid cable data and/or data from recent geophysical surveys will be reviewed to finalise the areas requiring remediation. Following this, a cable pre-burial survey using a Multibeam Sonar (Pipe/Cable Tracker), or similar device will be used to confirm the exact location and current cable burial depth/areas of exposure.

The vessel's crane wire will then be attached to the jetting equipment lift bridle and the equipment lifted overboard and down to a point approximately 2 m above the seabed. When in the correct orientation the vessel will move the jetting equipment directly over the cable and lower the equipment further to the required safe distance above the cable to conduct the burial operations.

The jetting equipment will be powered up and manoeuvred along the exposed cable route at a steady rate; nominally 1 m/min. A quick pass over the excavated length with the jetting equipment mounted sonar will determine the success of the operation. If necessary, another pass may be required to achieve the specified depth. A post-remediation survey will be undertaken.

Key parameters related to these activities are detailed in Table 3.5. As with the initial cable installation works, further details on cable repairs and/or remediation events would be included in any future Cable Burial Management Plan.

Table 3.5: Summary of cable repair/remediation included in PDE

Parameter	Minimum	Maximum
Offshore Export Cable		
No. of cable repairs over lifetime	0	5
Length of individual cable repair (length of seabed affected)	50 m	1 km
Width of individual cable repair (width of seabed affected)	50 m	50 m
Area (m^2) of seabed affected by individual cable repair	2,500 m^2	50,000 m^2
Area (m^2) of seabed affected by all cable repairs	0	250,000 m^2
Number of remediation events (re-burial)	6	12
Area (m^2) of seabed affected by remediation events	30 m x 1 km x 6 Area =180,000 m^2	50 m x 1 km x 12 Area = 600,000 m^2
Array Cables		

Parameter	Minimum	Maximum
No. of cable remediation events over lifetime	0	5
Length of individual cable remediation (length of seabed affected)	1,042 m	6,021 m
Width of individual cable remediation (width of seabed affected)	30 m	50 m
Area (m^2) of seabed affected by individual cable remediation	31,260 m^2	301,100 m^2
Area (m^2) of seabed affected by all cable remediation	156,300 m^2	1,505,250 m^2

3.5.3. Onshore Operation and Maintenance

Cable systems are reliable and do not tend to require intrusive maintenance. At the link box/link pillar locations, electrical connections to the high voltage alternating current (HVAC) cables can be removed, enabling tests to establish the integrity of the cable, identify any overheats during commissioning, and allow regular maintenance or repairs in the event of suspected damage.

Maintenance of the onshore export cables will, typically, be limited to annual visual inspections along the onshore cable corridor to ensure no developments (such as heavy loads) are potentially affecting the installed onshore export cables. There is no easy access to the main onshore export cable lengths outside of the jointing bays, therefore specific onshore export cable maintenance would only be carried out on a section if a problem occurs – and only on the relevant section where the problem is located. At this point, a section (typically tens of meters long) would be removed, a new section (cable spare) spliced in with field joints, and the onshore export cable reinstalled to its previous state.

The maintenance requirements of the onshore substation are unique, based on its component makeup and the environmental conditions it exists in. Some general rules apply, however, as summarised below.

In terms of workman usage, during repair works, there will be a minimum of 2 persons on site at any one time (24 hours per day, 7 days per week). This is a critical health and safety measure as the substation is located in a rural area.

The substation is operated within its working range (specified electrical limits) and does not exceed this range on a regular basis.

The initial maintenance requirements of the substation within its first 5-10 years of operation will be less in comparison to the work requirements of the same substation in later life; this will be accounted for in the future planning of work on the onshore substation.

Typically, a substation will require more maintenance and works after completion to correct any issues arising from the installation. This could be in the form of regular bi-monthly visits to the site, within these visits a number of these tasks could be carried out at any one time.

More intensive maintenance may also be required once the substation reaches an age beyond its optimum performance age but still within its working life. This type of repair schedule is referred to as a proactive maintenance, acting upon a problem before it happens rather than a corrective maintenance program which only reacts to a problem once it has occurred, leading to, in the worst-case, a loss of revenue. Some of these major overhaul procedures will require the shutdown of certain items of substation equipment.

3.6. Decommissioning Programme

The Project will be decommissioned at the end of its operational life. The initial operational life is 25 years; however, this may be extended should re-powering of the site happen. In the event of repowering, a further consenting process would be required to allow for operation beyond the initial 25 years assumed for this consent process and accompanying Environmental Impact Assessment (EIA). Any consent will likely be conditioned to require a decommissioning plan to be submitted to the consenting authority for approval in accordance with the Energy Act 2004 decommissioning requirements. Guidance from the Department of Business, Energy & Industrial Strategy (BEIS) states that the default position for decommissioning should be full removal, unless there are strong reasons for any exceptions (BEIS, 2019) (see Chapter 5: Policy and Legislation).

The decommissioning process will largely be the reverse of that undertaken during the construction. It is expected that the WTG, platforms, and mooring will be completely removed and returned to port for disassembly, re-use or disposal. Cable decommissioning will also be decided toward the end of the project lifetime. The preferred option from a technical and environmental perspective is for offshore cables to be left *in situ* as far as is possible.

Onshore export cables will likely be left *in situ* as is industry standard. It is noted that cable removal may result in disturbance to the local environment similar to installation. Contingency plans will be developed to ensure that appropriate actions are taken should any of the residual onshore export cables become exposed.

The operational life of the onshore substation is 40 years, whereas the operational life of an offshore wind farm is typically less than 30 years. The Project is likely to only have a licence for 25 years. At the end of this period, the onshore substation may be retendered for continued use (if, for example, the Project site is repowered), or the site will likely be decommissioned.

To decommission the onshore substation, all electric plant are removed from their foundations and transported to a facility for processing for reuse, recycling, or disposal. The foundations may be pulled out and disposed of, and any holes refilled with earth, if required. The control building can be demolished, and all materials disposed of.

4. Embedded Mitigation

A number of embedded mitigation measures have been incorporated into the Project Design Envelope (PDE) to prevent/reduce any potentially significant adverse effects on receptors where possible. These embedded mitigation measures have been accounted for in the Report to Inform Appropriate Assessment (RIAA) when assessing the potential magnitude of the effects from the pressures.

In addition to embedded mitigation, in some cases additional mitigation may be required, where measures are required to prevent or reduce any remaining potentially significant adverse effects. These are considered and detailed in any integrity test where they may be required.

4.1. Annex I Benthic Habitats

4.1.1. Standard Mitigation

A range of standard mitigation measures has already been applied to the Project as part of the over-arching site selection and the iterative design process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced to minimise potential impacts of the Project on any affected receptors.

Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential impacts on benthic ecology are listed below.

- Initial site selection (array) area avoided sensitive habitats including SAC/Annex I;
- Detailed pre-consent cable route refinement designed to avoid sensitive habitats including SAC/Annex I;
- Horizontal Directional Drilling (HDD) proposed at landfall, open cut trenching only included as contingency;
- Anchors proposed for floating offshore wind (FLOW) mooring, piling/drilling to only be used where sediment not thick enough to anchor;
- Amount of potential cable protection minimised via detailed route refinement and burial risk assessment studies;
- Use of standard operating procedures and equipment for activities disturbing sediment, e.g., installation of anchors, cable burial, dredging, sandwave levelling, trenching works nearshore, HDD;
- Cable burial design plan to minimise and mitigate the need for cable protection, and to reduce the risk of future cable exposure requiring additional maintenance work or cable protection;
- Invasive Non-Native Species (INNS) Plan (see Volume 3, Technical Appendix 9.4: INNS Plan);
- Marine Biodiversity Enhancement Strategy to be developed post-consent and pre-construction to account for any loss of key habitats;
- Production of a Project Environmental Management Plan (PEMP) to include details on Marine Pollution Contingency Plans (MPCP). This document will also include details of all chemicals proposed to be used, ensuring that those chemicals are approved under the Offshore Chemical Regulations 2002;

- Best practice techniques employed throughout all construction, Operation and Maintenance (O&M) and decommissioning activities. Construction practices will comply with a Code of Construction Practice (CoCP), to ensure appropriate Pollution Prevention Guidelines (PPG) and good practice guidelines are followed;

4.1.2. Additional Mitigation

None of the effects identified in Chapter 9: Marine and Coastal Ecology were major or moderate adverse (significant in Environmental Impact Assessment (EIA) terms). Therefore, no additional mitigation was required to reduce the significance to non-significant in EIA terms and the significance of residual effects remained unchanged.

The mitigation measures above will be considered with respect to the conservation objectives of all designated habitat features/sub-features and supporting habitats for designated and classified populations considered as part of the RIAA.

4.2. Annex II Migratory Fish

4.2.1. Standard Mitigation

A range of standard mitigation measures has already been applied to the Project as part of the over-arching site selection and iterative design process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced to minimise risk of Project impacts on receptors with the potential to be exposed to significant effects.

Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential impacts on fish and shellfish are listed below:

- Temporal mitigation, in terms of conducting work in as short a period as logistically possible, allowing for a reduction in ongoing disturbance and a return to baseline conditions as soon as possible;
- Initial site-selection with an aim to avoid areas of key importance to commercial fisheries for fish and shellfish species;
- Detailed pre-consent route refinement and burial assessment to minimise both direct impacts on the seabed habitat as well as the volume of external cable protection required;
- Soft-start approach to be taken to any piling activities with an aim to minimise subsea noise impacts;
- Deflagration (low-order) is the Projects preferred method for UXO clearance in order to minimise associated levels of subsea acoustic emissions;
- Production of a Project Environmental Management Plan (PEMP) to include details on marine pollution contingency plans. This document will also include details of all chemicals proposed to be used, ensuring that these chemicals are approved under the Offshore Chemical Regulations 2002.

4.2.2. Additional Mitigation

Potential pressures considered in Chapter 10: Fish and Shellfish Ecology included loss of habitat (both temporary and permanent); sediment suspension and deposition; noise; fish aggregating

device effects; Electromagnetic Field (EMF) effects; and fisheries displacement effects. With consideration of the standard mitigation measures, the effect of all pressures was assessed as minor adverse, even when assessed with worst-case scenarios. The standard mitigation measures will be implemented to ensure that the risks to fish and shellfish are managed effectively over the lifetime of the project. The EIA concluded that the significance of effect was not significant, therefore, no additional mitigation was required to reduce the significance to non-significant in EIA terms.

The mitigation measures above will be considered with respect to the conservation objectives of all designated population features/sub-features and supporting habitats for designated populations considered as part of the RIAA.

4.3. Annex II Marine Mammals

4.3.1. Standard Mitigation

A range of standard mitigation measures has already been applied to the Project as part of the over-arching site selection and iterative design process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced to minimise risk of Project impacts on receptors with the potential to be exposed to significant effects.

Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential impacts on marine mammals are listed below:

- Implementation of a piling and UXO clearance Marine Mammal Mitigation Plan (MMMP) (see Volume 3, Technical Appendix 12.3: Draft MMMP);
- Implementation of a Vessel Management Plan (VMP) which adopts best practice vessel handling protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme, the Scottish Marine Wildlife Watching Code, or the Guide to best practice for watching marine wildlife);
- Implementation of an unexploded ordnance (UXO) MMMP;
- Deflagration (low-order) is the Projects preferred method for UXO clearance in order to minimise associated levels of subsea acoustic emissions;
- Implementation of a decommissioning MMMP, subject to a separate Marine Licence application, prior to decommissioning.

4.3.2. Additional Mitigation

All impacts assessed for marine mammal receptors during construction, O&M and decommissioning have been assessed as minor or negligible, which are non-significant in EIA terms. Therefore, no additional mitigation was required to reduce the significance of the residual effects beyond those outlined above.

The mitigation measures above will be considered with respect to the conservation objectives of all designated population features/sub-features and supporting habitats for designated populations considered as part of the RIAA.

4.4. Annex I and Migratory Seabirds

4.4.1. Standard Mitigation

A range of standard design measures has already been applied to the Project as part of the over-arching site selection and iterative outline plan process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced to minimise potential impacts of the Project on any affected receptors.

Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential impacts on offshore ornithology are listed below:

- Additional data sets were sourced from NRW and JNCC, both publicly available and under licence, to inform the original site selection process. Further details are provided in Chapter 3: Site Selection and Alternatives. The offshore area of interest was refined to avoid areas of higher density seabird activity as identified in the following data sources:
    - NRW Seabird Data (NRW, 2021a);
    - Royal Society for the Protection of Birds (RSPB) Future of the Atlantic Marine Environment (FAME) and Seabird Tracking and Research (START) Seabird Data (RSPB, 2019);
    - Thaxter *et al.* (2012). Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas;
    - European Seabirds at Sea (ESAS), (JNCC, 2019a);
    - Seabirds at Sea (SAS) (sitting and flying) (NRW, 2021a);
    - Seabird Monitoring Programme (JNCC, 2019a);
- Deflagration (low-order detonation) is the Projects preferred method for UXO clearance in order to minimise associated levels of subsea acoustic emissions;
- Minimum 22 m air gap beneath between rotor tip and mean sea level at all tidal states to avoid collisions with birds flying at lower heights;
- Remotely Operated Vehicle (ROV) inspections of the moorings and sub-structures;
- A pre-installation (post-consent) geophysical survey will be carried out to identify any potential UXO targets in the vicinity of the planned cable route. If a UXO target is identified it is intended that the route will be adjusted to avoid the UXO and avoid interacting with it;
- Implementation of a VMP which adopts best practice vessel handling protocols (e.g. following the Codes of Conduct provided by the WiSe Scheme , the Scottish Marine Wildlife Watching Code , or the Guide to best practice for watching marine wildlife);
- Where possible doorway and walkway lighting on the semi-submersible floating platforms will all be sensor activated.

4.4.2. Additional Mitigation

For all pressures assessed for Annex I and migratory seabird receptors during construction, O&M and decommissioning it was assessed that there was no potential for an adverse effect on Natura 2000 site integrity. Therefore, no additional mitigation was required beyond those outlined above.

The mitigation measures above will be considered with respect to the conservation objectives of all classified population features/sub-features and supporting habitats for classified populations considered as part of the RIAA.

4.5. Annex I Terrestrial Habitats

4.5.1. Standard Mitigation

A range of mitigation measures has been applied to the Project as part of the over-arching site selection and iterative design process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced in line with common practice to minimise Project pressures on receptors with the potential to be exposed to significant effects.

Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential pressures on terrestrial habitats are listed below:

- The onshore cabling will be installed alongside tracks and/or field margins wherever possible to minimise habitat loss and/or disturbance;
- Proximity to watercourses has been avoided wherever possible;
- Areas considered to be more sensitive in terms of protected habitats have been avoided along the entirety of the onshore cable corridor (e.g. the Limestone Cliffs of South West Wales SAC fixed sand dune habitats located at the Broomhill Burrows SSSI);
- The Applicant will appoint a suitably qualified Ecological Clerk of Works (ECoW) prior to the commencement of any construction activities taking place. The ECoW will be present and oversee all construction activities as well as providing toolbox talks to all site personnel with regards to priority habitats, as well as undertaking monitoring works;
- Protection of habitat suitable for breeding bird from damage and/or destruction during the breeding season will need to be ensured. Wherever possible, all vegetation clearance will occur outside the bird breeding season (i.e. between September – March, inclusive), to ensure that no active nests are damaged or destroyed by the proposed works. If work is required after March 31st, the ECoW will search areas of clearance in advance of works and buffer active nests as appropriate. This would include any areas of clearance and vegetation removal for access tracks, compounds or laydown areas due to the populations of ground nesting birds on and around the site;
- In order to prevent pollution of watercourses within the site (with particulate matter or other pollutants such as fuel), best practice techniques will be employed. These are outlined in Chapter 19: Onshore Geology, Hydrogeology and Hydrology and will include:
    - For water crossings (i.e. those not being negotiated by HDD): buffer strips around sections of workings adjacent to watercourse crossings and bund and embankment features to be implemented;
    - For any temporary tracks, parking areas, compounds and laydown areas: camber in track or ground design; drains, e.g. infiltration trenches with check dams;
    - General drainage: no direct discharges of water from works areas to existing drainage channels or surface watercourses; drainage will be directed to infiltration trenches or settlement swales;

- Full details of construction mitigation measures will be provided in a Construction Environment Management Plan (CEMP) to be agreed with the Planning Authority, in consultation with NRW, post-consent but prior to the construction phase of the development commencing;
- If maintenance activities are necessary during the operational phase that require excavations or the clearance of hedgerows, trees and/or areas of scrub, such works will only take place following adequate protected species surveys to determine any licence requirements and mitigation measures.

The mitigation measures above will be considered with respect to the conservation objectives of all classified population features/sub-features and supporting habitats for classified populations considered as part of the RIAA.

4.5.2. Additional Mitigation

Potential pressures considered in Chapter 20: Terrestrial and Coastal Ecology and Onshore Ornithology include both temporary and permanent loss of habitat. Temporary loss of habitat is anticipated along the entirety of the onshore cable route due to the nature of the cable installation process and is anticipated to primarily result in temporary loss of arable land, arable field margins and hedgerows with anticipated pressures assessed as negligible to low adverse, with consideration of the standard mitigation measures. Additional mitigation measures are proposed to ensure that the overall habitat quality will be enhanced and improve overall habitat connectivity along the entirety of the onshore cable route over the lifetime of the project resulting in an overall moderate beneficial and significant net benefit to the condition of the terrestrial habitats within the onshore cable corridor.

Additional mitigation measures which the Project is committed to in the future, in order to minimise potential pressures and achieve overall net benefit on terrestrial habitats, are listed below:

- Sections of removed hedgerow, as well as existing gaps, will be reinstated as soon as possible. Semi-mature planting will also be installed to complement the existing species mix and additional native species of local or regional provenance, if available;
- The boundary of the proposed substation (located within arable farmland west of Lambeeth Farm) and will be planted with a combination of native trees, hedgerows and meadow grass mix consisting of species typical of this part of Wales. Where possible, seeds or staves of local or regional provenance will be used in order to maintain genetic consistency. Please refer to Chapter 21: Landscape and Visual Impact for details on the Landscape and Ecological Management Plan (LEMP).

The mitigation measures above will be considered with respect to the conservation objectives of all designated habitat features/sub-features and supporting habitats for designated and classified populations considered as part of the RIAA.

4.6. Annex II Terrestrial Mammals

4.6.1. Standard Mitigation

A range of mitigation measures has been applied to the Project as part of the over-arching site selection and iterative design process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced in line with common practice to minimise Project pressures on receptors with the potential to be exposed to significant effects.

Standard mitigation measures which the Project has already implemented, or is committed to in the future, in order to minimise potential pressures on otter and greater horseshoe bats are listed below:

- Proximity to watercourses has been avoided wherever possible;
- The Applicant will appoint a suitably qualified ECoW prior to the commencement of any construction activities taking place. The ECoW will be present and oversee all construction activities as well as providing toolbox talks to all site personnel with regards to priority species of protected mammals, as well as undertaking monitoring works;
- A Species Protection Plan (SPP) will be produced and agreed prior to construction commencement and then implemented during the construction period. The SPP will detail measures to safeguard protected species known to be in the area and will include for pre-construction surveys (including stretches of the onshore cable being installed using HDD) for protected species, complimenting the seasonality of the construction start date as well as ensuring the use of Best Practice measures during all construction activities (such as sensitive lighting, ramps exiting open excavations, etc.). The SPP will describe the process to be followed in the case that new protected species are recorded on site that will therefore also need to be protected during construction works, as well ensuring the implementation of effective toolbox talks to raise awareness of site personnel to sensitive ecological receptors on site;
- In order to prevent pollution of watercourses within the site (with particulate matter or other pollutants such as fuel), best practice techniques will be employed. These are outlined in Chapter 19: Onshore Geology, Hydrogeology and Hydrology and will include:
    - For water crossings (i.e. those not being negotiated by HDD): buffer strips around sections of workings adjacent to watercourse crossings and bund and embankment features to be implemented;
    - For any temporary tracks, parking areas, compounds and laydown areas: camber in track or ground design; drains, e.g. infiltration trenches with check dams;
    - General drainage: no direct discharges of water from works areas to existing drainage channels or surface watercourses; drainage will be directed to infiltration trenches or settlement swales;
- Full details of construction mitigation measures will be provided in a CEMP to be agreed with the Planning Authority, in consultation with NRW, post-consent but prior to the construction phase of the development commencing;
- If maintenance activities that require excavations or the clearance of hedgerows, trees and/or areas of scrub are necessary during the operational phase, such works will only take

place following adequate protected species surveys to determine any licence requirements and mitigation measures.

4.6.2. Additional Mitigation

Potential pressures considered in Chapter 20: Terrestrial and Coastal Ecology and Onshore Ornithology included loss of commuting features and foraging habitats for bats. Temporary loss of habitat is predicted along the entirety of the onshore cable route due to the nature of the cable installation process and is anticipated to result in a moderate adverse pressure. Permanent habitat loss is anticipated as a result of the footprint of the new substation building and the transition joint bay, although the habitats at these locations have been assessed as being of less than local value and so of a negligible adverse nature.

Additional mitigation measures are proposed to ensure habitat connectivity of linear commuting features for bats will be maintained throughout the duration of the construction period and any O&M activities that may lead to the severance of such features. Overall habitat quality will be enhanced, and habitat connectivity improved along the entirety of the onshore cable route over the lifetime of the project resulting in an overall moderate beneficial and significant net benefit to the condition of the terrestrial habitats within the onshore cable corridor.

Additional mitigation measures which the Project is committed to in the future, in order to minimise potential pressures and achieve overall net benefit on terrestrial habitats, are listed below:

- If construction works results in the removal of hedgerows within the active bat season (April-October, inclusive), linear connections throughout the night time will be provided to maintain connectivity for commuting bats. Installations will be at the height of the hedgerow that has been removed to maintain continuity of the linear feature. It is expected that this can be completed by standing the removed sections of hedgerow using supports which can be easily relocated in line with the remaining hedgerow at the end of each working day;
- Construction works will not be undertaken after dusk, wherever possible. When this cannot be avoided, works will be overseen by the appointed ECoW and ensuring sensitive lighting (as per BCT and ILP, 2018) will be used and the extent of the lit area will be restricted to works areas, as far as possible, to avoid light-spill on to any nearby features attractive to bats;
- Sections of removed hedgerow, as well as existing gaps, will be reinstated as soon as possible. Semi-mature planting will also be installed to complement the existing species mix and additional native species of local or regional provenance, if available;
- The boundary of the proposed substation will be planted with a combination of native trees, hedgerows and meadow grass mix consisting of species typical of this part of Wales. Where possible, seeds or staves of local or regional provenance will be used in order to maintain genetic consistency. Please refer to Chapter 21: Landscape and Visual Impact for details on the LEMP;
- The potential pressures of lighting on bats using habitats in the vicinity of the substation is to be reduced by adopting the following principles within security lighting (as per BCT and ILP, 2018):
    - Where and if possible, infra-red lighting will be used;

- Low-level at the minimum intensity possible, and using diffusers and/or screening, as necessary to limit light-spill across the wider area;
- Lighting across the planted areas of trees, hedgerow and grassland (i.e. the landscape planting at the substation) will be avoided, if possible, or maintained at a minimum.

The mitigation measures above will be considered with respect to the conservation objectives of all designated population features and supporting habitats for designated populations considered as part of the RIAA.

4.7. Annex I Terrestrial Birds

4.7.1. Standard Mitigation

A range of mitigation measures has been applied to the Project as part of the over-arching site selection and iterative design process (see below and Chapter 3: Site Selection and Alternatives). These have been introduced in line with common practice to minimise Project pressures on receptors with the potential to be exposed to significant effects.

Standard mitigation measures which the Project has already implemented, or is committed to implement in the future, in order to minimise potential pressures on the general breeding bird assemblage are the same as those proposed for terrestrial habitats (see Section 4.5.1).

4.7.2. Additional Mitigation

All impacts assessed for breeding chough during construction, O&M and decommissioning have been assessed as negligible and non-significant in EIA terms. Therefore, no additional mitigation was required to reduce the significance of the residual effects.

The mitigation measures above will be considered with respect to the conservation objectives of all classified population features/sub-features and supporting habitats for classified populations considered as part of the RIAA.

5. Overview of Habitats Regulations Assessment Screening

The full Habitats Regulations Assessment (HRA) screening methodology and results can be found in Volume 3, Technical Appendix 8.2: HRA Screening Report. A summary of the approach to screening is presented below, and the screening results and rationale are provided in Table 5.4 and Table 5.3, for Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), respectively. The determination of the integrity test for each site/qualifying feature screened into assessment is presented in Sections 0-0.

During the screening exercise, the criteria outlined in Table 5.1 were used to identify connectivity between Natura 2000, UK National Network and Ramsar sites, and influence zones associated with the Project. This was conducted to identify exposure of pressures from the Project on qualifying features of these sites.

Table 5.1: Criteria used for identification of Natura 2000 and Ramsar sites

Criteria
1. There is a direct spatial overlap between the Natura 2000/UK National Network/Ramsar site and the Project.
2. There is spatial overlap between the Natura 2000/UK National Network/Ramsar site and the Project or its secondary effect footprint[8].
3. The location hosts a mobile population of qualifying interest feature (e.g., Annex I birds, Annex II marine mammals, or Annex II migratory fish populations), or supporting habitat for the qualifying interest feature, that may interact directly with the spatial area[9] of the Project footprint.
4. The location hosts a mobile population of a qualifying interest feature (e.g., Annex I birds, Annex II marine mammals, or Annex II migratory fish populations), or supporting habitat for the qualifying interest feature, that may interact with the secondary effect footprint[8] associated with the Project.

Screening has been conducted on a receptor-pressure basis, where potential pressure pathways of relevance to each qualifying feature were screened. Where an interaction could not be ruled out and

[8] This is considered to occur where the envelope of indirect Project effects (e.g., sediment plume) overlaps with a Natura 2000, UK National Network or Ramsar site qualifying species or habitat.

[9] This is considered to occur where the Project overlaps with the foraging range of any qualifying species of any Natura 2000, UK National Network or Ramsar site, or habitat that potentially supports a prey species (all sites that are within foraging range, regardless of the possibility of prey species presence have been considered). As such, a coarse filter has been applied at the HRA screening stage. Where there is an overlap in foraging range, connectivity has been assumed and the Natura 2000, UK National Network or Ramsar site has been considered within the screening assessment in order to maintain a precautionary approach.

is likely to result in Likely Significant Effect (LSE), or where LSE could not be ruled out, the site and its qualifying feature(s) were screened into Stage 2: Appropriate Assessment (AA).

Table 5.2 presents a summary of the potential pressure pathways and screening outcome for each receptor group (of qualifying features). Full justification for the screening is included in Volume 3, Technical Appendix 8.2: HRA Screening Report and further details on the pressures are provided in the following sections of the Report to Inform Appropriate Assessment (RIAA):

- Annex I benthic habitats: Section 0;
- Annex II migratory fish: Section 0;
- Annex II marine mammals: Section 0;
- Annex I and migratory seabirds: Section 9;
- Annex I terrestrial habitats: Section 0;
- Annex II terrestrial mammals: Section 0;
- Annex I terrestrial birds: Section 0.

Table 5.2: High level overview of potential broad pressure pathways identified via the Habitats Regulations Assessment screening exercise

Key: ✓ = screened into Appropriate Assessment; X = screened out of Appropriate Assessment

Broad Pressure Groups	Marine				Terrestrial			
	Benthic	Fish	Mammals	Birds	Habitats	Mammals	Plants	Birds
Temporary/long-term habitat loss/disturbance	✓	✓	X	X	✓	✓	✓	✓
Temporary increases in suspended sediments, smothering, deposition	✓	✓	X	X	X	X	X	X
Accidental pollution or contamination	✓[10]	✓[10]	✓[10]	X	✓	✓	✓	X
Introduction or spread of invasive non-native species (INNS)	✓	X	X	X	✓	X	✓	X
Changes to physical processes	✓	X	X	X	X	X	X	X

[10] Screened in following consultation with the Joint Nature Conservation Committee, Natural Resources Wales, and The Wildlife Trusts.

Broad Pressure Groups	Marine				Terrestrial			
	Benthic	Fish	Mammals	Birds	Habitats	Mammals	Plants	Birds
Underwater noise/particle motion disturbance to receptors or prey, including piling/UXO detonation/clearance	✗	✓	✓	✓	✗	✗	✗	✗
Electromagnetic field (EMF) disturbance	✗	✓	✗	✗	✗	✗	✗	✗
Long term habitat loss/alteration	✗	✗	✗	✗	✓	✓	✓	✓
Disturbance and/or displacement	✗	✗	✓	✓	✓	✓	✓	✓
Collision risk	✗	✗	✓	✓	✗	✗	✗	✗
Entanglement	✗	✗	✓	✗	✗	✗	✗	✗
Barrier effects	✗	✗	✓	✓	✗	✗	✗	✗

5.1. Special Areas of Conservation and Features Screened In

Table 5.3 outlines the SACs and corresponding features screened into the assessment, and justification for the screening decision. It should be noted that for highly mobile receptor groups (marine mammals and migratory fish), a stepwise approach to assessment has been applied. An Appropriate Assessment is carried for nearby sites, with relatively high associated risk. If Adverse Effect On Site Integrity (AEOSI) cannot be ruled out, a sequential/iterative assessment would be carried out considering the next closest SAC population to the Project site. Table 5.3 includes those sites that were subject to Appropriate Assessment. A full list of sites considered in the assessment and sites and features ultimately screened out are included in Volume 3, Technical Appendix 8.2: HRA Screening Report.

Note: not all features are screened in for each site. Accordingly, Table 5.3 does not include an exhaustive list of features designated for each site. Features screened out of assessment are not listed.

Table 5.3: Special Areas of Conservation and relevant features screened into the assessment

Designated Sites	Feature/Receptor	Reason for screening decision
Pembrokeshire Marine/Sir Benfro Forol SAC	Grey seal *Halichoerus grypus*	Potential LSE as SAC directly overlaps with Project area.
	Allis shad *Alosa alosa* Twaite shad *Alosa fallax* Sea lamprey *Petromyzon marinus* River lamprey *Lampetra fluviatilis*	Potential LSE as site directly overlaps with Project area.

Designated Sites	Feature/Receptor	Reason for screening decision
	Otter *Lutra lutra*	There is direct overlap between the Project footprint and the SAC boundary at the landfall area. Otter may forage or use the rocky shore as a place of rest/for denning. Given the survey data are not currently available, and following a precautionary approach, this site is taken forward for further assessment in terms of LSE on otter.
	Primary reason for site selection: • Estuaries (H1130); • Large shallow inlets and bays (H1160); • Reefs (H1170). Annex I Habitat but not a primary feature for this site: • Sandbanks which are slightly covered by sea water all the time (H1110); • Mudflats and sandflats not covered by seawater at low tide (H1140); • Submerged or partially submerged sea caves (H8330).	There is direct overlap between the Project footprint and Annex I Habitats, although this may change depending on the final method for offshore export cable landfall.
Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru SAC	Greater horseshoe bat *Rhinolophus ferrumequinum*	There is no direct overlap between the Project footprint and the designated site. The eastern reach of the onshore cable corridor passes within 60 m of the SAC boundary; however, the proposed construction works may have LSE on the foraging activities of greater horseshoe bat originating from *hibernacula* within the SAC. Therefore, LSE cannot

Designated Sites	Feature/Receptor	Reason for screening decision
		be screened out at this stage.
	Annex I Habitat but not a primary feature for this site: • Submerged or partially submerged sea caves (H8330).	The sea caves feature of the Limestone Coast SAC is considered to have high similarity to the limestone sea caves designated for the Pembrokeshire Marine SAC and, given the spatial proximity, to be a linked continuation of these features along the Pembrokeshire coastline. As such, given that this feature is screened in for The Pembrokeshire Marine SAC, the linked feature for the Limestone Coast of South West Wales is also screened into Stage 2 assessment.
Afonydd Cleddau/Cleddau Rivers SAC	Sea lamprey *Petromyzon marinus* River lamprey *Lampetra fluviatilis*	Although this site is outside the 10 km threshold, it is screened in to Stage 2 AA due to the migratory habits of the species. The river Cleddau/Cleddau Ddu drains directly into Milford Haven, therefore, there is a high probability that individuals would pass through/close to the Project footprint during seasonal migration.
Cardigan Bay/Bae Ceredigion SAC	Bottlenose dolphin *Tursiops truncatus*	Potential LSE based on overlap between Project effects footprint and species-specific Management Unit.
Pen Llŷn a`r Sarnau/Lleyn Peninsula and the Sarnau SAC	Bottlenose dolphin *Tursiops truncatus*	Potential LSE based on overlap between Project effects footprint and species-specific Management Unit.

Designated Sites	Feature/Receptor	Reason for screening decision
West Wales Marine/Gorllewin Cymru Forol SAC	Harbour porpoise *Phocoena phocoena*	Potential LSE based on overlap between Project effects footprint and species-specific Management Unit.
Pembrokeshire Bat Sites and Bosherston Lakes/Safleoedd Ystlum Sir Benfro a Llynnoedd Bosherston SAC	Greater horseshoe bat *Rhinolophus ferrumequinum*	There is no direct overlap between the Project footprint and the designated site. The eastern-most reach of the onshore cable corridor passes within 2.89 km of the SAC boundary (at the Orielton Stable Block and Cellars SSSI conglomerate part of the SAC). However, the proposed construction works may have LSE on the foraging activities of greater horseshoe bat originating from *hibernacula* within the SAC. Therefore, LSE cannot be screened out for greater horseshoe bats at this stage.

5.2. Special Protection Areas and Features Screened In

Table 5.4 outlines the SPAs and corresponding features screened into the assessment, and justification for the screening decision. It should be noted that for highly mobile receptor species with extensive foraging ranges (e.g. Manx shearwater, northern gannet etc.), a stepwise approach to assessment has been applied. An Appropriate Assessment is carried for nearby sites, with relatively high associated risk. If Adverse Effect On Site Integrity (AEOSI) cannot be ruled out, a sequential/iterative assessment would be carried out considering the next closest classified SPA population to the Project site. Table 5.4 includes those sites that were subject to Appropriate Assessment. A full list of sites considered in the assessment and sites and features ultimately screened out are included in Volume 3, Technical Appendix 8.2: HRA Screening Report.

Table 5.4: Special Protected Areas and relevant screened into the assessment

Designated Site	Feature/Receptor	Reason for screening decision
Castlemartin Coast SPA **Component SSSIs:** • **Castlemartin Cliffs & Dunes SSSI;** • **Broomhill Burrows SSSI;** • **Stackpole SSSI.**	Breeding chough *Pyrrhocorax pyrrhocorax*	There is no direct overlap between the Project footprint and part of the coastal and clifftop habitats that may constitute part of the foraging grounds for chough, however the Project is within close proximity. This may change depending on the final method to breaching landfall and the results of the vegetation and breeding bird surveys. However, following the precautionary principle, in the absence of survey data, chough are screened in for further assessment.
Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro SPA Component SSSIs: • Dale and South Marloes Coast SSSI; • Skokholm SSSI;	***Breeding populations*** Atlantic puffin *Fratercula arctica* European storm petrel *Hydrobates pelagicus* Lesser black-backed gull *Larus fuscus* Manx shearwater *Puffinus puffinus*	Potential LSE as direct overlap of SPA with the Project area.

Designated Site	Feature/Receptor	Reason for screening decision
• Skomer Island and Middleholm SSSI.	***Migratory species*** Atlantic puffin *Fratercula arctica* European storm petrel *Hydrobates pelagicus* Lesser black-backed gull *Larus fuscus* Manx shearwater *Puffinus puffinus*	Potential LSE as direct overlap of SPA with the Project area.
	Assemblage species Razorbill *Alca torda* Common guillemot *Uria aalge* Black-legged kittiwake *Rissa tridactyla* Atlantic puffin *Fratercula arctica* Lesser black-backed gull *Larus fuscus* Manx shearwater *Puffinus puffinus* European storm petrel *Hydrobates pelagicus*	Potential LSE as direct overlap of SPA with the Project area.
Grassholm Component SSSIs: • Grassholm SSSI.	Northern gannet *Morus bassanus*	Potential LSE based on overlap between Project effects footprint and species-specific foraging distance.
Irish Sea Front SPA Component SSSIs: • Lundy SSSI.	Manx shearwater *Puffinus puffinus*	Potential LSE as project is located between the Irish Sea Front SPA and the Manx shearwater colony at Lundy, which uses the SPA for foraging during the breeding season.

6. Annex I Benthic Habitats Assessment

6.1. Introduction

This section covers the assessment of adverse effects on Special Areas of Conservation (SACs) designated for Annex I benthic habitats. The section provides information to determine whether there is an adverse effect on the integrity of the conservation objectives of the SACs screened into assessment resulting from the potential pressures of the proposed Project. The chapter is structured as follows:

- A summary of Habitats Regulations Assessment (HRA) screening results and potential pressure pathways;
- A summary of the proposed Project Design Envelope (PDE), outlining the worst-case scenario used to inform the assessment;
- For each SAC screened into the assessment:
  - A description of each SAC, its conservation objectives, and baseline information gathered to aid the assessment;
- For each feature of each SAC screened into the assessment:
  - A summary of the habitat's ecology;
  - An assessment of the pressures during construction and operation of the proposed Project alone;
  - An assessment of adverse effects when considering the proposed Project in-combination with other developments.

6.1.1. Summary of Screening

Screening was conducted in order to identify potential exposure pathways for Annex I benthic habitats (refer to Volume 3, Technical Appendix 8.2: HRA Screening Report). A zone of influence set in accordance with the largest anticipated pressure extent was used in site identification to account for indirect effects on Annex I Habitats. This is set to correspond with 1 tidal excursion distance i.e., the approximate distance over which water (or a section of plume with elevated suspended sediment concentration (SSC)) is advected during 1 flood or ebb tide. Under mean spring conditions, this is approximately:

- 10 km around the array area;
- 14-15 km around the middle of the export cable corridor (ECC) (approximately KP20);
- 18-19 km in the nearshore approaches to Milford Haven (approximately KP10);
- 5-8 km within Milford Haven.

The above screening distances are based on indirect SSC effects informed by Project-specific sediment modelling (Volume 3, Technical Appendix 6.1: Marine and Coastal Processes Assessment), as these are considered to represent the largest (in terms of spatial extent) anticipated effect for these features.

Based on these parameters the following sites and associated Annex I habitat qualifying features were screened into Stage 2 assessment (see Figure 6.1):

- Pembrokeshire Marine/Sir Benfro Forol SAC;
    - Sandbanks which are slightly covered by sea water all the time (H1110);
    - Reefs (H1170);
    - Mudflats and sandflats not covered by seawater at low tide (H1140);
    - Large shallow inlets and bays (H1160);
    - Estuaries (H1130);
    - Submerged or partially submerged seacaves (H8330);
- Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru SAC;
    - Submerged or partially submerged seacaves (H8330).

A total of 2 marine Annex I habitat qualifying features of the Pembrokeshire Marine/Sir Benfro Forol SAC were screened out, as no Likely Significant Effect (LSE) could be determined at Stage 1 screening:

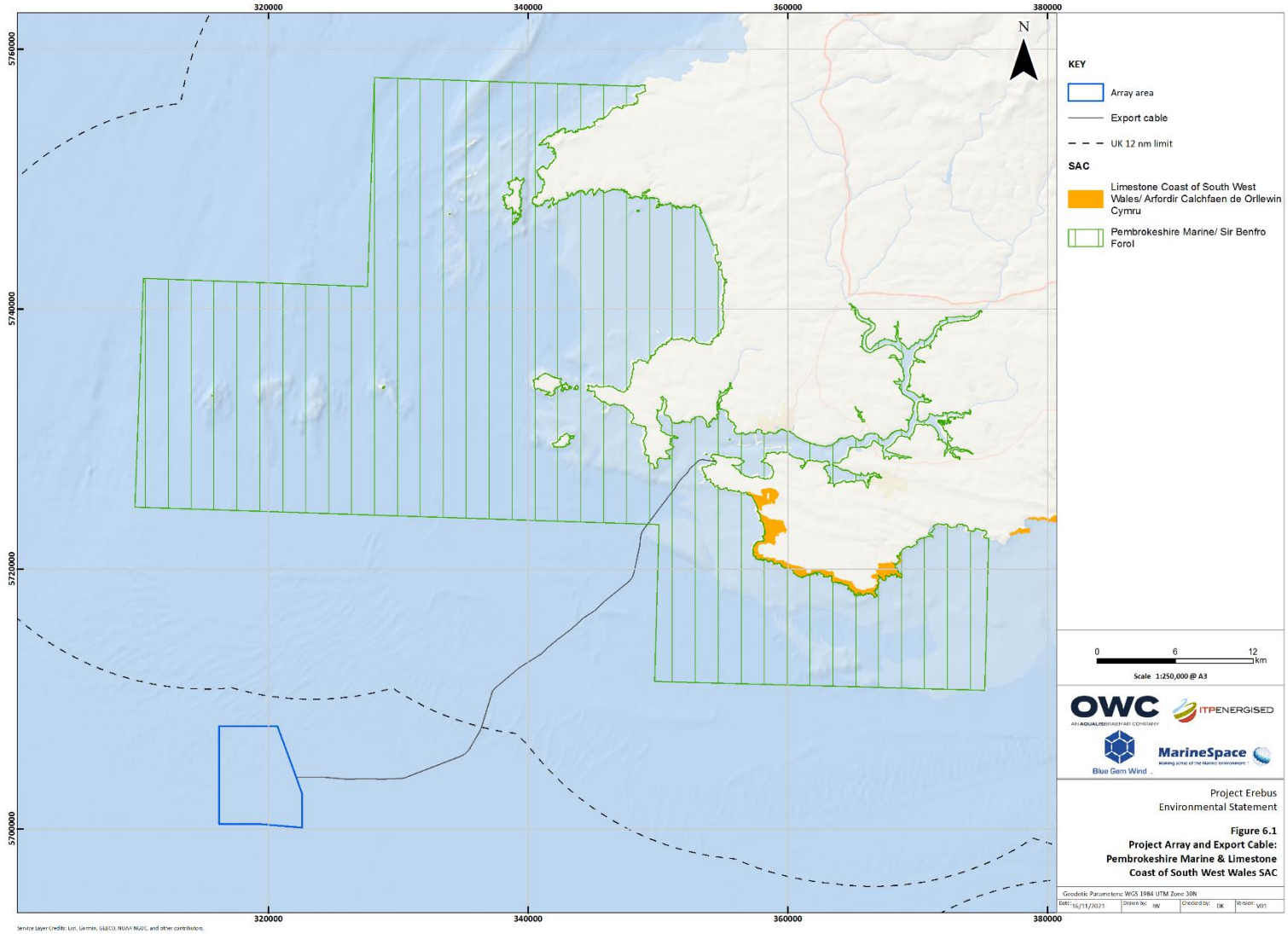
- Coastal lagoons (H1150);
- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) (H1330).

6.1.2. Summary of Potential Pressure Pathways

Several potential pressure pathways were identified for the remaining features in the screening process. No LSE could not be concluded for the following overarching pressure groups, and thus these are assessed within this report:

- Temporary/permanent habitat loss/disturbance;
- Accidental pollution;
- Temporary increases in suspended sediments/smothering;
- Colonisation of hard structures by Invasive Non-native Species (INNS);
- Changes to physical processes.

Figure 6.1: Location of Sites screened in for the next stage of the assessment for the Project in relation to Annex I Benthic Habitats



6.2. Project Design Envelope Parameters Relevant to Annex I Benthic Habitats

Table 6.1 provides parameters for use as the realistic worst-case scenario within assessment. It should be noted that details of temporary and long-term habitat disturbance are limited to disturbance within the boundary of the Pembrokeshire Marine SAC. It should be noted that although all parameters provided for temporary and long-term habitat disturbance within Table 6.1 represent pressures that will occur within the SAC boundary, these will not necessarily directly overlap with SAC features.

Given the inherent uncertainty over where they will be required, details of Operation and Maintenance (O&M) activities correspond with those proposed for the entire ECC. Although it is unlikely that all of these will be required within the SAC, this eventuality cannot be excluded at this stage. Similarly, in view of the distances over which these can be spread by vessel activity, parameters provided for assessment of INNS risk correspond with all Project activities and not just those planned for within the SAC.

Table 6.1: Project realistic worst-case scenario parameters for use in assessment of potential for adverse effects on designated Annex I benthic habitats within Pembrokeshire Marine Special Area of Conservation

Note: the realistic worst-case scenario parameter values are the total overlap with the Pembrokeshire Marine SAC and do not represent total overlap with individual qualifying habitat features of the SAC; this therefore ensures a precautionary assessment is undertaken for all habitat features

	Realistic Worst-case Scenario	Justification
Habitat Disturbance/Loss	**Temporary disturbance (within the Pembrokeshire Marine SAC boundary)** Offshore Export Cable • Dimension: 7.56 km length at 10 m width; • Area of seabed disturbed via cable installation: 75,671 m². Landfall • Area of potential placement of anchor/shallow barge deployment: 1,000 m²; • Area of temporary floatation pit: 7,200 m²; • Area of works associated with disturbance from open cut trenching: 6,354m². **Total Area of Temporary Habitat Disturbance (within the Pembrokeshire Marine SAC boundary): 22,121 m² (0.022 km²)**	This represents the maximum extent of temporary habitat disturbance within the Pembrokeshire Marine SAC throughout the construction phase, and hence the greatest disturbance of habitat over this period. Open cut trenching is the contingency option at the landfall and represents worst-case. HDD is the preferred option. Therefore, disturbance from open cut trenching is assessed here.

	Realistic Worst-case Scenario	Justification
	Long-term habitat loss/disturbance (within the Pembrokeshire Marine SAC boundary) Offshore Export Cable Area • Cable protection: 24,982 m² (up to 1,922 m of rock berm with 11 m base width). • Greenlink cable crossing cable protection (rock and mattress): 560 m² (0.000597 km²) Landfall • HDD exit protection areas: 210 m². • Open cut trenching 146 m² (permanent habitat loss) **Total Area of Long-term Habitat Loss/Disturbance (within the Pembrokeshire Marine SAC boundary): 25,752 m² (0.026 km²)** **Operation and Maintenance** 5 estimated repair events (export cable). 1 km estimated length for each cable repair. 250,000 m² total estimated area for each export cable repair. 150,000 m² estimated footprint per remediation event.	
Increased SSC Plume and Deposition Values	Maximum plume extent (spring tides, tidal excursion from the activity): 10 km array area; 14-15 km middle of the ECC; 18-19 km nearshore; 5-8 km within Milford Haven. Within <50 m of activity: SSC in order of thousands to hundreds of thousands of mg/l, reducing rapidly with time and distance to order of hundreds or tens of mg/l. For low height of release from seabed: SSC unlikely to exceed 150 mg/l beyond ~5 m for gravels, 30 m for coarse sand, 90 m for medium sand, and ~250-300 m for finer sands. The time required for redeposition	The parameters outlined here represent the worst-case scenarios for both plume dispersion and sediment deposition. The ECC and array area will comprise a range of sediment particle sizes, resulting in lower average sediment distribution ranges, suspension times, maximum SSCs and deposition thickness across the overall area.

	Realistic Worst-case Scenario	Justification
	of sands and gravels following resuspension is in the order of seconds to a few minutes. Sediment released at the water surface: SSC unlikely to be >150 mg/l beyond ~100 m away for gravels, ~500 m for coarse sand, ~1.5-2 km for medium sand, ~5 km for finer sands. Sands and gravels released at the water surface: settles, in the order of a few minutes to 1.5 hours. Finer sediment release at the surface: up to 50 mg/l, up to ~2 km downstream; decreasing to 1-5 mg/l within 1-3 days through progressive dilution and dispersion. At low height of release from the seabed, sediments deposit within a distance proportional to grainsize/settling rate. Approx. 5 m for gravels, 30 m for coarse sand, 90 m for medium sand, and ~250-300 m for finer sands. Time required for redeposition of sands and gravels following low height disturbance is in the order of seconds to a few minutes. Deposition – Sands and gravels: may cause measurable thickness of sediment deposition within the above described distances for SSC. However, can depend on other variables. Thicknesses 0.05–– 0.3 m are possible, but the maximum area of effect is inherently limited by the finite volume of sediment disturbed. Deposition – Fines: expected to become widely dispersed (order of several kms) and so will not resettle with measurable thickness locally.	
Invasive Non-native Species (INNS)	Maximum overall offshore construction duration = 18 months. Total area available for: 368,998 m^2 (0.37 km^2). semi-submersible floating platform: 74,260 m^2. Suction pile anchors: 4,020 m^2. Driven pile anchors: 996 m^2.	This represents the maximum surface area that may be available for colonisation by INNS on the marine infrastructure. Worst-case dimensions have been used for all calculations and for a full breakdown see Volume 3, Technical Appendix 9.4:

	Realistic Worst-case Scenario	Justification
	Mooring lines: 61,784 m^2. Mooring line clumps: 14,000 m^2. Array cables: 2,827 m^2. Array cable protection: 126,048 m^2. ECC cable protection: 84,896 m^2. HDD exit cable protection: 167.4 m^2.	INNS Plan.
Vessel Traffic	**Construction** Maximum overall offshore construction duration = 8 months. Vessel presence = 4 at any one time (for semi-submersible floating platform installation). **Operation and Maintenance** 7 x minor maintenance visits, each associated with 2 x vessels present on site for 12h/day. 5x cable repair events, each requiring 1-2 vessels on site for 2 weeks per event. 12 x remediation events, each requiring a single vessel on site for up to 2,160 hours.	Corresponds to the maximum number of vessels that would realistically be expected to be operating simultaneously. Each vessel contributes additional risk of accidental pollution incident.
Accidental Pollution	Offshore Construction period: 8 months Operation period: 25 years Vessel presence parameters as described for Vessel Traffic (above)	

6.3. Approach to Assessment

This assessment is provided to determine if Project activities can be expected to result in an adverse effect on the site integrity of the Pembrokeshire Marine/Sir Benfro Forol SAC and/or the Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru SAC.

For each SAC, the assessments are structured as follows:

- A summary of baseline surveys completed to date, and the key findings relevant to Annex I benthic habitats;
- A description of both SACs, including details of the Annex I habitat features for which they have been designated, the conservation objectives, and their current conservation status;

- A description of the potential pressures associated with the Proposed Development and assessment of how these may interact with the designated features and conservation objectives for these sites;
- An assessment of in-combination pressures when considering the Proposed Development together with other reasonably foreseeable plans and projects;
- Proposed mitigation measures to avoid adverse effects on the SAC features over and above embedded mitigation; and
- A summary of the potential for adverse effects on the site integrity of the Pembrokeshire Marine/Sir Benfro Forol SAC and the Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru SAC.

6.4. Offshore and Intertidal Surveys

6.4.1. Baseline Surveys

To characterise the benthic ecology of the Study Area and to support the identification of possible features of conservation interest (FOCI), subtidal and intertidal surveys were undertaken, capturing benthic ecological data.

Ocean Ecology Limited (OEL) was commissioned to undertake benthic ecological surveys in Autumn 2020 at the two proposed intertidal landfall sites options at Sawdern Point in Milford Haven, and West Angle Bay (just within the entrance to Milford Haven); and the subtidal areas of the ECC and array area (see Volume 3, Technical Appendix 9.4: INNS Plan and 9.3: Intertidal Report, respectively). In this chapter, only the proposed landfall and associated ECC route option at West Angle Bay will be discussed and assessed.

In May 2021, Coastal Assessment Liaison and Monitoring (CALM) was commissioned to undertake a local, shallow subtidal, survey within West Angle Bay, of an area between the survey boundaries of the intertidal and subtidal surveys, that was otherwise unmapped (see Volume 3, Technical Appendix 9.1, Annex 1: West Angle Shallow Subtidal Snorkel Survey Report)).

Table 6.2 provides a summary of the key survey outputs and Volume 2, Figure 9.2 shows the spatial coverage of sampling locations for the subtidal, shallow subtidal and intertidal surveys.

These project-specific surveys adhered to the following guidance documents:

- Countryside Council for Wales (CCW) Handbook for Marine Intertidal Phase I Survey and Mapping (Wyn *et al.*, 2006);
- Joint Nature Conservation Committee (JNCC) Guidance on assigning benthic biotopes using EUNIS of the Marine Habitat Classification of Britain and Ireland (Parry, 2019);
- JNCC Marine Monitoring Handbook (Davies *et al.*, 2001);
- JNCC Unmanned Aerial Vehicles for use in Marine Monitoring (Crabb *et al.*, 2019);
- NRW Benthic Habitat Assessment Guidance for Marine Developments and Activities: a Guide to Characterising and Monitoring Intertidal Rock Shore Habitats and Rock Pool Habitats (NRW, 2019a);
- Natural Resources Wales (NRW) Benthic Habitat Assessment Guidance for Marine Developments and Activities: a Guide to Characterising and Monitoring Subtidal Sediments (NRW, 2019b).

For the subtidal survey, Annex I assessments were undertaken for subtidal Reef (rocky and biogenic) and subtidal Sandbanks, and the methods for the Annex I assessment undertaken for these surveys, are all described under Chapter 9: Marine and Coastal Ecology Section 9.4.6.

For full details of the subtidal Environmental Baseline Surveys (EBS) and Habitat Assessment (HA) survey designs, methodology, data analysis and outputs, refer to Volume 3, Technical Appendix 9.1: Integrated Report and Technical Appendix 9.2: Environmental Baseline Report.

For the intertidal survey, following classification and mapping of habitats and biotopes, an assessment for the presence of Annex I habitats and Section 7 Habitats of Principal Importance (HPI) or Oslo Paris Convention (OSPAR) habitats was carried out. The approach for the assessments undertaken for Annex I features is described in Chapter 9: Marine and Coastal Ecology Section 9.4.6. For full details of the intertidal habitat survey design and methodology, refer to Volume 3, Technical Appendix 9.3: Intertidal Report.

With respect to the additional shallow sub-tidal survey (undertaken in May 2021), on completion of the survey, habitat and species information was ascribed Marine Habitat Classification biotope codes (JNCC, 2015); and assessment was made on the presence of rocky Annex I Reef and other habitats or species of know conservation importance. The methods for the Annex I assessment undertaken for these surveys, are all described in Chapter 9: Marine and Coastal Ecology Section 9.4.6. For full details of the shallow subtidal habitat survey design and methodology, refer to Volume 3, Technical Appendix 9.1, Annex 1: West Angle Shallow Subtidal Snorkel Survey Report.

Table 6.2: Summary of site-specific surveys undertaken to characterise the baseline for benthic ecology

Survey Type	Dates	Methods	Key Outputs
Intertidal Habitat	Autumn 2020 16.10.2020 – 17.10.2020	Phase I Unmanned Aerial Vehicle (UAV) and walkovers Phase II 0.25 m^2 quadrat assessments and 0.01 m^2 core sampling Community and habitat data. European Union Nature Information System (EUNIS) ascriptions. FOCI assessments. Habitat/biotope mapping.	318 UAV images. 86 target notes sites. 58 quadrats. 28 sediment cores.
Shallow Subtidal Habitats	Spring 2021 14.05.2021	Free-diving (snorkel) survey Habitat and species data. Sediment depths (if any). MNCR biotope ascriptions. FOCI assessments.	21 locations.

Survey Type	Dates	Methods	Key Outputs
Subtidal Habitats	Autumn 2020 *Nearshore* 21.10.2020 - 11.11.2020 *Offshore* 09.11.2020 – 29.11.2020	EBS Drop Down Video (DDV) and Drop Down Camera (DDC) imagery. 6.2 m^2 grabs (Day/DVV/ mini-Hamon). HA DDV and DDC. Macrobenthic community assessments. Physicochemical sediment analysis. Broadscale Habitat (BSH). EUNIS ascriptions. Habitat/biotope mapping. FOCI assessments.	ECC 56 EBS DDC. 50 EBS Grabs. 58 HA Transects. Array Area 15 EBS DDC. 57 EBS Grabs. 47 EBS/HA Transects.

6.4.2. Annex I Habitat Assessment

Following the surveys, relevant Annex I habitat assessment was undertaken on those features that had the potential to be deemed Annex I habitats. Assessments considered the following relevant guidelines and their associated criteria:

- JNCC report: The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop (Irving, 2009);
- JNCC report: Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef (Golding *et al.*, 2020);
- JNCC report: Defining and managing *Sabellaria spinulosa* reefs. Report of an inter-agency workshop (Gubbay *et al.*, 2007);
- JNCC report: Common Standards Monitoring Guidance for Sea Caves (JNCC, 2004);
- JNCC report: Annex I Sandbanks in the UK version 3 – 2019 (Public) Polygons (JNCC, 2019b);
- JNCC report: Method for Creating Version 3 of the UK Composite Map of Annex I Sandbanks slightly covered by seawater all the time (Pinder, 2020).

6.4.2.1. Annex I Reefs – Geogenic

Geogenic Reefs are hard, compact, substrata, generally composed of geological material, and topographically distinct from the surrounding seabed. There is a wide variety of topographical forms of Annex I Reef, ranging from vertical rock walls to horizontal ledges, sloping or flat bedrock (bedrock reef) to broken rock, boulder fields and aggregations of cobbles (stony reef) (JNCC, 2021a). A full assessment for the presence of subtidal Annex I geogenic reef, following Irving (2009), was

undertaken on the imagery in Bio Image Indexing and Graphical Labelling Environment (BIIGLE), to determine whether habitats met the criteria of Annex I stony reef (Table 6.3). There are currently no guidelines for determining the quality ('reefiness') of bedrock reef habitats, however some of the criteria listed in Table 6.3 can be adapted to also assess for this feature (e.g., composition and extent). Consideration was also given to the assessment of any 'low resemblance' reef following Golding *et al.* (2020).

For Annex I rocky reef to be classified as present within the intertidal zone, it must form a continuous feature and, thus, be connected to subtidal reef(s) (JNCC, 2021a). As such, it was important that any observations and assessments made across the rocky features of the intertidal zone on West Angle Bay were also cross-referenced to those made from the subtidal surveys in West Angle Bay; and to the later, shallower subtidal snorkelling surveys undertaken at this site that linked these two survey areas.

Table 6.3: Criteria for assessment of stony reef (Irving, 2009)

Characteristic	'Reefiness'			
	Not a Reef	**Low**	**Medium**	**High**
Composition*	<10%	10-40% matrix supported	40-95%	>95% clast supported
Elevation	Flat seabed	<64 mm	64 mm – 5 m	>5 m
Extent	<25 m2	>25 m2		
Biota	Dominated by infaunal species	>80% of species present composed of epibiota species		

*Proportion of boulders/cobbles > 64 mm or bedrock

6.4.2.2. Annex I Reefs – Biogenic

Biogenic reefs are biological concretions created by animals that rise from the seabed; and are less variable than rocky reef (JNCC, 2021a). A full assessment for the presence of subtidal Annex I biogenic ross worm *Sabellaria spinulosa* reef was undertaken on the imagery, in BIIGLE, to determine whether habitats met the criteria of a *S. spinulosa* reef following Gubbay (2007) (see Table 6.4).

Table 6.4: Characteristics of *Sabellaria spinulosa* reef (Gubbay, 2007)

Characteristic	'Reefiness'			
	Not a Reef	Low	Medium	High
Elevation (cm)	<2	2-5	5-10	>10
Extent (m2)	<25	25 – 10,000	10,000 - 1,000,000	>1,000,000
Patchiness (% Cover)	<10	10-20	20-30	> 30

6.4.2.3. Annex I Sandbanks which are slightly covered by seawater all of the time

Sandbanks which are slightly covered by seawater all of the time (hereafter referred to as Sandbanks) consist of sandy sediments that are permanently covered by shallow seawater, typically at depths of less than 20 m. This habitat comprises distinct banks (elongated, rounded or irregular mounds) which may arise from plains of sandy sediment Sandbanks can be categorised into four main types: gravelly and clean sands; muddy sands; eelgrass *Zostera marina* beds; and maërl beds (JNCC, 2021b).

All geophysical and ground truthing data were reviewed to assess for the presence and potential extent of Annex I subtidal Sandbanks. Potential subtidal Sandbanks were assessed following criteria set out in Pinder (2020), which outlines the three descriptors characterising this feature:

- Topography: elongated, rounded or irregular 'mound' shapes which may arise from horizontal or sloping planes of sandy sediment at depths of less than 20 m;
- Substrate/vegetation: mainly composed of sand (≥50%) and may support *Zostera marina* or maërl beds; and
- Proximity to known Sandbanks/similarity in benthic community: Areas of horizontal or sloping sandy habitats are closely associated with known Sandbanks.

Topographical features were determined by interpretation of the geophysical data, while ground-truthing data were used to assess sediment type and composition, and presence of key flora and fauna. Areas that met all of the above criteria were delineated and assigned confidence score of 'High', and 'Potential' assigned to areas meeting only some of the criteria and not including proximity to known Sandbanks.

6.4.2.4. Annex I Mudflats and sandflats not covered by seawater at low tide

Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide and form a major component of H1130 Estuaries and H1160 Large shallow inlets and bays. Three broad categories can comprise this habitat type: clean sands; muddy sands; and mud (JNCC, 2021c). Field observations and biotopes ascribed at West Angle were sampled to determine the presence and/or extent of this feature at the landfall site.

6.4.2.5. Annex I Submerged or partially submerged sea caves

Submerged or partially submerged sea caves (hereafter called sea caves) can vary in size, from only a few metres to extensive systems, and are typically associated with H1170 Reefs. Formations will vary from tunnels or caverns and with vertical and overhanging rocks providing marine habitats (JNCC, 2021d).

There are no established criteria for the assessment of quality of Annex I sea caves, however several characteristics are to be considered when assessing the condition of this feature (JNCC, 2004), and these include:

- Extent;
- Number in site;
- Biotope composition;
- Presence of representative/notable biotopes and their species composition; and
- Presence and/or abundance of specified species.

Field observations and biotopes ascribed at West Angle were used to determine the presence and/or extent of this feature at the landfall site.

6.5. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation

6.5.1. Site Details

The Pembrokeshire Marine/Sir Benfro Forol SAC (hereto referred as the Pembrokeshire Marine SAC) was designated in December 2004 by the National Assembly for Wales. The 1,380.4 km^2 site is located on, and off from, the southwest Pembrokeshire coastline, spanning from Abereiddy, on the north Pembrokeshire coast, to Manorbier on the south coast. The site includes the coasts of several islands offshore west of Pembrokeshire. The site is designated for the protection of 8 Annex I marine habitats and 7 Annex II species.

There are several conservation objectives for the habitat features of the Pembrokeshire Marine SAC, including (NRW, 2018a):

"*5.2.2 Range*

The overall distribution and extent of the habitat features within the site, and each of their main component parts is stable or increasing…

5.2.3 Structure and function

The physical, biological, and chemical structure and functions necessary for the long-term maintenance and quality of the habitat are not degraded. Important elements include;

- *geology,*
- *sedimentology,*
- *geomorphology,*
- *hydrography and meteorology,*

- *water and sediment chemistry,*
- *biological interactions.*

This includes a need for:

Nutrient levels in the water column and sediments to be:

- *at or below existing statutory guideline concentrations*
- *within ranges that are not potentially detrimental to the long term maintenance of the features species populations, their abundance and range.*

Contaminant levels in the water column and sediments derived from human activity to be:

- *at or below existing statutory guideline concentrations*
- *below levels that would potentially result in increase in contaminant concentrations within sediments or biota*
- *below levels potentially detrimental to the long-term maintenance of the feature species populations, their abundance or range*.

Restoration and recovery

As part of this objective it should be noted that; the Milford Haven waterway complex would benefit from restorative action…There is also need for some restoration of the populations of several typical species of the Milford Haven water complex:

- *The presence, abundance, condition, and diversity of typical species is such that habitat quality is not degraded*".

The following Annex I benthic habitat features of the SAC are screened in for assessment (features in **bold** have been identified as a primary reason for site selection):

- Sandbanks which are slightly covered by sea water all the time (H1110);
- **Estuaries (H1130)**;
- Mudflats and sandflats not covered by seawater at low tide (H1140);
- **Large shallow inlets and bays (H1160)**;
- **Reefs (H1170)**; and
- Submerged or partially submerged sea caves (H8330).

A description of each qualifying feature is provided in the following subsections.

6.5.1.1. Sandbanks which are slightly covered by sea water all the time

Feature Summary

Subtidal sandbanks are distributed throughout the site, in water depths 20-40 m, and are generally associated with coastal and benthic features, including headlands, islands, islets, and reefs. These features cause changes in tidal streams, and therefore sediment deposition patterns, which contribute to the formation and maintenance of sandbanks. The sandbanks present are generally linear, elongate, or ovoid, and are orientated along the axis of tidal streams. There are several major sandbanks that form part of the SAC: Bais Bank, Turbot Bank, and The Knoll, and those associated with St Govan's Shoals reefs, and in St Brides Bay (NRW, 2018a).

The subtidal sandbanks present within the Pembrokeshire Marine SAC largely consist of 2 subtypes: gravelly and clean sands; and muddy sands. Generally, the sediment nearer the top of the sandbank consists of well-sorted medium sand, increasing in grain size down the flanks, with poorly sorted sediments present at the base and in troughs. Sediment composition varies at the different sandbanks, ranging from mostly uniform medium sand at Bais Bank (located in the north of the SAC), and medium-coarse and gravelly sands on the banks in south St Brides Bay (NRW, 2018a).

Tidal streams are strong throughout the site, although variable from bank to bank, with Bais and Turbot Banks experiencing tidal flows of 1.0-1.5 m/s, compared with 2.5 m/s tidal flows recorded at other banks. Similarly, wave exposure is considered to be high to extreme at the banks, with the majority of banks orientated perpendicular to wave directions, giving them an exposed southern or western flank and a more sheltered northern or eastern flank (NRW, 2018a). Solid geographical features, such as islands and headlands, provide some shelter to parts of most sandbanks within the Pembrokeshire Marine SAC.

Faunal communities on the sandbanks are generally dominated by polychaete worm, crustacean, and mollusc species typical of the regional waters (NRW, 2018a). Species richness is spatially and temporally dynamic on individual sandbanks and thought to reflect recent hydrodynamic conditions and species recruitment. Species richness is lower on the upper areas of sandbanks, where wave exposure is greater, and sediments are more homogeneous. Higher species richness has been recorded in deeper waters, at the base/toe of banks, where heterogenous sediments are present.

Species associated with the sandbanks have a wide range inside and outside the SAC due to the wide extent of available habitat, such as sands and gravelly sands, and large tidal sand ridges within the wider Celtic Sea.

Feature Condition and Conservation Objectives

The most recent feature condition assessment was conducted in 2017 (NRW, 2018b), concluding that the extent and distribution, and structure and function of the subtidal sandbanks feature are in favourable condition. However, the typical species are in unfavourable condition, due to a recorded decline in species richness, abundance, and diversity. The overall feature condition is therefore considered to be **unfavourable**, although the confidence in the assessment is low due to age of the data used in the condition assessment.

There are no conservation objectives uniquely specific to this feature (NRW, 2018a).

6.5.1.2. Estuaries

Feature Summary

The Pembrokeshire Marine SAC covers several estuarine features within the Milford Haven waterway as well as 2 peripheral estuaries, the river Alun estuary and the Solva estuary (NRW, 2018a). The rivers that feed into Milford Haven form part of the Daugleddau estuary, which is considered one of the best examples of a ria (drowned river) estuary in the UK (JNCC, 2021e) and the only example in Wales (NRW, 2018a). The estuary spans 170 km, covering approximately 55 km^2, 30% of which is intertidal; representing around 34% of the UK resource of ria estuary.

Sediments vary widely throughout the waterway, ranging from coarse, stony and shell gravels; through mixed shelly gravels and sands; to fine sands and muddy sediments. Calcareous algal maërl deposits are present in the lower waterway (NRW, 2018a). In addition, there are areas of reef within the estuary complexes, as well as banks of boulders, cobbles, shell and sediments, all present as outcrops in areas of flatter sediments.

Due to the wide variety of habitat within the estuary complexes, overall species richness is considered to be extremely high (NRW, 2018a), however, little biomass data are available and population size is not known for most species. The expansive mudflats generally support a higher biomass than other sediments, with abundant and productive bivalve and annelid communities present. Intertidal communities present in the soft sediments comprise an important food source for overwintering birds, such as waders and wildfowl. In contrast, in the upper estuary, there are tide-swept sponge communities colonising the more consolidated shell and cobble sediments (JNCC, 2021e).

Feature Condition and Conservation Objectives

NRW (2018b) conducted a feature condition assessment in 2017, determining that the distribution and extent of estuaries within the Pembrokeshire Marine SAC has not altered since designation and therefore remains in favourable condition. However, the structure and function, and typical species, were both in unfavourable condition largely due to the presence of contaminants (such as mercury compounds and tributyltin) and decline of subtidal seagrass. Therefore, the estuaries feature of the Pembrokeshire Marine SAC is in **unfavourable** condition.

There are no conservation objectives uniquely specific to this feature (NRW, 2018a).

6.5.1.3. Mudflats and sandflats not covered by seawater at low tide

Feature Summary

Mudflats and sandflats not covered by seawater at low tide, also known as, and hereto referred as ‘intertidal mudflats and sandflats’, can exist as components of other features of the SAC, namely estuaries, and large shallow inlets and bays, or can occur independently (NRW, 2018a). Intertidal mudflats and sandflats are present throughout the SAC, predominantly located in embayments, inlets, and estuaries, but also on the open coast. When a component of inlets and bays, intertidal mudflats and sandflats are more sheltered and range from small patches of habitat to extensive mudflats at the outer extents of inlets and estuaries.

The sediment composition of intertidal mudflats and sandflats is highly variable within the site and is largely dependent on aspect, coastal topography, shore morphology, wave exposure, and sediment budget (NRW, 2018a). The more sheltered areas within Milford Haven generally consist of well-sorted fine sand and muddy sediments, but also contain some coarser material (gravel, shingle and shell), whereas the sediment flats on the open coast and in embayments consist almost entirely of well sorted sand, with localised areas of muddy sediment where wave exposure is lower.

Ecological communities vary across the sediment flats in the site, and diversity is generally high; but is also highly variable, between and within communities, sediment types, and individual sediment flats (NRW, 2018a).

More exposed areas, and those that lack heterogeneity, typically have lower species diversity, whereas other sediment flats support a wide variety of species, including worms, burrowing crustaceans, and bivalve molluscs. Macroalgae are present within the habitat, although generally limited to coarser sediments.

Feature Condition and Conservation Objectives

NRW (2018b) conducted a feature condition assessment in 2017, concluding that the distribution and extent of the mudflats and sandflats not covered by seawater at low tide within the Pembrokeshire Marine SAC is favourable, however, the structure and function, and the typical species, are both considered to be in unfavourable condition. Therefore, the overall condition of the feature within the SAC is **unfavourable**, with high confidence in the assessment based upon recent monitoring data, reports, and expert judgement.

There are no conservation objectives uniquely specific to this feature (NRW, 2018a).

6.5.1.4. Large shallow inlets and bays

Feature Summary

Referred to as 'inlets and bays', the large shallow inlets and bays Annex I habitat constitutes coastal indentations where the influence of freshwater is generally limited. In terms of the Pembrokeshire Marine SAC, this constitutes bays such as St Brides Bay and the ria of Milford Haven, as well as the peripheral embayment of Whitesands Bay (NRW, 2018a). The inlets and bays feature at the SAC is comprised of several component habitats, including 3 Annex I habitats (reefs, intertidal mudflats and sandflats, and sea caves). Intertidal sediment flats are prominent around the coasts of the inlets and bays feature, especially on the eastern shore of St Brides Bay.

St Brides Bay is the largest embayment within the SAC and has several peripheral bays enclosed by rock outcrops and prominent headlands. The seabed is gently sloping in most locations, although more complex areas with ripples and sandwaves can be found in the northwest and southwest. The bay feature is comprised of a wide variety of sediments (NRW, 2018a), including:

- Moderately sorted medium to very fine sands, located in shallow and near-shore areas in the northern proportion of the bay;
- Fine sands, located in the inshore regions of the bay;
- Well sorted muddy sediments, mostly present in the deep central areas of the bay;
- Poorly sorted muddy gravel and shell, located in the sheltered nearshore areas in the south of the bay;
- A mosaic of tide-swept gravels and cobbles, muddy gravel, and well sorted medium sand, oriented along the axis of tidal currents at the seaward boundary of St Brides Bay.

There are also areas of intertidal reef within St Brides Bay (NRW, 2018a). Refer to Section 6.5.1.5 for details on the Annex I reef habitat features, including those which form a subcomponent of the inlets and bays feature.

Embayments are comprised of a variety of component habitats, and therefore have a highly variable species diversity and richness. Ecological communities include those typical of intertidal and subtidal

reefs; sea caves; intertidal mudflats and sandflats; tidal stream structure sandbanks; and a variety of subtidal sediment habitats (NRW, 2018a). Deep, wave-sheltered areas are generally more species rich and stable, supporting a variety of species including long-lived macrofauna. Coarser sediments within the embayments, that are more exposed to tidal streams and waves, tend to support a low variety of resilient species. Data obtained within the site show that population sizes and distribution are patchy, although the habitat range of most species is extensive. However, it should be noted that some highly specialised species have much more restricted distribution (NRW, 2018a).

Feature Condition and Conservation Objectives

A feature condition assessment was completed in 2017 (NRW, 2018b), which found that the distribution and extent of the feature has not changed since the SAC was designated and therefore remains in favourable condition. However, the structure and function, and the typical species associated with the large shallow inlets and bays feature, were both assessed as in unfavourable condition. The overall condition of the feature is, therefore, considered to be **unfavourable**, with medium confidence in the data.

Several other features of the SAC are intricately linked to the large shallow inlets and bays feature, and, therefore, it is important to consider the condition of the following features:

- Estuaries (unfavourable);
- Mudflats and sandflats not covered by sea water at low tide (unfavourable); and
- Reefs (unfavourable).

In addition to the general overarching site conservation objectives outlined in Section 6.5.1, NRW (2018b) includes additional information specific to the large shallow inlets and bays feature.

For the range (distribution and extent of the feature), the main components are identified as:

- The embayment of St Brides Bay;
- The ria of Milford Haven; and
- Peripheral embayments and inlets.

Under restoration and recovery, NRW (2018b) notes that:

"*For the inlets and bays features, this includes the need for some restoration of the populations of several typical species which are severely depleted with respect to historical levels as a consequence primarily of human exploitation*".

6.5.1.5. Reefs

Feature Summary

The Pembrokeshire Marine SAC has a variety of reef habitats distributed throughout the site, at different depths and exposures. The intertidal zone is predominantly reef habitat and there are extensive rocky reefs in the sublittoral zone offshore west of Pembrokeshire and around the offshore islands. Large, isolated reef complexes are present offshore within the SAC, associated with St Brides Bay, West Dale Bay and the southeast coast of Freshwater West.

There are several geographically recognisable reefs within the Pembrokeshire Marine SAC (NRW, 2018a):

- Extremely exposed offshore reefs associated with the offshore islands, from Grassholm to The Smalls, and the Bishops and Clerks reef complexes;
- Skomer/Marloes Peninsula;
- Ramsey/St David's Peninsula;
- Skokholm to St Anne's Head and south St Brides Bay;
- Reefs at the entrance to Milford Haven;
- South Pembrokeshire limestone reefs.

Areas of reef within the site are intermittently covered and uncovered by mobile sediment, including fine sands in the more sheltered areas of the site, up to coarser gravelly sediment where wave and tidal stream exposure is higher. There are a variety of reef types within the site, including:

- Shallow reefs and reef platforms;
- Isolated reefs, not associated with any distinctive geographical feature;
- Vertical and steep slope reefs with depth levels ranging from 0-50 m;
- Horizontal reef at greater depths;
- Islands and islets;
- Intertidal reef, mostly with steeply sloping shore.

Intertidal reef is present along much of the coastline within the SAC, including at the offshore export cable landfall within West Angle Bay. The export cable corridor also passes an area of subtidal reef habitat immediately offshore of West Angle Bay.

The wide range of topography, type, exposure, and depth of reef influence the typical species and assemblages found on the reef habitats present. Species vary greatly over the site, depending on the aforementioned factors, and range from communities characterised by rock-boring and crevice-dwelling species to encrusting sponges, ascidians and anemones. Biomass has high spatiotemporal variability, both on a small scale (e.g., on the same reef complex, or season to season), and a large scale (across the different reef types, or between years).

Extremely exposed areas of reef are generally dominated by more robust species, such as sponges and anemones; whereas more sheltered reef is often characterised by silt-tolerant algae, fan worms, sea squirts, and brachiopods.

Whilst the spatial range of many species is extensive, more specialised species are generally found in a limited number of locations occupying a specific niche. Species recruit from both local and distant populations, due to the hydrodynamic regime in the region.

Feature Condition and Conservation Objectives

The most recent feature condition assessment was conducted in May 2017 (NRW, 2018b). Whilst the distribution and extent of reef within the SAC, and the typical species and assemblages are both in favourable condition, the structure and function of the reef has been assessed as in unfavourable condition based on monitoring data collected by NRW showing high levels of nutrients within

Milford Haven but not at the open coast. The overall condition of the feature, is therefore, considered to be **unfavourable** with medium confidence in the assessment.

There are no conservation objectives uniquely specific to this feature (NRW, 2018a).

6.5.1.6. Submerged or partially submerged sea caves

Feature Summary

Submerged or partially submerged sea caves, referred to as 'sea caves', are defined as "*caves situated under the sea or opened to it*" (EC, 2013). Sea caves within the Pembrokeshire Marine SAC vary greatly in size and support a wide range of species, including algae, marine invertebrates, and seals, and therefore are considered to be of significant conservation value (NRW, 2018a). Sea caves within the site were previously surveyed in 2002 and, therefore, information on their range, structure and function, and typical species is limited.

Sea caves are distributed along most of the rocky coasts within the SAC, with the largest known concentrations present on St David's Peninsula, Ramsey Island, Skomer Island, and along the Castlemartin coast (NRW, 2018a). The size of caves varies greatly, some consisting of small, enclosed overhangs, with others >50 m in length. Most known caves were discovered opportunistically and are located in depths shallower than 20 m, however, based on historical sea levels (>40 m below present levels) caves are also expected to be present at greater depths.

Sea caves on Skomer and Ramsey are in volcanic rock, whereas those on the south Pembrokeshire coast are limestone. There are also sedimentary rock caves present within the SAC, including some on Ramsey Island, in St Brides Bay, and at St David's and Marloes Peninsulas (NRW, 2018a). The cave floors mostly consist of coarse mixed sediments, including pebbles, cobbles and boulders.

Ecological communities within the caves are generally comprised of species tolerant to scour and high wave exposure (NRW, 2018a), and include specialist species such as the nationally rare lagoon snail *Paludinella littorina*. Different communities can be found on the different rock types, with limestone caves generally having the highest diversity due to the complex microtopography and the species that can bore into the rock. Where tall caves with dry ceilings are in locations inaccessible or undisturbed by humans, they are often used by grey seal for pupping and resting.

Feature Condition and Conservation Objectives

Although a feature condition assessment was completed in 2017 (NRW, 2018b), the overall condition of the submerged or partially submerged sea caves feature is **unknown**. Although the distribution and extent of the feature remains favourable as there has been no change since the SAC was designated, the condition of the structure and function, and the typical species is unknown. This is because no surveys or monitoring have been conducted since the original surveys by Bunker and Holt (2003) in 2002 (NRW, 2018b).

There are no conservation objectives uniquely specific to this feature (NRW, 2018a).

6.5.2. Assessment of Adverse Effects Alone

The potential pressures during construction operation and maintenance, and decommissioning for the proposed Project are:

- Temporary/permanent habitat loss/disturbance:
  - Abrasion/disturbance of the substrate on the surface of the seabed;
  - Habitat structure changes – removal of substratum (extraction);
  - Penetration and/or disturbance of the substratum below the surface of the seabed, including abrasion;
  - Physical change (to another seabed type);
  - Physical change (to another sediment type);
- Temporary increases in suspended sediments/smothering:
  - Changes in suspended solids (water clarity);
  - Smothering and siltation rate changes (Heavy);
  - Smothering and siltation rate changes (Light);
- Introduction/Spread of Invasive Non-native Species:
  - Introduction or spread of invasive non-indigenous species (INNS);
- Accidental pollution:
  - Hydrocarbon and polycyclic aromatic hydrocarbon (PAH) contamination;
  - Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals);
  - Transition elements and organo-metal (e.g. tributyltin (TBT)) contamination;
- Mobilisation of contaminated sediments:
  - Hydrocarbon and PAH contamination;
  - Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals);
  - Transition elements and organo-metal (e.g. TBT) contamination;
- Changes to physical processes:
  - Water flow (tidal current) changes, including sediment transport considerations;
- Wave exposure changes.

6.5.2.1. Construction/Decommissioning

The nature and magnitude of pressures associated with decommissioning activities, and the sensitivities of the receptor groups, are considered to be in-line with those for construction phase pressures; although in practice they are likely to be reduced for decommissioning. Where there is a potential variation, this is presented below.

Temporary/Long-term/Permanent Habitat Loss/Disturbance

Temporary and permanent habitat loss/disturbance may result from various Project activities, including:

- Seabed disturbance from cable installation/reburial (array area and ECC);
- Change of benthic substratum caused by placement of rock protection (array area and ECC);
- Open cut trenching (landfall);
- Potential placement of anchor/shallow barge deployment (landfall);
- Temporary floatation pit (landfall).

Note: sandwave levelling is not proposed within the Pembrokeshire Marine SAC, only cable installation via conventional plough/trenching tool.

The majority of these pressures are limited to the direct footprint of the activity. However, there is also potential for indirect disturbance through smothering, from mobilised sediments transported by wave and tidal processes. This section is limited to direct disturbance within the works footprint. Indirect effects related to smothering caused by elevated SSC levels are discussed in the following section 'Temporary Increases in Suspended Sediments/Smothering'.

As outlined above, temporary and permanent habitat loss/disturbance will only occur in areas of direct spatial overlap with designated Annex I habitat features. The Project array area is located >10 km from any SAC site and therefore pressure pathways are limited to effects associated with the export cable corridor or landfall. As such, the effects of embedment anchors, which will be limited to the array area, will not be considered further within this section.

Figure 6.2, Figure 6.3 and Figure 6.4 show the Annex I habitats along the section of offshore cable corridor within the Pembrokeshire Marine SAC, as determined by the 2020 habitat surveys (see Volume 3, Technical Appendices 9.4: INNS Plan and 9.3: Intertidal Report). There is a small area of Annex I Reef habitat in the intertidal zone, and although Annex I Reef habitat is also present in the area surrounding the subtidal offshore cable corridor, the offshore cable corridor follows a natural channel and does not intersect any subtidal reef habitat. This natural channel ('Rows Rocks') contains medium to coarse grained soft sediments and does not qualify as Annex I habitat. Between KP6.51 and KP10.08, the offshore cable corridor intersects an Annex I Sandbank feature which extends outside the boundary of the SAC.

Figure 6.2: Project export cable corridor (intertidal area) with burial classification category and spatial extent of Annex I habitats

Numbering within the map indicates 'Cable Section' number, with reference to Table 6.5

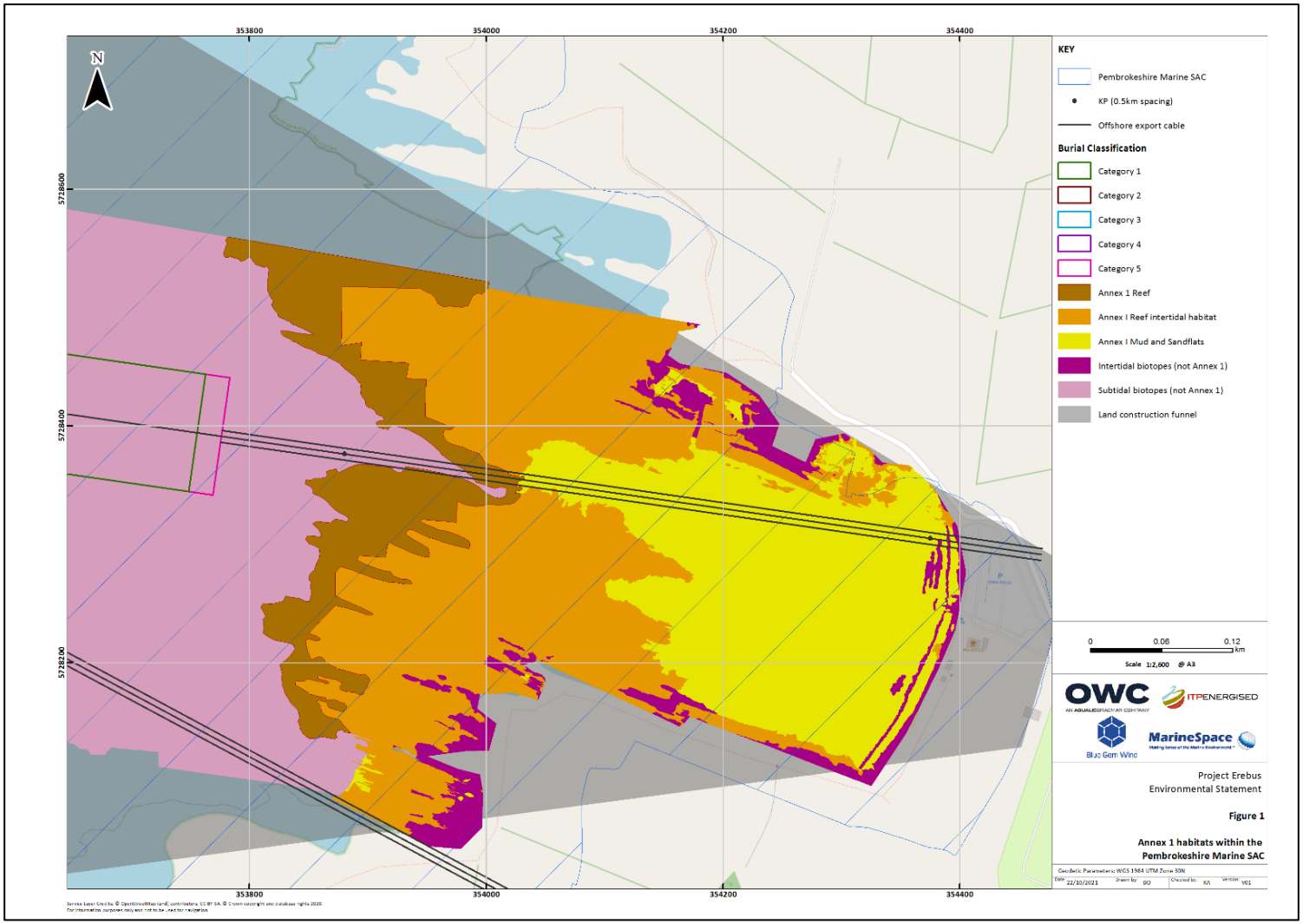


Figure 6.3: Project export cable corridor (KP0-KP6.5) with burial classification category and spatial extent of Annex I habitats

Numbering within the map indicates 'Cable Section' number, with reference to Table 6.5.

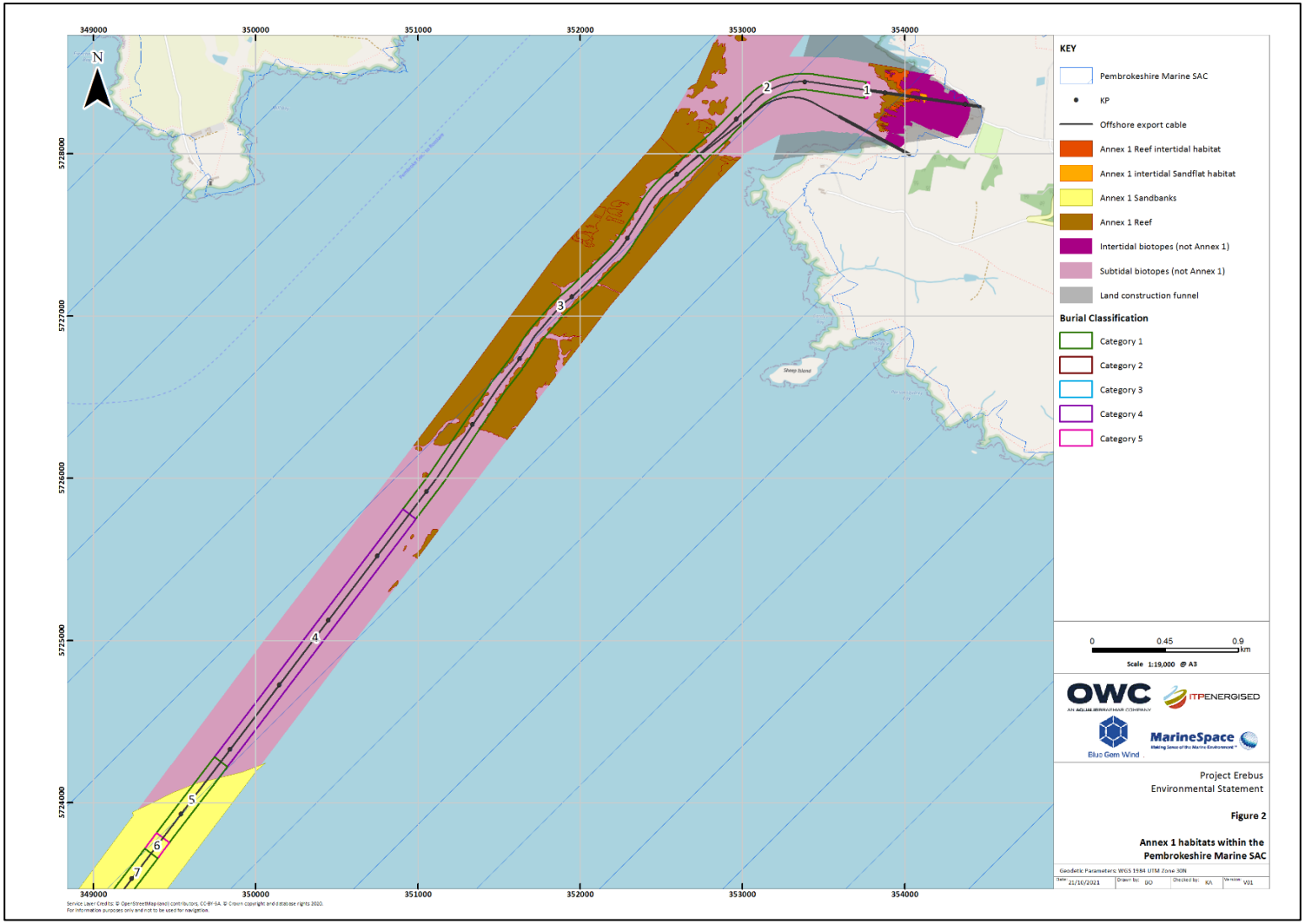
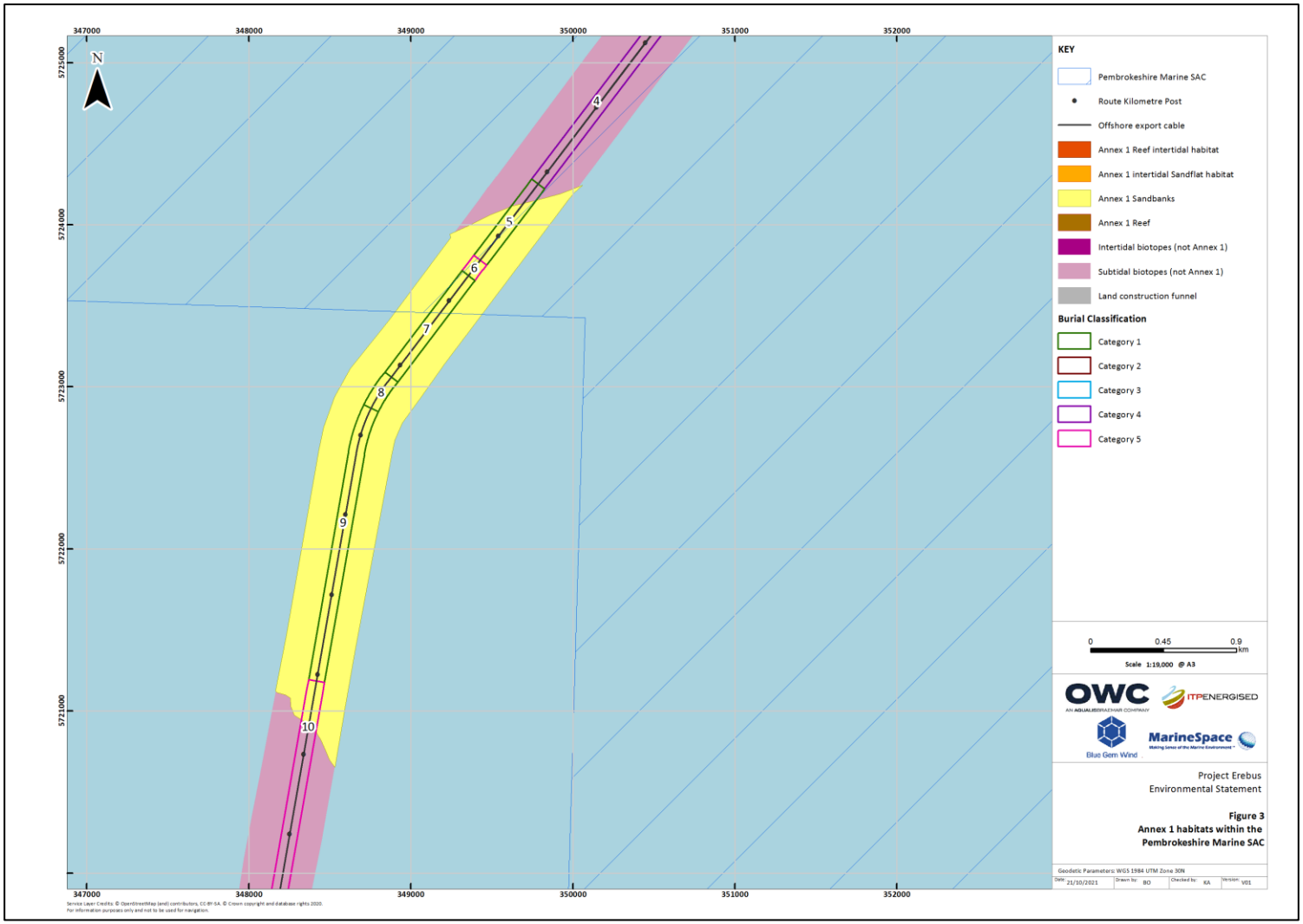


Figure 6.4: Project export cable corridor (KP6.5-KP10.5) with burial classification category and spatial extent of Annex I habitats

Numbering within the map indicates 'Cable Section' number, with reference to Table 6.5.



Annex I Subtidal Reef

No areas of biogenic reef have been identified at any location within the site-specific Project survey and this habitat is not thought to be present along the ECC. It is therefore considered that the only subtidal Annex I Reef feature which may be affected by temporary, long-term or permanent habitat loss/disturbance are Geogenic Reef (stony or bedrock Reef).

Details of cable installation methodology and parameters are provided in Chapter 4: Proposed Development Description. However, array cable and offshore export cable installation will be achieved through use of a submarine plough to minimise seabed disturbance. Other potential cable installation tools/methods that may be used include trenching and/or MFE. Submarine ploughs are towed by cable installation vessels and contain skids which have a contact width on the seabed of less than 5 m. An area of seabed typically less than 1 m width is actually disturbed by the plough cutting/burial tool.

Cable burial will be to a maximum depth of 2.5 m; however, where cable burial is not possible due to hard substrates, the array cable and offshore export cable will likely need to be surface laid, with cable protection then applied. The cable protection will (a) reduce navigation risk to mariners via removing risk of cable/anchor interactions; and (b) minimise risk of damage to the cable itself. Where required, the footprint of any rock protection is expected to extend to ≤5.5 m either side of the cable.

Disturbance to or long-term change in substrate type of Annex I Geogenic Reef is possible in instances where long term change to substratum type is caused by the placement of hard cable protection over areas of designated Annex I Reef. However, although the 2020 habitat survey identified various areas of Annex I Geogenic Reef, these did not extend into the channel that the offshore export cable will pass through ("Rows Rocks") (see Technical Appendices 9.2: Environmental Baseline Report and 9.3: Intertidal Report). It was concluded that there is no area of spatial overlap between the export cable corridor (defined in this context as the offshore export cable route with 5.5 m buffer either side of the cable) and subtidal Annex I Geogenic Reef (potential interaction between the export cable corridor and intertidal Geogenic Reef is considered below). As such, there is no pathway for adverse effects from cable installation or decommissioning works to this receptor. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of subtidal Reef features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance.**

Annex I Sandbank

There is potential for Project activities to lead to both temporary and permanent disturbance to Annex I Sandbank habitat due to cable installation and placement of rock protection respectively.

All proposed cable installation options (submarine plough, trenching or MFE) are associated with potential for temporary disturbance to benthic habitats. The worst-case scenario for temporary disturbance of Annex I Sandbank along the ECC route is based on the expectation that the maximum width of temporary habitat disturbance will be 10 m. This contrasts with the potential for 50 m disturbance width in areas where sandwave levelling is required (i.e. in other areas of the ECC; sandwave levelling is not proposed within the SAC). Based on this worst-case footprint, temporary

habitat disturbance from cable installation activities may overlap with 0.008 km² of Turbot Bank. Outside of the SAC, discrete sandwave levelling may be required at Turbot Bank, between KP8.1 and KP8.3, with approximately 200 m length of disturbance (maximum width of 50 m). Although most of the direct disturbance outside of the SAC will be limited to 10 m widths through standard cable burial, a worst-case precautionary assessment is applied assuming a 50 m wide corridor across this entire length. This represents a total potential area of disturbance outside of the SAC, of 0.14 km² of Turbot Bank.

The total area of Turbot Bank is 24.05 km² (19.1 km² inside the SAC and 4.95 km² outside) and, therefore, as a worst-case, 0.15 km² (0.008 km² + 0.14 km²) (0.62% of Turbot Bank) of this habitat feature will be temporarily disturbed from the installation works. In relation to the total area of sandbank features within the SAC (414.11 km²), this corresponds with temporary disturbance of only 0.036% of this designated site feature during construction. In relation to the total area of sandbank features both within the SAC (414.11 km^2) and outside the SAC (80.39 km²), only 0.20% of this feature that will be temporarily disturbed during construction.

Given the extent of this designated feature (both within and outside of the SAC), the availability of similar sediments outside of the disturbance footprint, and the scale of impacts during construction, the potential adverse effects are considered to be small in terms of magnitude. The Turbot Bank sandbank is exposed to natural disturbances from wave action and the faunal communities supported in these sandy and coarse sediments will be characteristic of moderately strong tidal conditions and, potentially, adapted to physical disturbances (GIL, 2019). The infaunal communities of these features will, in part, mirror those mobile species in other areas of sandy sediments locally (see Chapter 9: Marine and Coastal Ecology for more detail).

Grab samples across the two sandbanks recorded a community including the small echinoderm *Echinocyamus pusillus,* bivalves *Goodallia triangularis* and *Spisula* spp., the cat worm *Nephtys cirrosa* and other polychaetes including *Glycera* sp. and *Ophelia* sp.. Resident species such as the bivalve *Spisula* spp. will be intolerant to any loss of habitat; however, if displaced during movement of sediments during cable installation, it will be able to burrow back down rapidly to seek suitable conditions (Sabatini, 2007). *N. cirrosa* has high reproductive capacities and widespread larval dispersal stage and, therefore, recoverability of a population within physically disturbed sediments will be high (Ashley, 2016). *Glycera* worm populations, although they have a single breeding period and a slow growth rate, can recover through migration, persisting in disturbed sediments through their burrowing abilities (Tillin*,* 2016). As such, and in consideration of a community that will comprise both longer lived species and opportunists, this feature is considered to have reasonable capacity to recover from temporary disturbance.

Where cable burial is not possible due to hard substrates, or where the ECC crosses the Greenlink cable route, it will be necessary to apply hard cable protection.

The potential requirement for rock protection has been calculated as part of a preliminary burial assessment. Where rock protection may be required within any ECC section the burial assessment has indicated the proportion of the individual section length that will require rock protection (see Table 6.5).

This burial assessment has indicated that rock armour may be required within a single cable section which overlaps with sandbank features within the Pembrokeshire Marine SAC (Section 6 (KP7.19-7.31); Table 6.5). It should be noted that Section 10 (KP10.04-KP11.61) also requires rock protection over what is believed to be Annex I qualifying sandbank habitat; however, this is situated outside the SAC boundary. As such, associated effects are considered within Chapter 9: Marine and Coastal Ecology. Placement of rock protection on Annex I Sandbank features would result in a habitat change from soft sediment to hard substratum. It is expected that this material would be left in place for the entirety of the project lifetime (up to 25 years).

Rock protection will be required over 58.3 % of Section 6 (0.0005597 km²; Table 6.5) where there is a cable crossing with the proposed Greenlink cable route. The placement of rock armour within Section 6 may result in disturbance to Annex I habitat corresponding with 0.0001% of the 414.12 km² Annex I Sandbank habitat reported to be present within the boundary of the Pembrokeshire Marine SAC.

Table 6.5: Interaction between export cable corridor and Annex I habitats. Cells highlighted blue represent locations where rock protection may be required within sections where Annex I habitat has been identified

Cable Section	Distance from Landfall (km)	Amount of Rock Protection (%)	Amount of Rock Protection (km²)	Area of Overlap (km²)	
				Geogenic Reef	Sandbank
1	0.61-0.63	100	0.0001008	0	0
2	0.63-1.82	0	0	0	0
3	1.82-4.68	0	0	0	0
4	4.68-6.59	65	0.009974	0	0
5	6.59-7.19	0	0	0	0.005722
6	7.19-7.31	58.3	0.0005597	0	0.001566
7	7.31-8.09	0	0	0	0.01022
8*	8.09-8.32	0	0	0	0.002989
9*	8.32-10.04	0	0	0	0.022358
10*	10.04-11.61	80	0.01381	0	0.003617
11*	11.61-12.87	80	0.01108	0	0
12*	12.87-14.10	40	0.03923	0	0
Total				**0**	**0.046472**

**** Sections located outside the Pembrokeshire Marine SAC but included due to overlap with areas of what is determined to be an Annex I qualifying sandbank that extends from inside to outside the SAC boundary.***

Receptors will be sensitive to a change in seabed type (i.e., potential loss of currently present biotope), with burrowing infaunal communities of sandbanks vulnerable to such changes as could occur from the initial placement of rock protection. The Turbot Bank sandbank is part of a dynamic system, often reworked by strong tidal currents (GIL, 2019) and over time, rock protection may become buried, and any localised loss of the biotope would not be permanent. There is expected to be an initial period of sediment accumulation within and around the rock berm, accumulating within an order of a few weeks to a few months. Following initial accumulation and development of a naturally stable slope and surface, sediment transport will continue over the berm at natural ambient rate and direction by natural sediment movements, with deposited substrates again locally available for lateral migration and recruitment by fauna. This is expected to lead to a gradual reduction in the spatial extent of this initial change in seabed type.

With respect to the conservation objectives for the SAC, there is no indication that permanent/long-term habitat loss will lead to a reduction in environmental quality, nor will it inhibit natural environmental processes (see also Chapter 6: Marine Coastal Processes). It is predicted that there will be a slight loss of habitat extent, however, this represents 0.00014% of the Annex I Sandbank habitat features within the SAC. Given the extent and distribution is currently deemed to be in favourable condition, the magnitude of the impact on the Annex I habitat qualifying features of the site is considered to be negligible and would result in an insignificant change in the baseline condition. Although typical species are in unfavourable condition due to a recorded decline in species richness, abundance, and diversity, the infaunal communities present are common regionally and, as such, any localised habitat loss would not be expected to have a disproportionately high effect on any benthic taxa.

Based on these assessments, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of sandbank features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Annex I Intertidal Reef

The preferred methodology for cable installation at landfall is HDD. However, open cut trenching is also included within the proposed methodology in case HDD fails/is not feasible:

- An HDD would progress from the acceptable point of cable emergence onshore to the point of safe cable exposure offshore. This operation requires a special drilling tool capable of drilling horizontally and with the flexibility to change height as it drills to gradually curve from the entry point to the eventual exit height;
- If HDD were judged to not be feasible, open-cut trenching would be undertaken at landfall, with the cable laid within a trench that is cut into the seabed and then backfilled. This operation would likely require use of a land-based excavator in the intertidal region and marine plant in the shallow sub-tidal section.

If HDD is pursued, it is expected that 2 area of rock protection, each 21 m by 5 m, will be required at the HDD exit sites. However, this area is characterised by coarse and fine sediments which do not qualify as Annex I habitat and the HDD exit is anticipated to be at approximately 3.5 m below LAT

and as such does not directly overlap with intertidal habitats. The 2020 survey did not identify any Annex I habitats within a 25 m radius of the potential HDD exit site (see Volume 3, Technical Appendices 9.2: Environmental Baseline Report and 9.3: Intertidal Report). As such, no permanent habitat loss of Annex I habitat is predicted from placement of rock protection at the HDD exit site and this option is not expected to result in any adverse effects on site integrity and designated Annex I habitat features.

However, if open cut trenching is required, this will extend through the intertidal areas of West Angle Bay. The potential trenching footprint does overlap 146 m² of sublittoral bedrock, which qualifies as Annex I Reef habitat. If open cut trenching activities intersect an area of Annex I Reef, this would be expected to result in permanent habitat loss. This area of geogenic reef at risk within the intertidal zone corresponds to <0.00004% of the 409.97 km² Geogenic Reef reported to be present within the Pembrokeshire Marine SAC.

It should be noted that subtidal habitat surveys and ground level intertidal surveys covered the entire survey area, with the exception of a patch 0.00947 km² in area. This extent fell within shallow subtidal waters at a depth that could not be reached by the survey vessel. Benthic habitats within this area were initially determined based on aerial imagery before an additional free-diving (snorkelling) survey was completed in May 2021 to verify the exact composition and extent of habitats within this 'data gap' (see Volume 3, Technical Appendix 9.1, Annex 1: West Angle Shallow Subtidal Snorkel Survey Report). The dive survey concluded that extensive, but patchy, Annex I bedrock reef habitats (H11710) are present across 70% of the 100 x 10 m corridor surveyed.

Although some boulders and cobbles are also present, these were not sufficient to be considered additional Annex I habitat; the extent of stony reef habitat was not considered significant. It was noted that all of the reef habitats identified within the survey area are commonly occurring, both within the Pembrokeshire Marine SAC and nationally. These areas are strongly influenced by sand and are characterised by benthic communities that have a relatively low species richness. All the species recorded were common, both within the Pembrokeshire Marine SAC and nationally. No habitats or species of known nature conservation importance were found during the survey.

Although there is potential that open cut trenching may be required, which would lead to permanent loss of intertidal Annex I Reef habitat, the spatial extent of loss would be very small (146 m²) and correspond with a negligible portion (<0.00004%) of the Geogenic Reef reported to be present within the Pembrokeshire Marine SAC. The 2021 dive survey confirmed that this reef habitat did not contain any rare features and was similar to other reef habitat across the SAC. Extent and distribution of this feature is currently classified as being in favourable condition and therefore this very small loss is not expected to jeopardise the conservation objectives for this site. Such a small loss will not adversely affect the structure and functioning of the feature within the SAC. Accordingly, it is determined that there is **no potential for an adverse effect on site integrity, having regard to the conservation objectives of intertidal reef features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Annex I Intertidal Mudflats and Sandflats

In addition to permanent disturbance to intertidal geogenic reef, open cut trenching (if required) would extend through the intertidal Annex I Sandflats (H1140) within West Angle Bay. The total area

of this feature at the intertidal area, as mapped from the baseline surveys, is 0.058 km² (Volume 3 Technical Appendix 9.2: Environmental Baseline Report). The worst-case design scenario for disturbance to this habitat from construction trenching would cause temporary disturbance to an area up to 10 m in width. This area (0.003 km²) corresponds with 0.02% of the total extent of this feature within the SAC (19 km²). It is not expected that this will result in any permanent habitat changes, or adversely affect the structure and function if the habitat.

The intertidal habitats that overlap with the area of potential open cut trenching are primarily littoral sediments ranging from muds to gravels. Trenching operations within the intertidal area have potential to impact the SAC qualifying feature Annex I Mudflats and Sandflats Not Covered by Seawater at Low Tide. However, any disturbance to this soft sediment habitat would be temporary. The predominant biotope mapped for this habitat was A2.2 ('littoral sand and muddy sand') (see Chapter 9: Marine and Coastal Ecology and Volume 2, Figure 9.9) and, within A2.2, A2.231 ('polychaetes in littoral fine sand') was recorded across the lower to mid shores. This biotope comprises a community of mobile and opportunistic species, resilient to physical disturbances on and within the sediments, with a high recoverability rate and therefore recovery would be expected to occur rapidly following any disturbance.

Given the small spatial extent and temporary nature of habitat disturbance predicted for this feature, there is no suggestion that temporary habitat loss/disturbance would adversely affect the ability for the conservation objectives of this SAC to be achieved. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of intertidal mudflats and sandflats features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Annex I Large Shallow Inlets and Bays

The ria of Milford Haven is the most prominent 'inlet and bay' feature within the vicinity of the Pembrokeshire Marine SAC. However, given the geographic separation between this and the Project site, there is no potential for temporary/permanent habitat loss/disturbance. The Project ECC extends through West Angle Bay, and therefore there is potential for interaction between the bay feature and activities within the ECC, including trenching, HDD exit point protection, floatation pits, and barge anchoring. However, these interactions and associated impacts are assessed above within '*Annex I Intertidal Mudflats and Sandflats*'. In addition, the presence of floatation pits and barge anchoring may lead to highly localised benthic disturbance. For the worst-case design scenario of open cut trenching during construction, this will occur over 3 months, and would be associated with a temporary footprint from anchors of nearshore barges of 1,000 m² (0.001 km²) and temporary flotation pit of 7,200 m² (0.007 km²).

Benthic habitats in this area are dominated by moderately to exposed rocky habitats, which generally support low diversity species assemblages, resilient to natural physical pressures. Sand (scour) tolerant species are present and shallow water rocky areas contain a complex of A3.21 ('kelp and red seaweeds on moderately exposed sublittoral rock') (see Volume 2, Figure 9.9) and the broad biotope A3.12 ('Sediment-affected or disturbed kelp and seaweed communities'). Within this biotope, opportunistic algae characterise the shallow rocky habitats, where rapid growth is important in the frequently sand scoured disturbed areas. Despite a high resilience to abrasion that may directly or indirectly occur during installation on the seabed or from anchoring, these biotope(s)

have a low resistance and high sensitivity to changes to a different habitat type, which may occur during any local sediment disposal. As such, it is considered that these habitats have high resilience to any disturbance that may result from the presence of floatation pits and barge anchoring. Any effect would be temporary, and communities would recover rapidly following cessation of construction activities.

With respect to conservation objectives, above and beyond the general overarching site conservation objectives outlined in Section 6.5.1, and assessed above for Annex I Intertidal Mudflats and Sandflats, NRW emphasises the requirement for restoration of several typical species within Annex I Large Shallow Inlets and Bays (NRW 2018b). Given the rapid recovery of typical species and the dynamic nature of this environment, there is no indication that the highly localised and temporary habitat disturbance within West Angle Bay will negatively affect typical species, or the structure and functioning within this habitat. As such, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of large shallow inlets and bays features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Annex I Estuaries

Given the geographic separation between the Milford Haven estuary and the Project site, there is no potential for temporary/permanent habitat loss/disturbance to this feature from Project activities. As such, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of estuaries features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Annex I Submerged or Partially Submerged Sea Caves

Sea caves are distributed along most of the rocky coasts within the Pembrokeshire Marine SAC. At West Angle Bay there was only one sea cave recorded, and this habitat was assigned the biotope A1.44C 'Pontic mediolittoral caves with *Hildenbrandia, Phymatolithon, Lithophyllum*, bryozoans, *Pachygrapsus, Eriphia*', which belongs to its parent classification of A1.44 'Communities of littoral caves and overhangs' (Marine Nature Conservation Review (MNCR) code LR.FLR.CvoV). This feature was observed as having a shingle bottom, with encrusting barnacles present. The feature recorded is a cave due to its size (larger than a crevice), but with a single entrance and relative limited extent, associated low species diversity, and isolated as it is the only one observed. In view of the single observation, this feature is not considered a notable characteristic of the landfall site.

The extent of temporary/permanent habitat loss/disturbance from Project activities will be limited to the direct array area/ECC footprint. The sea cave feature that was recorded within West Angle Bay was located away from the export cable corridor and therefore there is no potential for spatial overlap with the temporary/permanent habitat loss/disturbance pressures. As such, it is considered that there is no risk that this pressure will affect sea cave features within the Pembrokeshire Marine SAC. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of submerged or partially submerged sea caves features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Temporary Increases in Suspended Sediments/Smothering

Throughout the construction phase of the Project there will be disturbance of seabed sediments. This disturbance can release sediment into the water column as a plume, increasing SSC and thus increasing water turbidity, until the plume becomes dispersed by tidal currents and the sediments re-settle on the seabed.

The principal causes of this disturbance during construction will be:

- Sandwave levelling with dredge and/or use of MFE and subsequent return of this material to the water column at/near the sea surface;
- Installation of anchors;
- Drilling fluid release associated with HDD at landfall;
- Drill arisings released from drilling for pile anchors;
- Pre-lay cable trenching or cable installation using a plough, jetting or MFE tool(s);
- Flotation pit construction;
- Material released from open cut trenching at landfall (contingency).

The scale of this impact will depend upon the installation activity, local sediment type and hydrodynamic and geomorphological processes.

The potential changes caused by longer duration activities that can cause sediment disturbance (such as drilling, dredging, overspill, cable trenching, or cable installation using a jetting or MFE tool) were assessed and the release of drilling fluids (bentonite and drill cuttings) at HDD cut out sites also quantified. These are summarised below for the respective designated Annex I habitats and full results are provided in Technical Appendix 6.1: Marine and Coastal Processes Technical Appendix.

The greatest level of sediment deposition will occur in instances where coarse sediment is disturbed and released close to the seabed. This may lead to sediment deposition up to 0.3 m in thickness. Conversely, in scenarios where plumes of fine sediments are mobilised, these will disperse over a large area and resettlement will not occur with measurable thickness. Where deposition of sediment does occur, winnowing will cause dispersal of these sediments within a few tidal cycles.

Annex I Subtidal Reef

In this nearshore region, the export cable will be installed in Rows Rocks, a sediment filled channel surrounded by subtidal Annex I Geogenic Reef habitat. Any disturbance of sediments within this channel, will lead to mobilisation of sediment which may, in turn, disperse and settle on the adjacent reef habitat.

Chapter 6: Marine and Coastal Processes predicted that the spatial extent of an increased SSC plume in this area will be limited to a few tens of metres at the time of disturbance, with concentrations increasing to very high values (>thousands of mg/l). However, the duration of increased SSC will only last as long as the active disturbance period, plus 30 minutes post-event. Sediment deposition will comprise both sands and gravels, with local thickness of tens of centimetres, potentially reaching 0.3 m at distances up to 10 m. With respect to the potential deposition of sediment on Annex I habitats in this area, the effect will be relatively localised, comprising a very small proportion of reef

habitat within the Pembrokeshire Marine SAC (409.97 km²). In addition, any effects will be temporary in nature and therefore will not result in long-term effects on Annex I habitats.

Within this habitat, the high energy biotope A4.131 ('bryozoan turf and erect sponges on tide-swept circalittoral rock') was dominant. In the Marine Evidence-based Sensitivity Assessment (MarESA), Tyler-Walters *et al.* (2018) define light and heavy smothering as "*deposition of up to 5 cm or 30 cm of fine material added to the seabed in a single, discrete event*", respectively. Bryozoans such as *Flustra foliacea* exhibit a degree of tolerance to increased SSC in the water column, and this biotope is also insensitive to light or heavy smothering and siltation. Noting that burial in excess of 0.3 m may cause mortality to some individuals and species, the receptors associated with the habitats present generally show a low sensitivity (due to medium resistance and high resilience) at the benchmark of heavy smothering. However, it is expected the deposited materials will be removed quickly by strong hydrodynamic conditions (Readman, 2016). It should also be noted that physical conditions in the site mean that in instances where sediment deposition approaches 0.3 m, it is expected that it would rapidly disperse, preventing the benchmark from being met for any meaningful periods of time.

Given the level of tolerance expected in benthic communities found on this feature and the short duration of any sediment accumulation, this pressure is not expected to adversely affect the ability for the conservation objective for this SAC from being achieved with regards to typical species and assemblages, or the structure and function of the reef. There is no pathway for elevated SSC to affect extent and distribution, and therefore it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of subtidal reef features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Annex I Sandbank

The Project ECC overlaps with 0.008 km² of Turbot Bank within the SAC, and 0.14 km² outside of it. No sandwave clearance is proposed for within the SAC and, thus, disturbance to Turbot Bank will be restricted to cable lay and burial.

It has been predicted that for the area in close proximity to Turbot Bank, the spatial extent of any short-term increased SSC plume will only be within a few tens of metres, will last no more than 1 hour after the end of activity, and have no long-term or permanent change in SSC values. Fine sediment is also unlikely to redeposit in measurable thickness (see Chapter 6: Marine and Coastal Processes).

Sandbanks can be dynamic features and assessed to have capacity to recover from perturbations such as from sediment deposition. It is expected that the faunal communities within these features, are resilient to a degree of increased SSC and smothering, and can reorientate and right themselves through their burrowing capabilities. Biotopes mapped on Turbot Bank within the near-field study area comprised a mosaic of A5.25 and A5.14 biotopes, associated with Valued Ecological Receptor (VER) Groups L and I, respectively (see Volume 2 Figure 9.7b, Figure 9.12a). Biotope A5.25 (VER Group L) was the dominant habitat mapped across the bank within the SAC, and is assessed as having a high resilience and low sensitivity to changes in suspended solids and smothering or changes in siltation rates. MarESA (Tyler-Walters *et al.*, 2018) defines light and heavy smothering and siltation changes as deposition of up to 5 cm and 30 cm of fine material in a single event,

respectively. The high resilience and low sensitivity of the receptor is attributed to bivalves' and polychaetes' capacity to survive limited periods of sediment burial. However, if heavy siltation does occur then there may be some mortality (Tillin, 2016).

The natural resilience of benthic communities associated with the Turbot Bank feature mean that the predicted small elevation in SSC is unlikely to affect the physical and biological structure and function of this feature, in a manner that leads to long-term degradation of habitat quality. Accordingly, these activities are considered to be in line with the conservation objectives for this site and it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of sandbank features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering.**

Annex I Intertidal Reef

Within the intertidal and shallow subtidal areas, the worst-case design scenario in terms of benthic effects is open cut trenching across the infralittoral and littoral area. This activity may take up to 3 months and will involve anchoring or shallow barge deployments in the shallow subtidal area of West Angle Bay. This represents the contingency option to the primary solution at landfall, of HDD. With HDD, impacts on rocky habitats will be avoided.

It is expected that any sediment disturbed from trenching and anchoring in the shallow waters will mostly comprise finer particles. Therefore, dispersion of this sediment is expected to be widespread, with subsequent sediment deposition being minimal (in terms of thickness). Coarser sand particles may be limited to a 500 m dispersion distance from source of impact, however due to the dynamic nature of the site, regular sediment movement of fine and coarse particles is experienced at the site.

West Angle Bay is situated on the southern side of the entrance of Milford Haven where the sediment movement is generally ebb tide dominated, so any resuspended sediments will predominantly be transported downstream, away from the Haven, and not brought back to site.

These moderately to highly exposed rocky habitats generally support low species assemblages, resilient to natural physical pressures. The intertidal A1.113 biotope, characterised by barnacles and limpets is one of the key habitats identified across the intertidal bedrock. Any increases in suspended finer sediments in the water column that may arise from trenching, may locally enhance food supply for filter feeders such as barnacles, but if levels are too high, this can impair feeding mechanisms by clogging gills and reducing light for photosynthesis of algae (Tillin and Hill, 2016). However, Tillin and Hill (2016) note that with regular tidal inundations, these settled sediments are likely to rapidly remobilise and alleviate any longer-term effects of smothering. MarESA (Tyler-Walters *et al.*, 2018) divides smothering into 2 categories: light and heavy. Light smothering is "*deposition of up to 5 cm of fine material added to the seabed in a single, discrete event*", and heavy smothering is "*…up to 30 cm…in a single, discrete event*". Tillin and Hill (2016) determined that the biotope has medium sensitivity to both light and heavy smothering. It should be noted that physical conditions in the site mean that there is no expectation of that benchmark being met.

The subtidal rocky biotopes are characterised by sand tolerant species. These communities are sensitive to a change in habitat (e.g. rock to sedimentary), but in such a dynamic environment it is expected that any deposited sediments will be repeatedly resuspended and transported away. As

such, it is not expected that these changes in SSC will lead to adverse effects on these sand tolerant species.

Given the level of tolerance expected in benthic communities found on this feature, and the rapid clearance expected for any sediment that is deposited, this pressure is not expected to degrade habitat quality in a manner that would adversely affect the diversity or abundance of typical species and assemblages, or the affect the structure and function of the reef. There is no pathway for elevated SSC to affect extent and distribution. Therefore, it is determined there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of intertidal reef features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Annex I Intertidal Mudflats and Sandflats

The greatest level of SSC uplift/smothering in areas of Annex I Sandflats not covered by seawater at low tide is predicted for open cut trenching activities. Sediment types within the intertidal area are similar to the shallow subtidal sediments in the areas surrounding West Angle Bay. As such, it is unlikely that the proposed cable installation/open cut trenching works will result in deposition of different sediment types across this Annex I habitat.

The most widespread biotope within the lower to mid shore was A2.231 ('polychaetes in littoral fine sand'). This biotope comprises a community of species resilient to physical disturbances from smothering/siltation and increases in SSC, with little or no sensitivity to such pressures. (Ashley, 2016). The MarESA (Tyler-Walters *et al.*, 2018) defines light smothering as deposition of up to 5 cm of fine sand and heavy smothering as up to 30 cm of fine sand, in a single, discrete event. Ashley (2016) determined that the biotope is not sensitive to light smothering (high resistance and resilience) and has low sensitivity to heavy smothering (low resistance and high resilience). If deposition occurs, it may reduce available preferred habitat but, following a tidal cycle, such sediments are expected to be re-suspended and dispersed.

In view of the natural variation in SSC within this intertidal region, and the small temporal nature and magnitude of any change resulting from Project activities, there is no indication that temporary increases in suspended sediments/smothering would adversely affect the presence, abundance, condition or diversity of typical species and assemblages. The natural structure and function involves dynamic sediment exchange, and the feature extent is also not expected to be affected. Therefore, it is concluded there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of intertidal mudflats and sandflats features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Annex I Large Shallow Inlets and Bays

Sediment plumes from ECC installation and remediation works may potentially extend into the ria of the Milford Haven Annex I Inlet and Bay feature. However, it is expected that only fine sediment plume components will extend this far. Given the naturally turbid conditions within this estuarine environment, it is expected that typical species present would possess natural tolerance of fluctuations in SSC and would not be adversely affected by these small magnitude, temporary, uplifts. Similarly, as discussed above, benthic assemblages within West Angle Bay have little or no

sensitivity to elevated SSC and would not be adversely affected by the expected small-scale temporary changes (Ashley, 2016; Tillin, 2016; Tillin and Hill, 2016).

It should be noted that the Milford Haven Estuary contains maerl bed habitats (2.3 km from landfall), seagrass beds (2.4 km from landfall), saltmarsh habitat (5.3 km from landfall), and blue mussel beds (5.4 km from landfall). However, project specific modelling of potential for SSC impacts on these receptors (see Chapter 6: Marine and Coastal Processes) determined there would be no measurable thickness of accumulation on these receptors.

In view of this, there is no evidence that temporary increases in SSC/smothering would prevent achievement of conservation objectives and therefore it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of large shallow inlets and bays features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Annex I Estuaries

There are no conservation objectives from the Pembrokeshire Marine SAC specific to Annex I Estuaries. Estuaries are often designated with nested features that form part of the overarching estuary feature. Although the EU Habitats Interpretation Manual stated that Estuaries are "*coastal inlets where, unlike 'large shallow inlets and bays' there is generally a substantial freshwater influence*", Milford Haven waterway is considered an Estuary *and* the Milford Haven ria is classified as a Large Shallow Inlets and Bays (NRW, 2018a). There is a high degree of overlap between the spatial area considered for the Milford Haven Estuary feature and for the Milford Haven ria Large Shallow Inlets and Bays feature. As such, all effects of temporary increases in suspended sediments/smothering on estuary have been assessed above with respect to Annex I Large Shallow Inlets and Bays. It is concluded that there is no evidence that temporary increases in SSC/smothering would prevent achievement of conservation objectives. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of estuaries features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Annex I Submerged or Partially Submerged Sea Caves

Sea caves are distributed along most of the rocky coasts within the Pembrokeshire Marine SAC. Although there are various notable sea cave features within the SAC, particularly on St. David's peninsula, Ramsey Island, Skomer Island and the Castlemartin coast, it is thought that there are also many unrecorded smaller, inconspicuous or inaccessible intertidal caves or unknown subtidal sea caves (NRW, 2018a). As such the number or characteristics of sea caves that are situated within the secondary effects range of Project activities is not known. Specifically, these features may be affected by plumes of sediment mobilised during cable installation, reburial or remediation and decommissioning activities.

Sea caves on the Pembrokeshire coast are typically limestone features and cave floors mostly consist of coarse mixed sediments, including pebbles, cobbles and boulders. These features generally support scour and high wave exposure tolerant species, and are typically colonised by encrusting animal species but may also support shade-tolerant seaweeds near their entrances (NRW, 2018a).

Sediment frequently accumulates in sheltered locations within sea caves. The type of sediment can influence habitat suitability and thereby species diversity and composition within the cave (NRW, 2018a).

In view of this point, there is risk that elevated SSC caused by Project activities may influence sediment concentration, potentially affecting habitat suitability. However, the mobilisation and deposition of sediment as a result of water movement is regular and widespread and as such it is expected that any changes caused by temporary increases in SSC due to Project activities would be short-term and rapidly counteracted by natural processes.

The concentration of suspended particulate matter within sea caves with local sediment supply is generally significantly higher than levels in the adjacent external water column (NRW, 2018a). As such, it would be expected that benthic communities at these sites will have a natural tolerance to highly turbid environments.

With respect to the site conservation objectives, it is considered that temporary increases in SSC or smothering only has potential to influence structure and function, or typical species. However, any SSC uplift will be small in magnitude and of short duration. Given the natural tolerance of typical species within these features to turbid environments, it is not considered that these changes would result in any adverse effects. Although it is possible that smothering by mobilised sediments may influence physical functions such as sedimentology, it is likely that any resultant changes in sediment composition will rapidly be replaced by the naturally high rates of sediment mobilisation and deposition. The MarESA sensitivity for 'submerged or partially submerged sea caves', is determined as not-sensitive to low, for deposition of sediments (Tyler-Walters *et al.*, 2018). The designated site 'Advice on Activities' identifies a pressure benchmark of >5cm deposition in a single event. As noted above, physical conditions in the site mean that there is no expectation of that benchmark being met.

It is therefore concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of submerged or partially submerged sea caves features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Introduction/Spread of Invasive Non-native Species

There will be a potential increased risk of introduction of INNS into the area during the construction phase, via increased vessel activity. Milford Haven is the third largest port in the UK, with a busy shipping channel and high recreational boat use. As such, it is likely that INNS resident in, or newly introduced into these waters, can be further introduced into the benthic environment surrounding the Proposed Development. The INNS American slipper limpet *Crepidula fornicata* has been resident in Milford Haven since the 1950s and there is concern that, with its high larval dispersal potential, Project activities during construction/installation could allow recruitment of juveniles (GIL, 2019). For a full list of introduction vectors and potential INNS that may be introduced, see Volume 3, Technical Appendix 9.4: INNS Plan.

It has been determined that introduction or spread of INNS is most likely to occur via vessels, semi-submersible floating platform and any areas of offshore export cable protection, and is less likely with areas of array cable protection and/or the mooring lines located within the array area.

The main construction phase activities associated with the Project that were identified as potentially introducing or spreading INNS are:

- Installation of anthropogenic structures (i.e., semi-submersible floating platform platforms and associated mooring system, and array and offshore export cables, and associated cable protection) in the Study Area;
- Fabrication and towing of the semi-submersible floating platform;
- Requirement of vessels from outside the local area for construction and decommissioning activities.

It is difficult to predict the exact nature of potential impacts from the introduction or spread of INNS, as associated sensitivities of, and interactions with, existing benthic communities/species can be complex, and habitat/species/community specific. Project embedded standard mitigation measures include the development of an INNS Plan that will provide a framework for management of biosecurity issues and invasive species for the Project duration and will include compliance with relevant guidance regarding ballast water. These measures will reduce the overall risk of introduction.

Considering the embedded mitigation that will be employed to reduce the potential risk of INNS, there is no indication that the colonisation of hard structures or introduction of INNS would adversely affect the ability for the conservation objectives of this SAC to be achieved with regards to the extent, structure and function, or restoration and recovery of typical species. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with introduction/spread of invasive non-native species**.

Accidental Pollution

The presence of numerous works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events, as far as possible. A Marine Pollution Contingency Plan (MPCP) will be produced and agreed with stakeholders, post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity, in combination with its physical environment. For example, fresh oil spills occurring directly on intertidal areas are likely to have a greater impact than if spilled subtidally, where oil sinks and becomes emulsified and adsorbed onto particles (Stamp, 2015). The strong hydrodynamic regime across the Study Area, means that should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential impact on the benthic environment.

In consideration of the standard mitigation and adoption of best practice it is expected that if any accidental pollution event(s) do(es) occur, it will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to Annex I benthic habitats.

During construction and decommissioning activities there is a risk of accidental pollution events, which may impact benthic communities. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the physical, biological, and chemical structure and functions necessary for long-term habitat quality or would lead to degradation in the abundance or condition of typical species. As such, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with accidental pollution**.

Mobilisation of Contaminated Sediments

The installation of array cables and the offshore export cable using a plough, jetting or MFE tool(s) at the seabed, or cutting tools within the intertidal environment, will lead to sediment disturbance, and under the worst-case scenario, 1.35 km² of seabed is predicted to be disturbed during installation. An additional 3.74 km^2 of temporary habitat disturbance is predicted in the operational phase via the catenary action of mooring lines and cable repair/remediation activities.

The associated sediment disturbance has the potential to re-mobilise sediments that contain chemical contaminants. However, subtidal sediment contamination across the array area and ECC is low (see Chapter 7: Marine Sediment and Water Quality for baseline information).

Arsenic was the most common contaminant, being recorded in excess of Cefas Action Level 1. Nickel, chromium and cadmium were also recorded in excess of this threshold. These limited number of instances, where concentrations of metals exceeded standard thresholds, also showed no clear pattern of distribution. It is apparent that where contamination does occur, it is not concentrated in broad regions, but intermittently distributed throughout the footprint of the Project (see Chapter 7: Marine Seabed and Water Quality for full details).

Only 1 of these elevated results was recorded for a sample station close to the historic Milford Haven dredge disposal site (LU170), last used in 1994. The absence of elevated contaminant levels in sediments collected close to the historic Milford Haven disposal site indicates that there is low risk that cable installation through this area will result in mobilisation of contaminated sediments. In view of the analysis results for sediments collected in this area, works within the footprint of the historic disposal ground are not considered to pose an increased risk to benthic features.

Hydrocarbons were generally recorded at relatively low concentrations, and with a general pattern of higher concentrations at nearshore stations compared with offshore stations, which is most likely due to the proximity to coastal urban settings. Threshold Effect Level (TEL) was exceeded at a limited number of stations for hydrocarbon compounds, but no samples exceeded Probable Effect Level (PEL), which means concentrations were below levels in which adverse effects may be expected in a wider range of organisms.

In consideration of the duration and scale of disturbance during Project construction, and the regional low concentrations and distribution of contaminants (heavy metals, hydrocarbons etc.), the magnitude of effects from caused by mobilisation of contaminated sediments will be very low.

In terms of site conservation objectives, it is a requirement to maintain site structure and function with regards to water and sediment quality. NRW advises that contaminant levels in the water column and sediments derived from the proposed activity must be "*at or below existing statutory guideline concentrations*", "*below levels that would potentially result in increase in contaminant concentrations within sediments or biota*" and "*below levels potentially detrimental to the long-term maintenance of the feature species populations, their abundance or range*" (NRW, 2018a). In view of the low levels of contamination present in local sediments relative to guideline thresholds, inclusive of those for marine biota, there is no indication that the proposed works will negatively affect site conservation objectives. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with mobilisation of contaminated sediments**.

Changes to Physical Processes

The long-term placement of subsea structures on the seabed (e.g., cable protection; mooring lines), may result in localised scour around these structures due to changes in tidal currents and seabed morphology. Scour may, in turn, lead to a loss of sediment, which may directly impact the physical structure of the adjacent habitats and indirectly effect resident benthic communities. Sediment type and hydrodynamics is an important consideration for predicting the degree of scour that can occur. Scour can increase over periods of years on sandy sediments, and over mixed gravelly sediments only the sand particles will re-mobilise if tidal currents are not strong enough to sweep away heavier fractions (Whitehouse *et al.*, 2011).

For the Project, localised scour may occur in association with:

- Cable protection;
- Mooring lines;
- Mooring line clump weights;
- Drilled, driven or suction pile anchors.

Localised scour only has the potential to affect soft sediment habitats. In addition, no Project activities within the intertidal area are expected to result in scour. In view of this, and the small spatial extent of any scour that does occur, effects within the Pembrokeshire Marine SAC are not expected for any Annex I habitat other than Sandbanks.

Placement of cable protection on surface laid subsea cables will prevent sediment scour around the cable, thus protecting it. However, a small amount of localised secondary scour may form at the edges of the berm, which will be in proportion to the overall dimensions (height and slope angle) of the berm, its position, and clast (rock fragment) size used.

Cable protection berm height will not exceed 2 m, with a base width of 11 m. Therefore, the footprint of any such rock berms only represents a very small proportion of the total water depth. The sloped sides (18°) of these berms are also designed to minimise the impact on tidal currents.

The berm axis will potentially lie across the natural sediment transport pathways, which may present some obstruction to bedload transport. It is predicted that, initially, small volumes of sediment will accumulate on the updrift side, within and around the berm, as bedload transported sediment is trapped between gaps in the clast.

The thickness of sediment predicted to accumulate on the updrift side will range from 2-30 cm, reaching its maximum within an order of weeks to a few months. As the 18° slope of berm is within the range of naturally stable bed slopes, a stable sediment slope will develop and sediment transport will return to natural conditions over the berm, and no measurable change to seabed is expected more than a few metres from the updrift edge.

Downdrift of the berms, a small local depression (scour) may occur, but within only a few metres. and to a shallow depth (e.g. only a few centimetres). This is a result of the temporary reduction in sediment supply during initial accumulation on the updrift side of the berm. This pattern of accumulation or scour may naturally vary over the lifetime of the berm, and can be episodic or seasonal in nature; however, it is expected that there will be no measurable difference in sediment type or texture around these protection structures.

In addition, the presence of cable protection on the seabed has the potential to present local blockage or resistance to the passage of currents and waves. The direct change is most likely to appear as a wake or shadow feature in the lee of the obstacle, where the baseline or ambient conditions may be modified. However, due to the limited depth, height, or other dimensions of the obstacles being introduced as part of the Proposed Development, changes are likely to be of limited scale and extent. As a result, indirect changes to sediment transport rate and direction, controlled by the current and wave regimes, are also not likely (where measurable changes to currents and waves do not extend to the seabed), or would be limited to the same relatively small-scale and local extent (up to tens of metres for cable protection).

The rock protection proposed for the Greenlink crossing (located within the Annex I designation associated with the wider Turbot Bank feature) is in waters 39-40 m in depth. Accordingly, this area of cable protection height (max. 2 m) constitutes only a small proportion (<5%) of the total water depth. Where currents and waves interact with the berm, it is unlikely that the berm will present a sufficient obstacle to cause changes to their magnitude or direction beyond the very local nearbed area. Any changes to sediment transport will be localised and will therefore not extend to the main crest of Turbot Bank (around 2 km to the east).

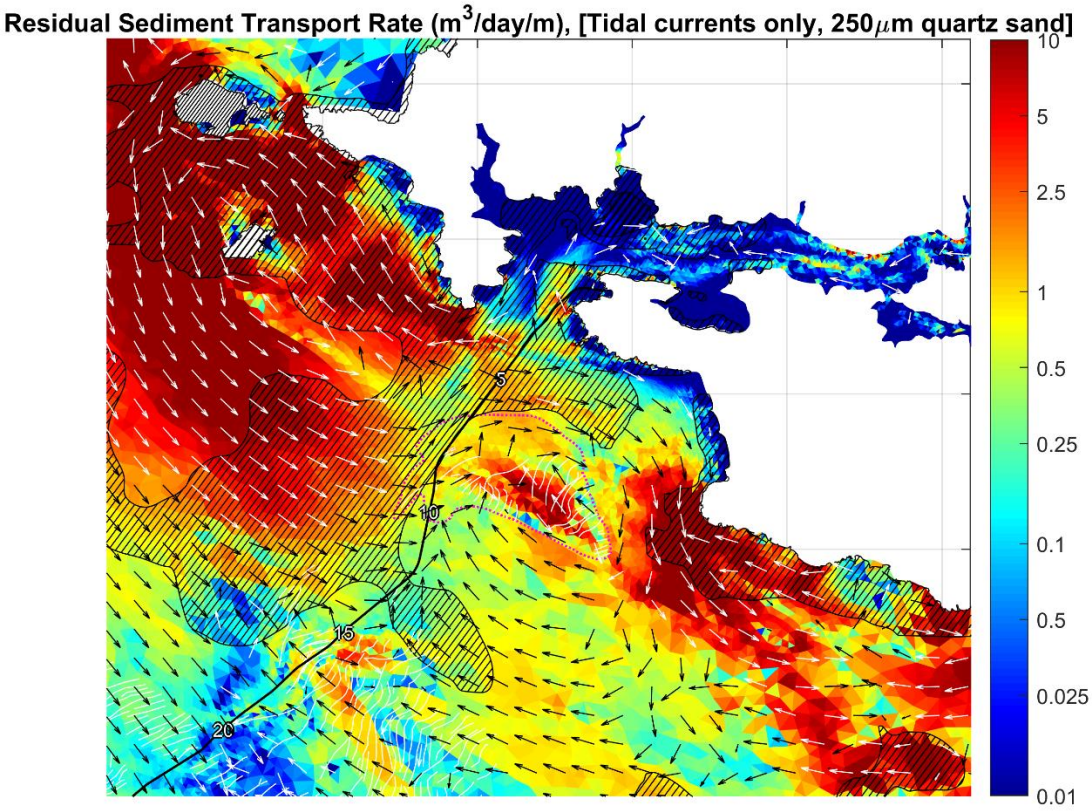
Numerical sediment transport modelling has been undertaken to quantify the potential rate of sediment transport under tidal current forcing (see Chapter 6: Marine Coastal Processes). The

patterns of magnitude and direction of net transport within the modelling outputs are consistent with naturally observed distribution and migration behaviour of sedimentary features.

Illustration of net sediment transport (Figure 6.5) helps to identify and differentiate the factors controlling the behaviour of sediment pathways and bedforms around the ECC route. Net sediment transport vectors for areas of the ECC to the west of Turbot Bank converge on the export cable corridor, but then re-orientate north as part of the circulatory pattern around the bank. Sediment that is present between KP10 and KP5 of the ECC is shown to be on the outside edge of the recirculation system around Turbot Bank.

Sediment contained within the wider Turbot Bank system approaches the export cable corridor from the southeast at KP10, then migrates north parallel to the route, and then moves away from the route to the northeast at KP5.

Figure 6.5: Daily average net sediment transport rate and direction over a representative mean spring-neap cycle as determined by numerical sediment transport modelling outputs. The crest lines of larger sandwave features are shown by white lines, and areas identified as exposed rock substrate are illustrated by black hatched areas (From: ABPmer, 2021)



The location and extent of the main body of Turbot Bank, and the migration of bedforms around it, is therefore shown to be controlled and maintained by the local and regional patterns of tidal currents and resulting net sediment transport. The bank itself is only a temporary sink for sediment. Inputs of sediment are likely to come mainly through pathways from the south, with potentially

smaller amounts from the west. This is likely to be balanced by sediment output from the system along the transport pathway to the southeast of the bank. It is therefore apparent that there is extremely limited potential for placement of rock protection on section of the export cable corridor to obstruct sediment supply to Turbot Bank and, thereby, impact the form/structure and function of this feature.

With regards to the conservation objectives of the Pembrokeshire Marine SAC, any changes that may result from placement of rock protection at this location are not expected to be sufficient to lead to long-term degradation of this Annex I Sandbank feature. Although there may be some localised changes in hydrodynamic processes, these will be small in magnitude.

It is not expected that this structure will cause an obstruction to sediment supply to the main Sandbank feature or lead to any measurable change in feature extent or mobility. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with changes to physical processes**.

6.5.2.2. Operation and Maintenance

Temporary/permanent habitat loss/disturbance

Temporary disturbance to Annex I features may occur due to reburial or remediation O&M works. The current application allows for the following:

- Up to 5 export cable repair events, each up to 1 km length, with a maximum temporary disturbance footprint of 50,000 m² per event, i.e. total footprint of 250,000 m^2;
- An additional up to 5 repair events of the array cables, totalling 1,505,250 m^2 of temporary habitat disturbance are also assessed;
- 10 cable remediation events, totalling 600,000 m^2 of temporary habitat disturbance.

Due to the nature of O&M repair/remediation events it is not possible to accurately forecast where the export cable repairs and/or remediation will be required, and therefore what is the risk of overlap with respective Annex I habitat types. However, any disturbance within the O&M phase will be smaller in magnitude than those caused during construction and therefore will fall within the parameters described within Section 6.5.2.1.

The 10 O&M cable repair events and 12 remediation events covered in this application are required to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between construction and any one O&M event, and between each of the O&M events themselves. With respect to temporary habitat disturbance from cable burial, recovery is expected to occur rapidly in all benthic habitats (see Chapter 9: Marine and Coastal Ecology for details). Given the likely temporal separation between individual repair/remediation events, it is likely that any affected habitat will have recovered to baseline conditions ahead of any subsequent disturbance.

The 10 repair events and 12 remediation events covered within this application are proposed for the entire ECC and array area. As such, it is considered likely that these will be distributed along the ECC length and within the array area and there is low likelihood of spatial overlap between disturbance

events. If it transpired that there was spatial overlap between separate O&M events, this would limit the total extent of seabed disturbance over the Project lifetime to a smaller area. Whilst this may hinder the recovery of benthic habitats within the specific area affected, it would also increase the extent of local habitats that remain unaffected. Although this scenario is possible, it is much more likely that sequential works will affect different areas of seabed. It is therefore anticipated that there will be sufficient time between any potential repeat disturbance events for benthic communities to fully recover.

With respect to the conservation objectives for the SAC, there is no indication that the expected temporary disturbance will lead to a reduction in environmental quality, nor will it inhibit natural environmental processes. Any reduction in habitat extent will be localised and temporary. Given the extent and distribution is currently deemed to be in favourable condition, the magnitude of the impact on the Annex I habitat qualifying features of the site is considered to be negligible and would result in an insignificant change in the baseline condition. Although typical species are in unfavourable condition due to a recorded decline in species richness, abundance, and diversity, the infaunal communities present are common regionally and, as such, any localised habitat loss would not be expected to have a disproportionately high effect on any benthic taxa.

Based on these assessments, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with temporary/permanent habitat loss/disturbance**.

Temporary increases in suspended sediments/smothering

Temporary increases in suspended sediments/smothering will result from any remediation/reburial O&M activities that are required. However, the spatial scale of these effects will be smaller than those during the construction phase, and these would not be greater in magnitude than effects of construction activities. Given that O&M activities will be required to intervene in instances where cable becomes de-buried along the export cable corridor or the array cables, the spatial extent of any works will necessarily fall within the envelope assessed for construction. Any plumes caused by construction or O&M works will disperse within a maximum of 3 days. As such, in terms of effects residency it is expected there will be no temporal overlap between phases for this pressure and construction phase activities are considered as the worst-case parameters for assessment.

As recognised in Section 6.5.2.1, faunal communities recorded along the Project ECC and array area are resilient to a degree of increased SSC and smothering and most can recover rapidly from temporary increases in SSC or smothering (Ashley, 2016; Tillin, 2016; Tillin and Hill, 2016). This natural resilience means that the small elevation in SSC is unlikely to affect the physical and biological structure and function of this feature in a manner that leads to long-term degradation of habitat quality. Accordingly, these activities are considered to be in line with the conservation objectives for this site and it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Introduction/Spread of Invasive Non-native Species

There will be a potential increased risk of spread of INNS into the area during the O&M phase, due to the necessity for the presence of O&M vessels on site. Given the expected use of locally based vessels, it is expected that there is minimal risk for introduction of INNS previously absent from the region. Additional details of this risk are provided, with regards to construction/decommissioning works, in Section 6.5.2.1. However, it should be noted that fewer vessels will be required during O&M than during construction/decommissioning. As such, it is considered that the risk that INNS may be spread due to vessel activities will be lower, and fall within the worst-case assessment envelope for Section 6.5.2.1.

In addition to risk of INNS associated with vessel activity, during the O&M phase there is also risk that Project infrastructure introduced into the marine environment provides suitable artificial habitat for settlement and becomes colonised by INNS. The Project will be in operation for up to 25 years and, therefore, will provide a suitable timeframe for colonisation of these structures by INNS. With an expected temporal shift in climatic baseline, it may also be expected that a greater number of southerly Lusitanian species will migrate into Welsh waters, extending their northerly range.

Offshore wind farms can act as 'stepping stones' for INNS, providing a network of substrates to exploit, in environments that otherwise would not be suitable for colonisation. It has been calculated that the total area available for potential colonisation by INNS on the installed marine infrastructure is 499,478 m^2 (0.50 km^2); with approximately 46% of this available from the ECC (and HDD exit) cable protection, 25% for array cable protection, and 15% for the semi-submersible floating platforms themselves. The remaining surfaces are provided by the anchors, mooring lines and clumps and unprotected array cables. Although there is no spatial overlap between all of these areas and the Pembrokeshire Marine SAC, they would still lead to increased risk to designated Annex I habitats due to the 'stepping stone' effect.

It is difficult to predict the exact nature of potential impacts from the introduction of INNS as associated sensitivities of, and interactions with, existing benthic communities/species can be complex, and habitat/species/community specific. Project embedded standard mitigation measures include the development of an INNS Plan that will provide a framework for management of biosecurity issues and invasive species for the Project duration, and will include compliance with relevant guidance regarding ballast water. These measures will reduce the overall risk of introduction.

Considering the embedded mitigation that will be employed to reduce the potential risk of INNS, there is no indication that the colonisation of hard structures or spread of INNS would adversely affect the ability for the conservation objectives of this SAC to be achieved with regards to the extent, structure and function, or restoration and recovery of typical species. Therefore, it is determined there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with introduction/spread of invasive non-native species**.

Accidental pollution

As detailed in Section 6.5.2.1, the presence of works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels. Although vessel activity will be lower during the O&M phase than during construction or decommissioning, there remains a risk of pollution event within the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. An MPCP will be produced and agreed with stakeholders, post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity in combination with its physical environment. For example, fresh oil spills occurring directly on intertidal areas are likely to have a greater impact than if spilled subtidally, where oil sinks and becomes emulsified and adsorbed onto particles (Stamp, 2015). The strong hydrodynamic regime across the Study Area, means that should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential impact on the benthic environment. In consideration of the standard mitigation and adoption of best practice it is expected that if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to Annex I benthic habitats.

During O&M activities, there is a risk of accidental pollution events, which may impact benthic communities. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the physical, biological, and chemical structure and functions necessary for long-term habitat quality, or would lead to degradation in the abundance or condition of typical species. As such, it is determined there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with accidental pollution**.

Mobilisation of Contaminated Sediments

Cable repair and remediation works will necessitate localised disturbance of seabed sediments. It is assumed that a series of cable repairs and/or cable remediation will be required over the lifetime of the Project, with up to 5 repairs anticipated in the array area, and 5 within the ECC.

However, the spatial extent of seabed disturbance will be less during O&M than during construction works. In addition, the disturbance events that do occur will be intermittent as opposed to a single sustained construction programme. As such, any effects from this pressure during O&M works will be less than that determined for construction (see Section 7.5.2.1 for details), for which no adverse effect on site integrity was determined. Accordingly, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with mobilisation of contaminated sediments**.

Changes to physical processes

Section 6.5.2.1 provided a comprehensive assessment of potential risk to physical processes from the introduction of Project anthropogenic structures during construction activities. Given the extended temporal nature of any changes, it was necessary for that assessment to include associated effects during the Project operational lifetime, As such, any effects associated with the O&M phase have been fully covered within Section 6.5.2.1 and are not assessed further here.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I features of the Pembrokeshire Marine SAC from any pressures associated with changes to physical processes**.

6.5.3. Assessment of Adverse Effects In-combination

The potential for in-combination effects on designated habitat features of the Pembrokeshire Marine SAC is limited to those associated with projects that either spatially overlap with the SAC site, or result in secondary effects envelopes which overlap with the site. It is considered that the potential for secondary effects on Annex I benthic habitats is limited to a maximum range of one spring tidal excursion ellipse. Under mean spring conditions the maximum tidal excursion is approximately:

- 10 km around the array area;
- 14-15 km around the middle of the ECC (approximately KP20);
- 18-19 km in the nearshore approaches to Milford Haven (approximately KP10);
- 5-8 km within Milford Haven.

It should be noted that due to the spatial separation between the Project array area and the Pembrokeshire Marine SAC (>10 km), it is considered there is no potential for Project activities within the array area to affect this SAC site, and these will not be considered further herein. The parameters listed above (tidal excursion distances) were applied to the Project long-list provided in Volume 3, Technical Appendix 30.1: Cumulative Long List, and the following Projects have been identified as requiring assessment within the in-combination assessment:

- Greenlink Interconnector;
- Marine Energy Test Area (META) - Dale Roads;
- META - Warrior Way;
- Project Valorous.

Although localised work on the Pembroke Dock Slipway was identified within the cumulative effects long-list, this has been excluded from further assessment as it is expected to be completed before works on the Proposed Development commence. It is not expected that there will be any additional operational impacts that require consideration within the in-combination assessment.

Table 6.6 provides a summary of the relevant parameters for the Projects.

Table 6.6: Developments considered within the benthic Annex I Habitats in-combination Assessment. Project details included for reference

Development Type	Project	Tier	Distance from Array (km)	Distance from ECC (km)	Development Footprint (km^2)	Construction Timings
Marine Energy (FLOW)	Erebus	n/a	n/a	n/a	5.15	May 2026 – September 2027
Interconnector	Greenlink	2	17.8	0	0.16	2021-2024
Marine Energy (Wave power)	META Dale Roads	2	39.6	2.3	0.195	As test sites deployment and recovery will be dictated by client bookings. There is no programme, and activity will be managed by NtM and stakeholder updates.
Marine Energy (Wave power)	META Warrior Way	2	12.6	12.6	0.093	
Marine Energy (FLOW)	Valorous	2	3.3	9.7	4.7	2026-2028

6.5.3.1. Temporary/Permanent Habitat Loss/Disturbance

Loss of Annex I Reef habitat due to construction of the Greenlink Interconnector was deemed to result in an adverse effect on the integrity of the Pembrokeshire Marine SAC, and has successfully received consent after satisfying the requirements of Article 6(4) (NRW, 2021b). In-combination assessments are required to identify projects which would not by themselves have adversely affected the coherence of the Natura 2000 network, UK National Network or Ramsar sites, but which would, in-combination with others. Given that it was determined that the Greenlink Project would have an adverse effect on site integrity alone, it should not also be taken forward for assessment in-combination due to compensation having been secured in respect of impacts to Annex I reef. Accordingly, the Greenlink project will not be considered in terms of in-combination loss of Annex I Reef habitat within the Pembrokeshire Marine SAC. Any other residual effect from the Greenlink Interconnector (e.g. any related to pressure pathways other than loss of Annex I Reef habitat are considered within in-combination assessment).

With regards to disturbance to soft sediment habitats, inclusive of Annex I Sandbanks and Annex I Intertidal Mudflats and Sandflats, the Greenlink RIAA (GIL, 2020) notes that although cable laying activities may lead to a fractional coarsening of sediments, due to suspension of as finer silts, this "*is unlikely to have any significant effect, given the narrow trench size (1m)*". The habitats likely to be affected by cable burial are characterised by short-lived, fast-growing, opportunistic epifauna which rapidly colonise any additional habitat that becomes available (GIL, 2020). This is expected to ensure that any area of disturbance recovers rapidly following cessation of works.

The Environmental Statement (ES) produced for the META projects makes no reference to permanent habitat loss (RPS, 2019a). However, it is specified that temporary disturbance is likely where seabed clearance activities occur, e.g. boulder and debris clearance; however, this will be limited to ≤10 m from each device/mooring footprint. It should be noted that construction of these developments will proceed without the requirement for seabed levelling. The total combined temporary habitat disturbance predicted to occur at any one time, across all 3 META test sites, is ≤124,679 m² [11]. The worst-case design scenario for these projects allows for up to 150 installation events during the project lifetime (15 years). This, therefore, introduces potential for repeat disturbance to areas of seabed previously affected by installation activities. It is considered that many of the characterising species of affected sediments and habitats are infaunal and will, therefore, be largely unaffected by seabed disturbance during project works. It is predicted that recovery will occur within 2 years following cessation of works. In terms of Annex I habitats, the works may lead to temporary habitat disturbance within Annex I Estuaries and Annex I Large Shallow Inlets and Bays, but there is no overlap with any known Annex I Reef habitat.

Interaction between Project Valorous and the Pembrokeshire Marine SAC will be limited to cable installation, remediation, reburial and decommissioning activities associated with the ECC. The methodology proposed for Project Valorous activities is expected to be similar to that for the Proposed Development (MarineSpace, 2020). Due to the early stage of project development, the precise export cable route is not yet known for Project Valorous. Accordingly, it is not known which, if any, Annex I habitats will be intersected by this route. However, in accordance with the assessment of likely effects for cable installation, remediation, reburial and decommissioning of the Proposed Development, it is likely that any impacts that do occur will be highly localised around the cable route, and of limited temporal extent.

Project Erebus Construction Phase

Construction works for both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 6.6). This ensures that only O&M works at these sites have potential to contribute to in-combination effects. Conversely, construction of Project Valorous will not commence until after construction of the Proposed Development is

[11] It should be noted that META – East Pickard Bay (Bombora) is scheduled for construction in summer 2022 for a maximum duration of 18 months, including removal. As such, there is no potential for temporal overlap with the Proposed Development and this project is screened out of in-combination assessment.

complete. Accordingly, there is no pathway for in-combination effects between Project Valorous and Project construction works. Cable repair/remediation O&M activities are only expected to be required infrequently. For example, the Greenlink Interconnector ES indicated that up to 5 cable repair operations would be required within Welsh jurisdiction during the 40-year operational lifetime of the cable. Although the META projects have not indicated how many interventions would be expected, it is expected to be lower still, due to their proximity to the coast. Industry used 'rule of thumb' is that one fault should be expected each 10 years per 100 km of cable. Given the expected infrequent occurrence of O&M activities at these sites, it is considered the risk of temporal overlap with Project construction activities is small. Where there is overlap between construction of the Proposed Development and O&M works for the other projects considered, the limited temporal extent and magnitude of effect of O&M activities is unlikely to markedly increase overall effect, above that assessed for construction of the Proposed Development alone.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination effects with O&M activities for the Greenlink Interconnector and META projects, and both construction and later O&M activities associated with Project Valorous. O&M activities will only occur infrequently (see details above). The current application allows for an estimated 10 repair events (up to 5 along the ECC and 5 along the array cables) and up to 12 cable remediation events. These 10 O&M cable repair events and 12 remediation events are required to provide contingency for the entire Project operational lifespan, i.e., 25 years. As such, it is likely that there will be substantial temporal separation between construction and any one O&M event, and between each of the O&M events themselves. With respect to temporary habitat disturbance from cable burial, recovery is expected to occur rapidly in all benthic habitats (see Chapter 9: Marine and Coastal Ecology for details). Given the likely temporal separation between individual repair events, it is likely that any affected habitat will have recovered to baseline conditions ahead of any other potential disturbance.

Despite the expectation of temporal separation between O&M works for the Proposed Development and O&M activities for the other projects considered, in order to maintain a precautionary approach it is necessary to consider the worst-case scenario, i.e. O&M activities within the Pembrokeshire Marine SAC, occurring for all of these projects concurrently. However, any disturbance within the O&M phase will be smaller in magnitude than those caused during construction and even where there is concurrent disturbance this would be expected to fall within the parameters described for the Project construction phase.

The greatest potential for in-combination effects with Project O&M activities will be with construction activities for Project Valorous. However, O&M activities for the Proposed Development are only expected to be required for soft sediment environments, where magnitude of effect will be small, and recovery will occur rapidly (see Section 6.5.2.2). As such, it is expected that this will result in a negligible increase above the pressures expected for Project Valorous alone.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and magnitude to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However,

the expected lifetime of the META projects is 15 years (RPS, 2019b) and, as such, these projects will be decommissioned before completion of the 25-year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined effects of META projects as assessed for construction. As such, risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

Given the relatively small area affected by Project activities, the likely temporal separation between disturbance events, and that rapid recolonisation that would be expected from surrounding undisturbed habitats that would be expected following temporary disturbance, it is determined that the combined effect from these projects is unlikely to exceed the worst-case parameters assessed for impacts alone. There is no known risk of in-combination permanent habitat loss within pressure pathways identified and which qualify for in-combination assessment.

There is no indication that this potential in-combination effect with other projects would lead to an adverse change in distribution and extent of habitat features within the SAC site, or would lead to ether a long-term degradation in either physical, biological or chemical structure and functions of the designated habitats or a degradation of presence, abundance, condition and diversity of typical species. Based on the infrequent occurrence of activities causing habitat disturbance, temporary duration of effects, and the expected rapid rate of recovery where effects do occur, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of temporary/permanent habitat loss/disturbance from these projects**.

6.5.3.2. Temporary Increases in Suspended Sediments/Smothering

The Greenlink RIAA did not include specific consideration of effects from temporary increases in suspended sediments/smothering. However, given the proximity of these two developments and similarity between the installation techniques proposed for Greenlink and those proposed for the Project (i.e. MFE jetting and trenching), it is expected that the associated effects will be similar.

Sediment disturbance at the META sites may occur following gravity base installation or drilling required for pile installation (RPS, 2019a). All activities proposed at each of the META sites are of a temporary and intermittent nature with the Warrior Way and Dale Roads sites being limited to a single device testing at any one time.

As determined for the Proposed Development, any coarse sediment disturbed by installation of META devices is predicted to settle relatively quickly to the seabed in the immediate vicinity of the works, i.e. within the boundaries of the META sites. At Warrior Way, all but the finest material is predicted to settle within 1 hour. Any plume would result in an SSC uplift of 40 mg/l, although this would settle within 2 hours. This fine sediment plume may travel up to 100 m from the site. Due to the high silt components in sediment at the Dale Roads site, it is expected that any fine sediment plume would increase ambient SSC by up to 50 mg/l and extend approximately 600 m from source.

The methodology proposed for Project Valorous activities is expected to be similar to those for the Proposed Development (MarineSpace, 2020). Accordingly, it is expected that any temporary

elevation in SSC will be highly localised in terms of spatial effect and would disperse within a short period. It is predicted for the Proposed Development that any SSC plume will be limited to a few tens of metres at the time of disturbance, with concentrations increasing to very high values (>thousands of mg/l). However, the duration of increased SSC will only last as long as the active disturbance period, plus 30 minutes post-event. It is assumed that effects associated with Valorous will be similar in terms of extent and residency.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 6.6). This ensures that only O&M works at these sites have potential to contribute to in-combination effects. Conversely, construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. Cable repair/remediation O&M activities are only expected to be required infrequently. For example, the Greenlink Interconnector ES indicated that up to 5 cable repair operations would be required within Welsh jurisdiction during the 40-year operational lifetime of the cable. Although the META projects have not indicated how many interventions would be expected, it is expected to be lower still due to their proximity to the coast. Industry used 'rule of thumb' is that one fault should be expected each 10 years per 100 km of cable. Given the expected infrequent occurrence of O&M activities at these sites, and the short duration and rapid recovery expected following any SSC increase, it is considered the risk of in-combination pressures is small.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination effects with O&M activities for the Greenlink Interconnector and META projects; and both construction, and later O&M activities, associated with Project Valorous. O&M activities will only occur infrequently (see details above). The current application allows for an estimated 10 repair events and up to 12 cable remediation events. These events are required to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between construction and any one O&M event, and between each of the O&M events themselves. Although it is highly likely there will be both temporal separation between O&M works for the Proposed Development and O&M activities for the other projects considered, in order to maintain a precautionary approach it is necessary to consider the worst-case scenario, i.e. O&M activities occurring within the Pembrokeshire Marine SAC, for all of these projects concurrently. However, any elevated levels of SSC will be temporary, and plumes will clear rapidly following cessation of works. In addition, the scale of works required, and therefore extent of pressures during the O&M phase will be smaller in magnitude than those caused during construction. Even where there is concurrent disturbance, this would be expected to fall within the parameters described for the Project construction phase.

The greatest potential for in-combination pressures with Project O&M activities will be with construction activities for Project Valorous. However, given the temporary nature of predicted pressures, and low receptor sensitivity, it is expected that this will result in a negligible increase above the effects expected for Project Valorous alone.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and magnitude to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and, as such, these projects will be decommissioned before completion of the 25 year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects, as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

There is no indication that this potential in-combination effect with other projects would lead to an adverse change in distribution and extent of habitat features within the SAC site, or would lead to ether a long-term degradation in either physical, biological or chemical structure and functions of the designated habitats or a degradation of presence, abundance, condition and diversity of typical species. Given the low sensitivity to this pressure for Annex I habitats within the Pembrokeshire Marine SAC, and the expected short residency of any plumes that are created or additional sediment deposited, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of temporary increases in suspended sediments/smothering from these projects**.

6.5.3.3. Introduction/Spread of Invasive Non-native Species

The Greenlink project has committed to adopting similar measures to the Project, with regards to control of introduction/spread of INNNS. The Greenlink RIAA notes that risk will be managed under measures provide by the International Convention for the Control and Management of Ship's Ballast Water and Sediments standard, and that the latest guidance from GB non-native species secretariat (2015) will be followed, and a Biosecurity Plan produced pre-installation. It was determined that the adherence to these measures would reduce the magnitude of the effect to a negligible level (GIL, 2020).

The ES for the 3 META sites states that the combined increase in vessel activity for these sites will be up to an additional 80 vessel movements/round trips to port per year, and involvement of up to three vessels at any one time (RPS, 2019a)[12]. However, given the high baseline level of vessel traffic within the Milford Haven Waterway (Milford Haven Port Authority (MHPA) records report 5,004 commercial vessel movements per year), any uplift in vessel traffic associated with the META projects will be small relative to existing baseline levels. In accordance with measures for the

[12] It should be noted that META – East Pickard Bay (Bombora) is scheduled for construction in summer 2022 for a maximum duration of 18 months including removal. As such, there is no potential for temporal overlap with the Proposed Development and this project is screened out of in-combination assessment.

Proposed Development and the Greenlink Interconnector, an Invasive Species Management Plan is proposed for the META developments. This will be developed and agreed in consultation with the statutory consultees.

The scoping report for Project Valorous (MarineSpace, 2020) notes that:

"*Vessels used during the project may inadvertently transport INNS. This can have significant impacts on local fauna through displacement, and the effects may not be restricted to the immediate area as any INNS could spread rapidly.*

It is expected that infrastructure will be brought into and out of the nearby Pembroke Dock, and the introduction of the structures themselves may allow a localised spread of any already established INNS populations in the region."

However, the project has committed to complying with guidelines on mitigating the introduction and spread of INNS (Biosecurity Management Plan) and it is expected that the project will not be consented without requirement for adherence to best practice INNS risk management.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 6.6). However, vessel activity required for O&M works at these sites will still introduce risk of INNS introduction and/or spread. Construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. It is considered that the mitigation measures that will be employed by the Proposed Development and the other projects considered will be sufficient to reduce risk of INNS spread/introduction to negligible levels. As such, the combined pressures of these projects are not determined to pose a risk of adverse effect on site integrity.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination effects with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. Although the precise number and frequency of vessel activities is not known, O&M activities will only occur infrequently. The current application allows for an estimated 10 repair events and up to 12 remediation events to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between O&M events. Additional in-combination effects may result from construction activities for Project Valorous and from placement of additional artificial (turbine) structures within the marine environment during construction of Project Valorous.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and extent to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and as such these projects will be

decommissioned before completion of the 25-year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined effects of META projects as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

Given the mitigation measures that will be put in place to prevent the introduction and spread of INNS, it is considered there is negligible potential that in-combination effect with other projects would lead to an adverse change in distribution and extent of habitat features within the SAC site, or would lead to ether a long-term degradation in either physical, biological or chemical structure and functions of the designated habitats or a degradation of presence, abundance, condition and diversity of typical species. In view of the expected mitigation measures for these sites, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of introduction/spread of invasive non-native species from these projects**.

6.5.3.4. Accidental Pollution

The Greenlink RIAA scoped potential effects on Annex I habitats from accidental pollution out of the Stage 2 Assessment within the HRA. However, it did note that "*Control measures and shipboard oil pollution emergency plans (SOPEPs) will be in place and adhered to under MARPOL Annex I requirements for all project vessels*".

Assessment of accidental pollution events within the ES for the META developments notes that the associated risk will be addressed through implementation of an environmental management plan (EMP) during installation, which will include an MPCP, providing measures to address any potential contaminant releases and include key emergency contact details. As with the Proposed Development, any lubricants used at the META sites will be European Union (EU)/internationally approved for use in marine environments. It is expected that adherence to the measures outlined in the EMP, in addition to standard best practice guidance will minimise the likelihood of an accidental pollution event occurring and allow rapid containment if any did occur. As noted in Section 6.5.2.1, the META ES also acknowledges that any contaminants that are released will be rapidly dispersed by the high energy waters and twice daily tidal flushing.

The scoping report for Project Valorous notes that mitigation measures for dealing with the risk of accidental spills will be adopted and risks will be managed through the implementation of industry standard best practice guidelines (MarineSpace, 2020). Examples are provided such as establishment of spill response procedure, appropriate use of chemicals, adoption of marine pollution contingency plans and pollution prevention guidelines (PPGs). In addition, project vessels will comply with the International Maritime Organisation (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) standards. It is expected that adoption of these mitigation measures will minimise the risk of pollution events occurring and allow effective control in the unlikely event that they do.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 6.6). However, vessel activity required for O&M works at these sites will still introduce risk of accidental pollution events. Construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. It is considered that the mitigation measures that will be employed by the Proposed Development and the other projects considered will be sufficient to reduce risk of accidental pollution events occurring, and to contain any that do occur.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination effects with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. Although the precise number and frequency of vessel activities is not known, O&M activities will only occur infrequently. The current application allows for an estimated 10 repair events and up to 12 remediation events to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between O&M events. Additional in-combination pressures may result from construction activities for Project Valorous. However, given the mitigation measures that will be put in place to reduce the likelihood of pollution events occurring, and contain any that do, it is expected there is no risk of adverse effects on designated Annex I features.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and extent to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and, as such, these projects will be decommissioned before completion of the 25-year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

In view of the mitigation measures that will be put in place to avoid accidental pollution events, and to contain any that may occur, there is no indication that this potential in-combination effect with other projects would lead to an adverse change in distribution and extent of habitat features within the SAC site. There is also no evidence to indicate that in-combination effects would lead to ether a long-term degradation in either physical, biological or chemical structure and functions of the designated habitats or a degradation of presence, abundance, condition and diversity of typical species. In addition, given the low magnitude of effect expected for all of these sites, and the level to which the mitigation measures proposed for the Project are expected to reduce the likelihood of such events, and contain any that do occur, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat**

features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of accidental pollution from these projects.

6.5.3.5. Mobilisation of Contaminated Sediments

Although the ECC of the Proposed Development intersects the Greenlink Interconnector route and overlaps with the Bombora Wave Energy project, construction of these developments is expected to be complete by 2024. As such there will be no temporal overlap with construction associated with the Proposed Development. However, cumulative pressures may occur, if operational cable reburial works required for these sites occur during construction of the Proposed Development. The Greenlink Interconnector route will pass close to the historic Milford Haven dredge disposal ground, and the ECC for the Proposed Development will intersect the footprint of this disused spoil area. However, as described in Chapter 7: Marine Sediment and Water Quality, the absence of elevated contaminant levels in sediments collected close to the historic disposal site suggests that there is low risk that cable installation through this area will result in mobilisation of contaminated sediments. Sediment samples collected by Intertek (GIL, 2019) demonstrate that contaminant levels in sediments surrounding the Greenlink Interconnector are largely below the limits of detection. The risk associated with disturbance of these sediments is decreased further given the low chance of interaction between, and small SSC increase associated with, respective sediment plumes.

Potential for sediment contamination for META Phase Two project sites is determined to be very low (RPS, 2019a). Although site-specific sediment sample data are not available for Project Valorous project at the time of assessment, given the proximity, they can be assumed to be similar to that of the Proposed Development.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 6.6). This ensures that only O&M works at these sites have potential to contribute to in-combination effects. Conversely, construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. O&M activities associated with seabed disturbance are only expected to be required infrequently. For example, the Greenlink Interconnector ES indicated that up to 5 cable repair operations would be required within Welsh jurisdiction during the 40-year operational lifetime of the cable. Although the META projects have not indicated how many interventions would be expected, it is expected to be lower still due to their proximity to the coast. Industry used ‘rule of thumb’ is that one fault should be expected each 10 years per 100 km of cable. Given the expected infrequent occurrence of O&M activities at these sites, and the low levels of contaminants present in seabed sediments, it is expected that any uplift in contamination will be dispersed rapidly within the water column.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination effects with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. O&M activities will only occur infrequently (see details above). The

current application allows for an estimated 10 repair events and up to 12 remediation events. Although it is theoretically possible for O&M activities to be required at all projects simultaneously within the Pembrokeshire Marine SAC, this is considered to be highly unlikely. However, even if this did occur, given the low contamination levels in local sediments, any elevated levels of contamination will be temporary and rapidly disperse within the water column. In addition, the scale of works required, and, therefore, extent of effects during the O&M phase will be smaller in magnitude than those caused during construction. Even where there is concurrent disturbance this would be expected to fall within the parameters described for the Project construction phase.

The greatest potential for in-combination pressures with Project O&M activities will be with construction activities for Project Valorous. However, given the temporary nature of predicted pressures, and low levels of contaminants present, it is expected that this will result in a negligible increase above the pressures expected for Project Valorous alone.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and magnitude to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and, as such, these projects will be decommissioned before completion of the 25-year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects, as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

It is considered unlikely that there will be sufficient temporal and spatial overlap for interaction between sediments mobilised during construction/O&M/decommissioning activities required for these projects. However, these may all combine to affect spatially distinct parts of the Pembrokeshire Marine SAC. Nevertheless, even if this does occur, the low contaminant levels in underlying sediments ensures that the magnitude of any increase would be low. Due to the large volume of the receiving water and the capacity for dilution and flushing it is unlikely that these modest introductions of contaminants will affect the site. It is notable that the low levels of chemical contaminants in Project water samples indicate that any contaminants that are mobilised from benthic sediments are unlikely to lead to failure relative to water quality environmental quality standards (EQS).

As detailed in Section 6.5.1, site conservation objectives require that contamination levels are maintained within guidelines thresholds and that there should be no increase in contamination within sediment or biota, in order to prevent levels reaching the point at which they would increase contaminant concentrations within local sediments or biota. In view of the low levels of contamination present in local sediments relative to guideline thresholds, inclusive of those for marine biota, there is no indication that the combined effect of these proposed works will negatively affect site conservation objectives. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I**

habitat features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of mobilisation of contaminated sediments from these projects.

6.5.3.6. Changes to Physical Processes

The ES produced for the Greenlink Interconnector concluded that there would be no residual effects on marine physical processes from project activities, other than minor adverse effects from pre-sweeping of sandwaves. Although pre-sweeping may cause temporary changes to these features, whether this is through localised remobilisation by MFE or dredge removal and subsequent re-deposition up-current and close to the disturbed sandwaves, disturbed sediment will remain within the system. It is expected that features will reform and recover through natural sediment migration back onto the sandwaves within 1-2 years. Given the temporal separation between construction of the Greenlink Interconnector (2021-2024) and The Proposed Development (2026) it is expected that any adverse effects from this pressure will have recovered ahead of Project construction works. As such, it is considered there is no pathway for in-combination effects.

The ES for the META projects notes that the abstraction of wave energy at the Dale Roads site can potentially alter the wave climate and disturb sediment transport regimes in an area. However, these pressures are only expected to extend to ≤100 m from each device. In addition, energy extraction is expected to account for less than 0.2% of the mean incident wave height. These changes are not expected to have any significant effect on sediment transport. Tidal devices at the Warrior Way site are not expected to cause any change in the flow regime, with indiscernible changes in current speed outside the immediate area.

The potential for changes to physical processes for Project activities will be greatest at the end of the construction phase and throughout the operation stage, once all WTGs and project infrastructure are installed. Maintenance activities are not expected to cause any increase above changes predicted for construction, and decommissioning activities are likely to result in changes similar in magnitude but back towards pre-construction conditions. As such, in-combination assessment of individual Project phases is not necessary for this pressure pathway.

Detailed assessment of potential changes to coastal processes is not included within the scoping report for Project Valorous (MarineSpace, 2020). As such there is insufficient information currently available to include this within the present in-combination assessment. Assessment of in-combination pressures from Project Valorous on physical processes will therefore be deferred to the full assessment for that project.

There is no indication that this potential in-combination pressure with other projects would lead to an adverse change in distribution and extent of habitat features within the SAC site or would lead to ether a long-term degradation in either physical, biological or chemical structure and functions of the designated habitats or a degradation of presence, abundance, condition and diversity of typical species. In view of the lack of effect pathway with respect to the Greenlink Interconnector and the small scale highly localised changes expected for the META developments. it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of changes to physical processes from these projects**.

6.5.4. Summary

The screening process indicated that LSE on the Annex I features of the Pembrokeshire Marine SAC could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of this sites has been undertaken.

The assessment has considered the potential impacts of the Project during construction, operation and maintenance and decommissioning, alone and in-combination with other relevant plans and projects with respect to the site's conservation objectives.

With respect to the conservation objectives, there is no indication that the Proposed Development would prevent the favourable condition of any designated Annex I feature for which the Pembrokeshire Marine SAC is designated from being maintained. On this basis, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Pembrokeshire Marine SAC from any pressures associated with any effect associated with the Project (alone or in-combination)**.

6.6. Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru Special Area of Conservation

6.6.1. Site Details

The Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru SAC (hereto referred as the Limestone Coast SAC), is a 15.8 km^2 site located on the south coast of Pembrokeshire. The site was designated in 1995 and is designated for the protection of 6 Annex I habitats, 1 of which is a marine habitat, as well as 3 Annex II species (JNCC, 2021f).

The SAC comprises a series of coastal Sites of Special Scientific Interest (SSSIs), spanning from Castlemartin in the west to the Bishopston Valley in the east (CCW, 2008a). The Limestone Coast SAC supports a wide variety of species and habitats, including marine and terrestrial, ranging from vegetation communities atop sea cliffs to submerged sea caves along the coastline.

The overarching vision for the site, which the feature-specific conservation objectives are based upon, is:

"*for the SAC habitat features to be stable or increasing in area and the SAC and SPA species features to achieve favourable conservation status. The factors that affect these habitats and species must also be under control*" (CCW, 2008a).

The only marine habitat feature of the SAC that is screened in for assessment is:

- Submerged or partially submerged sea caves (H8330).

6.6.1.1. Submerged or partially submerged sea caves

Feature Summary

There is little information available on the sea caves feature of the Limestone Coast SAC, however, as the site is linked to the Pembrokeshire Marine SAC, the feature is expected to be similar to the

limestone sea caves previously described (refer to Section 6.5.1.6). Sea caves are present within several of the component SSSIs that are located within the SAC (CCW, 2008a), including at the following locations:

- Castlemartin Cliffs and Dunes SSSI;
- Stackpole SSSI;
- Stackpole Quay to Trewent Point SSSI;
- Lydstep Head – Tenby Burrows SSSI;
- Gower Coast: Rhossili to Port Eynon SSSI (where sea caves are a key habitat).

Feature Condition and Conservation Objectives

In 2006, the submerged or partially submerged sea caves feature was assessed as in **favourable** conservation status, however, CCW (2008a) notes that there is low confidence in the assessment due to the lack of actual evidence, and the assessment was largely based upon lack of human disturbance to the feature.

In 2017, another feature condition assessment was completed for the SAC, however, the overall condition of the sea caves feature was assessed as **unknown** due to limited data availability, as the most recent surveys were conducted in 2002 (NRW, 2018c).

CCW (2008a) outlines several conservation objectives for the submerged or partially submerged sea caves feature of the Limestone Coast of South West Wales SAC:

"*These features are cross-boundary features between the Limestone Coast SAC and the Pembrokeshire Marine SAC. Other than prevention of human disturbance to both the caves themselves and any species which may be using them (mainly bats and grey seals), there is little management required or indeed possible for this feature.*

- *There should be minimal disturbance to the caves and they should remain closed to the public.*
- *The caves should remain suitable as bat roost/hibernation sites.*
- *The caves used by grey seal should remain free of human disturbance.*
- *The geological interest of the caves will be unconcealed.*
- *Natural processes such as small rock falls will be tolerated.*
- *The affects* [sic] *of tidal activity in partially submerged caves should have a minimal effect on the internal environment of the cave (where the cave is a bat roost)*".

There are several performance indicators for the sea caves feature outlined in the conservation objectives document for the SAC (CCW, 2008a), including:

- Extent and distribution, with a lower limit set as the current distribution of the caves;
- Condition of the caves, with no specified limits set;
- Access and recreation, with no public access allowed.

6.6.2. Assessment of Adverse Effects Alone and In-combination

The sea caves feature of the Limestone Coast SAC is considered to have high similarity to the limestone sea caves designated for the Pembrokeshire Marine SAC and given the spatial proximity, to be a linked continuation of these features along the Pembrokeshire coastline.

Given the similarity and linkage between the two features it is likely that effects on the Limestone Coast SAC sea cave feature would be similar in nature to those at the Pembrokeshire Marine SAC. In addition, given the greater degree of geographic separation, it should be considered that the magnitude of any adverse effect would be no greater for the Limestone Coast SAC than the Pembrokeshire Marine SAC. Section 6.5 concluded that there would be no impacts on the integrity of the Pembrokeshire Marine SAC from Project activities. In view of the similar nature of impacts on the Limestone Coast SAC and smaller magnitude of effect expected, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of any of the Annex I habitat features of the Limestone Coast of South West Wales SAC from any pressures associated with any effect associated with the Project (alone or in-combination)**.

7. Annex II Migratory Fish Assessment

7.1. Introduction

This section covers the assessment of adverse effects on Special Areas of Conservation (SACs) designated for Annex II migratory fish. The section provides information to determine whether there is an adverse effect on the integrity of the conservation objectives of the SACs screened into assessment resulting from the potential effects of the proposed Project. The chapter is structured as follows:

- A summary of Habitats Regulations Assessment (HRA) screening results and potential pressure pathways;
- A summary of the proposed Project Design Envelope (PDE), outlining the worst-case scenario used to inform the assessment;
- For each SAC screened into the assessment:
  - A description of each SAC, its conservation objectives, and baseline information gathered to aid the assessment;
- For each feature of each SAC screened into the assessment:
  - A summary of the ecology of the species;
  - An assessment of the pressures during construction and operation of the proposed Erebus project alone;
  - An assessment of adverse effects when considering the proposed Erebus project in-combination with other developments.

7.1.1. Summary of Screening

Screening was conducted in order to identify potential exposure pathways for Annex II migratory (diadromous) fish populations (refer to Volume 3, Technical Appendix 8.2: HRA Screening Report). The fish species considered in the screening were:

- Allis shad *Alosa alosa*;
- Twaite shad *Alosa fallax*;
- River lamprey *Lampetra fluviatilis*;
- Sea lamprey *Petromyzon marinus*;
- Atlantic salmon *Salmo salar*.

Due to lack of pressure-receptor pathway, no sites where Atlantic salmon is a qualifying feature were screened into assessment.

Following consultation with Natural Resources Wales (NRW), the threshold for screening SAC sites was amended from 10 km, to being in-line with the maximum extent of potential impacts as determined by the Project-specific noise modelling. Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration specifies that the worst-case impact range for piling effects, based on criteria from Popper *et al.* (2014), was 20 km. As such, the screening threshold was amended to 20 km from Wind Turbine Generators (WTGs). The maximum level of disturbance associated with the ECC is likely to result from Unexploded Ordnance (UXO) clearance. Acoustic emissions caused by UXO

clearance will be emitted as a single pulse; Popper *et al.* (2014) provide specific criteria for explosions, and these are used in the determination of potential impact range. The Project is seeking consent for one UXO detonation via deflagration (low-order). Whilst deflagration charges typically have a Trinitrotoluene (TNT) equivalent charge weight of <250 g, a realistic worst-case scenario is represented within the assessment as having a charge weight of 2 kg.

Although high order UXO detonation is not deemed realistic for this Project, it is reported in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration and is used as a precautionary threshold for HRA. The maximum range for mortality and potentially mortal injury, based on criteria provided by Popper *et al.* (2014), was determined to be 930 m.

In accordance with the information provided above, the threshold for screening SAC sites has been set as 20 km from the array area and 930 m from the Export Cable Corridor (ECC). However, although the Afonydd Cleddau/Cleddau Rivers SAC is located 13.6 km from the Project ECC (>65 km from array area) this site has been screened into Stage 2 integrity test as the river drains directly into Milford Haven. It is therefore considered that there is a high probability that individuals of migratory fish populations would pass through/close to the Project footprint during seasonal migration. Figure 7.1 shows the location of sites screened into assessment in relation to the Proposed Development.

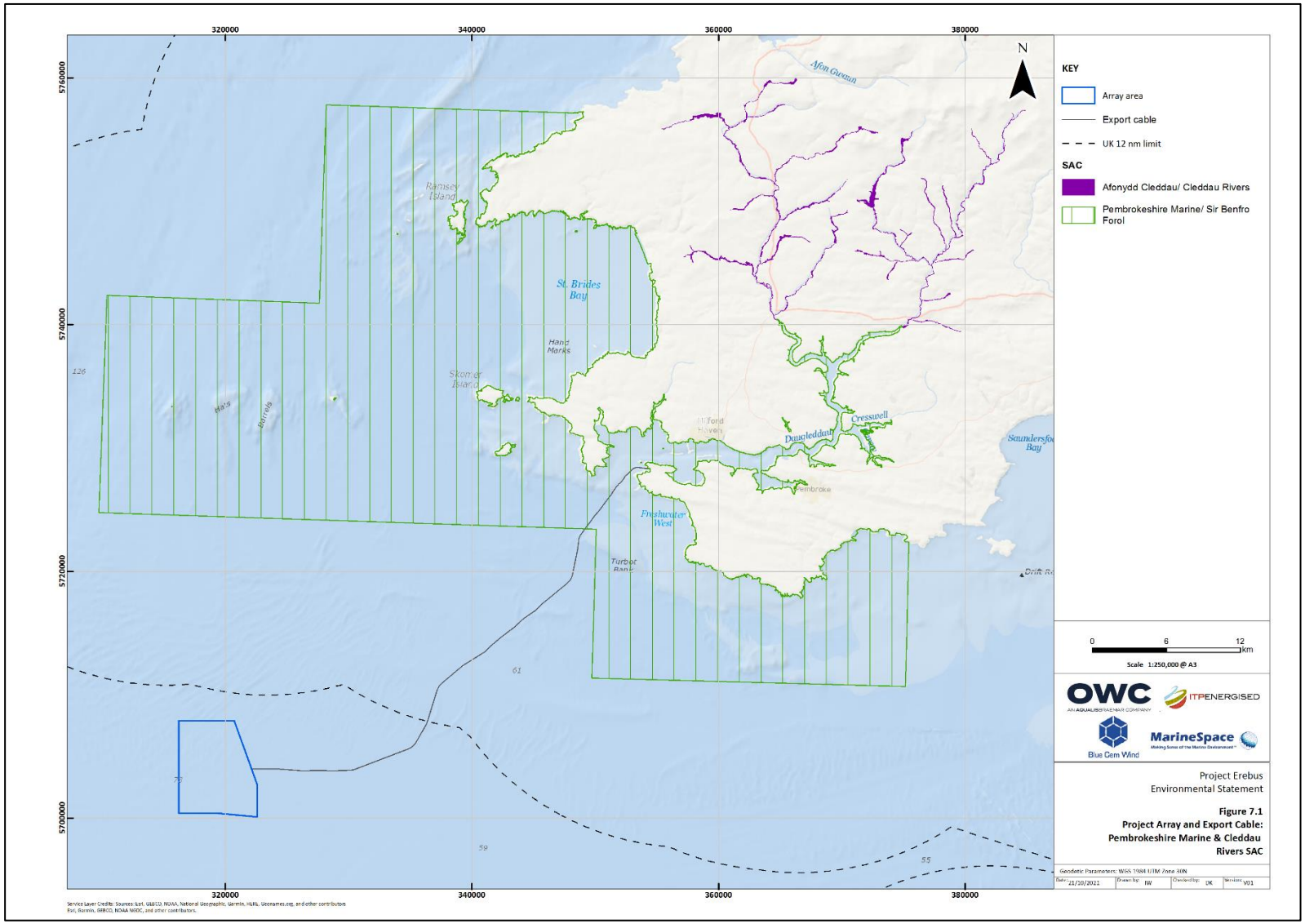
In order to provide a further precautionary level to assessment, and in recognition of levels of uncertainty associated with migratory fish behaviour and noise sensitivity of species such as shad, a stepwise approach is also applied. An Appropriate Assessment will be carried out on the closest site to the proposed plan or project location first. If Adverse Effect On Site Integrity (AEOSI) cannot be ruled out, a sequential/iterative assessment will be carried out considering the next closest SAC population to the Project site.

7.1.2. Summary of Potential Pressure Pathways

Several potential pressure pathways were identified for the remaining features in the screening process. No Likely Significant Effect (LSE) was determined for 1 of these pathways (long-term habitat loss/alteration) and therefore that pressure group has been screened out of requiring HRA Stage 2 integrity test. No LSE could not be concluded for the remaining pressures, and thus these are assessed within this report:

- Temporary habitat disturbance;
- Temporary increases in suspended sediments and sediment deposition;
- Underwater noise from unexploded ordnance detonation, drilling, and/or piling/particle motion disturbance;
- Electromagnetic fields;
- Accidental pollution.

Figure 7.1: Location of sites screened in for the next stage of the assessment for the Project in relation to Annex II migratory fish species.



7.2. Project Design Envelope Parameters Relevant to Annex II Migratory Fish

Table 7.1 provides parameters for use as the realistic worst-case scenario within assessment. It should be noted that these parameters are not limited to those for which there is spatial overlap between the direct or indirect area of effect and an SAC site. Due to the highly mobile nature of migratory fish, it is necessary to consider pressure pathways outside SAC boundaries in order to consider potential for adverse effects on designated Annex II features during transit to or from an SAC site. As such, the parameters provided in Table 7.1 describe the full range of marine activities associated with the Project, and are not limited to those in any specific spatial extent associated with any particular SAC boundary.

Table 7.1: Project realistic worst-case scenario parameters for use in assessment of potential for adverse effects on designated Annex II migratory fish populations

	Realistic Worst-case Scenario	Justification
Habitat loss/ Disturbance/Alteration	**Temporary Loss/Disturbance** Construction Phase • Maximum overall offshore construction duration = 8 months <u>Offshore Export Cable</u> • Length: 49 km; • Area of seabed disturbed via cable installation: 650,000 m^2; • Area of potential sandwave clearance 150,000 m^2. <u>Landfall</u> • Area of potential placement of anchor/shallow barge deployment: 1,000 m^2; • Floatation pit: 7,200 m^2; • Open cut trench: 6,354 m^2. <u>Array Area</u> • Array area: 43.5 km^2; • Area of seabed impacted by embedment anchors: 234,150 m^2; • Area of seabed impacted via interarray cable installation: 285,000 m^2; • Area of potential sandwave clearance within array area: 11,000 m^2;	This represents the maximum extent of temporary habitat loss throughout the construction phase, and hence the greatest potential loss in habitat over this period. The use of floatation pits at landfall represents a worst-case scenario. The barge may instead rely on 4 anchors for stabilisation, which would represent a significantly reduced impact.

	Realistic Worst-case Scenario	Justification
	• Number of WTG: 10; • Number of array cables: 10; • Number of mooring lines: 35; • Number of anchors: 63. **Total Area of Temporary Habitat Disturbance: 1,354,504 m^2** O&M Phase <u>Offshore Export Cable</u> • Estimated cable repair during lifespan: 5; • Duration of each cable repair: 2 weeks; • Estimated area of seabed disturbance per cable repair: 50,000 m^2 (total 250,000 m^2); • Cable remediation events – reburial: 12; • Footprint of seabed disturbance per remediation event: 50,000 m^2 (total 600,000 m^2). <u>Array Area</u> • Estimated cable array repair during lifetime: 5; • Duration of array repair: 2,160 hours; • Footprint of disturbance per cable array repair: 301,050 m^2 (total 1,505,250 m^2); • Footprint of disturbance via mooring line catenary swept area: 1,303,194 m^2 • Footprint of disturbance via array cable catenary swept area: 82,500 m^2 • **Total Area of Temporary Habitat Disturbance (via cable repair/remediation/catenary swept area): 3,704,944 m^2**	

	Realistic Worst-case Scenario	Justification
	Long-term Habitat Loss Array Area • Area of seabed impacted by piles: 175 m^2; • Area covered by drill arisiings: 11,340 m^2; • Area of array cable protection: 11,000 m^2 • Area of array cable stabilisation: 56,250 m^2 Offshore Export Cable • Area of seabed impacted via export cable protection (inclusive of Greenlink crossing): 83,380 m^2	
Temporary Increase in Suspended Sediment	Maximum plume extent (spring tides, tidal excursion from the activity): 10 km array area; 14-15 km middle of the ECC; 18-19 km nearshore; 5-8 km within Milford Haven. Within <50 m of activity: SSC in order of thousands to hundreds of thousands of mg/l, reducing rapidly with time and distance to order of hundreds or tens of mg/l. For low height of release from seabed: SSC unlikely to exceed 150 mg/l beyond approx. 5 m for gravels, 30 m for coarse sand, 90 m for medium sand, and ~250-300 m for finer sands. The time required for redeposition of sands and gravels following resuspension is in the order of seconds to a few minutes. Sediment released at the water surface: SSC unlikely to be >150 mg/l beyond ~100 m away for gravels, ~500 m for coarse sand, ~1.5 to 2 km for medium sand, ~5 km for finer sands. Sands and gravels released at the water surface: settles, in the order of a few minutes to 1.5 hours. Finer sediment released at the surface: up to 50 mg/l, up to approx. 2 km downstream; decreasing to 1-5 mg/l within 1-3 days through progressive dilution and dispersion. At low height of release from the seabed, sediments deposit within a distance proportional to their grainsize/settling rate.	The parameters outlined here represent the worst-case scenarios for both plume dispersion and sediment deposition. The ECC and array area will comprise a range of sediment sizes, resulting in lower average sediment distribution ranges, suspension times, maximum SSCs and deposition thickness across the overall area.

	Realistic Worst-case Scenario	Justification
	Approx. 5 m for gravels, 30 m for coarse sand, 90 m for medium sand, and ~250-300 m for finer sands. Time required for redeposition of sands and gravels following low height disturbance is in the order of seconds to a few minutes. Deposition - Sands and gravels: may cause measurable thickness of sediment deposition within the above described distances for SSC. However, can depend on other variables. Thicknesses 0.05 m-0.3 m are possible, but the maximum area of effect is inherently limited by the finite volume of sediment disturbed. Deposition – Fines: expected to become widely dispersed (order of several kms) and so will not resettle with measurable thickness locally.	
Underwater Noise	**Construction Activities** The following activities are expected to result in acoustic emissions ranging in source level between 161 dB re 1 µPa @ 1 m - 192 dB re 1 µPa @ 1 m: • Vessel movement of large and medium ships; • Backhoe dredging; • Suction dredging; • Cable laying; • Trenching; • Rock placement; • Drag embedment anchors; • Suction pile installation; • Drilling. If required, impact piling would involve 2,820 strikes over 114 minutes for each 2.5 m diameter pile with an unweighted SPL_{peak} of 236.9 dB re 1 µPa @ 1 m **UXO Clearance** Low order clearance or deflagration for UXO disposal using a 2 kg explosive charge, SPL_{peak} source level of 276.6 dB re 1 µPa @ 1 m	Source levels used are based on datasets collected for underwater noise modelling. Modelling assumes a worst-case of all sources operating for 12 hours within a 24-hour period, other than vessel noise which is assumed as being present for the full 24 hour period. Cable snapping assessment assumes all turbines producing the maximum number of snaps in a day, equivalent noise levels from multiple locations affecting a receptor to the same degree. *High order detonation of up to 525 kg device also modelled in line with*

	Realistic Worst-case Scenario	Justification
	High order clearance for UXO disposal using a 525 kg charge. **Operational Activities and Cable Snapping** Operational noise at a distance of 100 m is predicted to produce an unweighted 158 dB re 1 µPa^{2}s SEL over a one hour period. Cable snapping of 10 WTGs is predicted to produce up to 160 dB re 1 µPa^{2}s over 24 hours.	*DEFRA Policy Paper*[13] *and assessed, although judged to be a unrealistic worst case scenario.*
Electromagnetic Fields	EMF levels will be measurable at 7µT above background levels (48.7µT) at 0 m from the cable, decreasingly rapidly with distance to levels negligible from background at 4 m, and 5 m at cable crossings. EMF effects will be present in both the water and sediment within this area. Where the cable lies on the seabed, 50% of the area of increased EMF will be within the water column and 50% will be within the sediment. Up to 3.3 km of array cable will be situated within the water column. The total volume of EMF influence will be 3,939,618 m^3 (0.0039 km^3), of which a maximum of 178,550 m^3 will be entirely within the water column. Heat emissions have the potential to increase sediment temperatures by no more than 5.5 ˚C, within a few centimeters of the cable, when buried at a depth of 1 m. Changes in water temperature have been assessed as being negligible due to the high heat capacity of water and water flow around the cable.	This represents the maximum EMF levels anticipated throughout the project. It is likely that due to burial and armouring, as well as the use of cable voltages lower than those, the EMF level and area of influence within the water column will be lower for the Project.
Accidental Pollution	Operation period: 25 years. Vessel presence: • <2 weeks of vessels on site per cable repair/remediation event.	

[13] DEFRA Policy Paper: Marine environment: unexploded ordnance clearance joint interim position statement. Published 16 November 2021

	Realistic Worst-case Scenario	Justification
	1 x major O&M campaign (tow back to port) each year.	

7.3. Approach to Assessment

This assessment is provided to determine which Project activities can be expected to result in an adverse effect on the integrity of the conservation objectives of the Pembrokeshire Marine/Sir Benfro Forol SAC and/or the Afonydd Cleddau/Cleddau Rivers SAC.

The subsequent sections are structured as follows:

- A summary of baseline surveys completed to date, and the key findings relevant to Annex II migratory fish species;
- A description of the Pembrokeshire Marine/Sir Benfro Forol SAC and/or the Afonydd Cleddau/Cleddau Rivers SAC, details of the Annex II migratory fish features for which they have been designated, the conservation objectives and their current conservation status;
- A description of the potential effects associated with the Proposed Development and how these may interact with the designated features and conservation objectives for this site;
- An assessment of in-combination effects when considering the Proposed Development together with other developments;
- Proposed mitigation measures to avoid adverse effects on the SAC features over and above embedded mitigation;
- A summary of potential for adverse effects on the integrity of the Pembrokeshire Marine/Sir Benfro Forol SAC and/or the Afonydd Cleddau/Cleddau Rivers SAC.

7.4. Underwater Noise Modelling

Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report provides an assessment of the subsea acoustic emissions expected to result from Project activities, uses underwater noise modelling software to predict the distribution of noise around the Proposed Development, and estimates ranges at which various thresholds dictated by relevant guidance would be exceeded. Guidance for fishes is based primarily on Popper *et al.* (2014) and provides noise thresholds within which potential injury and onset of effects on hearing (both Permanent Threshold Shift (PTS), and Temporary Threshold Shift (TTS)) could occur in relevant species. These are based on both instantaneous and longer duration exposure to the noise.

Noise sources expected during the construction phase include ground preparation activities such as dredging, trenching, cable laying, and rock placement, turbine mooring activities such as the installation of ground embedment anchors, drilling and suction piling, and vessel movements. Impact piling is considered unlikely but has been included to cover the worst-case scenario. Disposal

of UXO may also be required, and the assessment has also considered the noise that could result from this activity.

Ground preparation, vessels and mooring installation (other than by impact piling) are relatively low-level noise sources and have been assessed using a simple propagation model alongside the impact criteria from Popper *et al.* (2014). Assuming the most plausible scenario for modelling, that a receptor swims away from the noise source when it is operating, any fish would need to be within 20 m of the source to receive sufficient exposure for a potential recoverable injury or permanent hearing impairment. A temporary, recoverable hearing impairment of fish species could potentially occur up to 100 m from the source. In the event that impact piling is required, the maximum PTS onset range is 280 m.

The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the Environmental Statement and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 13: Marine Mammals.

Deflagration (low-order) is the Project's preferred method for UXO clearance and based on current industry knowledge and precedent set by other offshore wind farms, is considered the realistic worst case scenario, e.g. Sofia Offshore Wind Farm (Sofia Offshore Wind Farm UXO Clearance Marine License Application (GoBe, 2021) MLA/2020/00489). High order UXO detonation, as an absolute worst case, has been modelled and reported in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report. However, this has been considered for completeness and is not deemed realistic, as the Project intends to employ deflagration (low-order) as the clearance method.

With respect to the high-order scenario, the assessment made in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report indicates that mortality and potential injury to fish with a swim bladder involved in hearing may occur at distances of up to 810 m following the deflagration of a UXO device using a 525 kg charge. As this noise will be instantaneous, individuals will not be able to flee.

This approach is informed by the UXO Threat and Risk Assessment (6-Alpha Associates, 2020) completed to inform project specific geotechnical surveys, which provides an assessment of potential threat sources and the likelihood of contamination across the Project array area and export cable corridor. The Project is also cognisant of the recently consented Marine Licence for the Greenlink Interconnector and the UXO approach adopted for the cable route in Welsh waters, i.e. the same as that proposed for the Project.

Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an Effective Deterrent Radius (EDR) of 5 km (based on a 2 kg detonation) is applied when considering the potential for disturbance from an individual UXO clearance event. The detonation of such a device, assuming no degradation over time, could lead to PTS onset impact ranges of a maximum of 1.9 km for Very High Frequency cetaceans and

0.35 km for the Low Frequency Cetacean marine mammal categories. So the use of a 5 km EDR for migratory fish is considered to be appropriately precautionary.

When operational, predictions of the continuously present underwater noise have been made for the turbines proposed, based on extrapolations from measurements of other turbines installed in the UK and US. Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report concluded that there would be no significant adverse impacts from noise from operational turbines to any fish species.

7.5. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation

7.5.1. Site Details

The Pembrokeshire Marine/Sir Benfro Forol SAC (hereto referred as the Pembrokeshire Marine SAC) was designated in December 2004 by the National Assembly for Wales. The 1,380.4 km^2 site is located on the southwest Pembrokeshire coastline and into the near offshore marine environment, spanning from Abereiddy on the north Pembrokeshire coast to Manorbier on the south coast, including the coasts of several islands offshore west of Pembrokeshire. The site is designated for protection of 8 Annex I marine habitats and 7 Annex II species.

There are several conservation objectives for the species features of the Pembrokeshire Marine SAC, including (NRW, 2018a):

- "*The population is maintaining itself on a long-term basis as a viable component of its natural habitat*";
- "*The species population range within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future*";
- "*The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance, and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include:*
    - *distribution*
    - *extent*
    - *structure*
    - *function and quality of habitat*
    - *prey availability and quality.*

  As part of this objective:
    - *The abundance of prey species subject to existing commercial fishing needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term;*
    - *The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term;*
    - *Contamination of potential prey species should be below concentrations potentially harmful to their physiological health;*

- *Disturbance by human activity is below levels that suppress reproductive success, physiological health, or long-term behaviour*".

Annex II migratory fish species included in the following assessment are:

- Allis shad *Alosa alosa* (S1102);
- Twaite shad *Alosa fallax* (S1103);
- River lamprey *Lampetra fluviatilis* (S1099);
- Sea lamprey *Petromyzon marinus* (S1095).

A description of each qualifying feature is provided in the following subsections.

7.5.1.1. Allis Shad *Alosa alosa* and Twaite Shad *Alosa fallax*

Feature Summary

Allis and twaite shad are closely related species that spend the majority of their adult lives in the sea, but return to river environments in order to spawn. Breeding populations are present in several British rivers, with adults migrating through estuaries to spawning grounds in March-May, trigged by water temperatures of around 10-12°C. Juveniles migrate from the freshwater spawning grounds from August-October, spending some time feeding in estuaries during this period. In their first year, juveniles will migrate back to freshwater systems in the spring, however, older fish are capable of migrating >1,000 km and can be found offshore in large shoals.

Both British shad species use the Pembrokeshire Marine SAC area as an access corridor between their freshwater spawning grounds in rivers and the open sea, however, there are little data on the specific areas used by, and range of, shad within the SAC (NRW, 2018a). The abundance of shad at any time is likely to be highly dynamic and, as such, there is no population estimate for the SAC. The population dynamics (age and sex) and physiological health within the site are also unknown.

Data from outside the SAC suggest that the salt wedge at the head of the tide and warm shallow inshore waters and estuaries comprise important habitat for shad species. Both of these habitats exist within the SAC. Suitable habitats should also include prey resource and high water quality with limited levels of contaminants. The importance of the Pembrokeshire Marine SAC for feeding and the status of prey species within the site is not fully understood.

Feature Condition and Conservation Objectives

The most recent feature condition assessment was conducted in May 2017 (NRW, 2018b). The freshwater population and marine habitat for allis and twaite shad were both assessed as being in favourable condition. Therefore, the overall condition of the allis and twaite shad features of the Pembrokeshire Marine SAC is considered to be **favourable** with high confidence in the assessment.

There are no conservation objectives uniquely specific to these features.

7.5.1.2. River Lamprey *Lampetra fluviatilis* and Sea Lamprey *Petromyzon marinus*

Feature Summary

River and sea lamprey can be found all around the UK and lay their eggs in clean river gravels. Larvae remain in the river sediment for several years before undergoing metamorphosis and migrating to estuaries and inshore waters where they parasitise on various fish species. Once fully grown, adults migrate upstream to spawn in freshwater rivers, after which they die.

River lamprey are predominantly coastal and estuarine species in their marine phase, preying on small fish species such as Atlantic herring *Clupea harengus* and sprat *Sprattus sprattus*. However, trawl data from Cefas have recorded them up to 40 km from shore, and as river lamprey are parasitic on a range of fish species, their distribution at sea is likely to depend on the host species (NRW, 2018b). Sea lamprey (in comparison to river lamprey) travel much further offshore (up to 400 m offshore, in depths up to 1,000 m) and parasitise much larger host organisms, including sharks and cetaceans.

Within the Pembrokeshire Marine SAC, river lamprey population is derived from monitoring of the Afonydd Cleddau/Cleddau Rivers SAC, upstream of the Pembrokeshire Marine SAC, where extent and density of juvenile lamprey are monitored. As lamprey do not display site fidelity (i.e., they do not necessarily return to their natal (same) river to spawn), populations using the Pembrokeshire Marine SAC are likely to be a component of a wider population that covers the Bristol Channel. Populations present in the River Wye/Afon Gwy SAC, River Usk/Afon Wysg SAC, Afon Tywi/River Tywi SAC, Afon Teifi/River Teifi SAC, Severn Estuary/Môr Hafren SAC, Afonydd Cleddau/Cleddau Rivers SAC, and Carmarthen Bay and Estuaries/Bae Caerfyrddin ac Aberoedd SAC are considered to be linked to the Pembrokeshire Marine SAC population (NRW, 2018a).

Adult river lamprey migrate through the Pembrokeshire Marine SAC from October-December to spawn upstream, and the juveniles migrate downstream to the estuaries and inshore waters in spring, and sometimes in autumn (NRW, 2018a). As juvenile river lamprey feed and grow in estuaries, it is reasonable to assume they are present within the SAC year round. Sea lamprey migrate upstream in the spring and early summer (March-June), with juveniles taking the reverse migration route from December-June, spending time to feed in the estuaries and nearshore waters before migrating offshore once fully grown (NRW, 2018a). Various life-stages of sea lamprey are likely to be present within the SAC at all times of year.

Lamprey feed on a wide range of fish. River lamprey target coastal fish, particularly Atlantic herring, sprat, and European flounder *Platichthys flesus*, with the latter 2 species likely to be the predominant food source within the Pembrokeshire Marine SAC. Sea lamprey target prey based on size rather than taxon. A preference for demersal species has been suggested, however is not confirmed.

Feature Condition and Conservation Objectives

The most recent feature condition assessment, carried out in 2017 (NRW, 2018b), shows that the marine habitat component for both river and sea lamprey is in unfavourable condition, based on a 2015 water quality assessment. The freshwater population for sea lamprey is also in unfavourable

condition, however, the river lamprey freshwater population is in favourable condition, both based upon monitoring data from Afonydd Cleddau/Cleddau Rivers SAC. The overall assessments show that both species are in **unfavourable** condition, with medium confidence in the assessments.

There are no conservation objectives uniquely specific to these features.

7.5.2. Assessment of Adverse Effects Alone

The potential pressures during construction operation and maintenance, and decommissioning for the proposed Erebus Project are:

- Temporary habitat loss/disturbance/alteration:
  - Abrasion/disturbance of the substrate on the surface of the seabed;
  - Habitat structure changes – removal of substratum (extraction);
  - Penetration and/or disturbance of the substrate below the surface of the seabed, including abrasion;
  - Physical change (to another seabed type);
  - Physical change (to another sediment type);
- Temporary increases in suspended sediments/smothering:
  - Changes in suspended solids (water clarity);
  - Smothering and siltation rate changes (Heavy);
  - Smothering and siltation rate changes (Light);
- Underwater noise:
  - Underwater noise changes;
  - Vibration;
- Electromagnetic fields (EMF):
  - Electromagnetic changes;
- Accidental pollution:
  - Hydrocarbon and polycyclic aromatic hydrocarbon (PAH) contamination;
  - Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals);
  - Transition element & organo-metal (e.g. tributyltin (TBT)) contamination;
- Mobilisation of contaminated sediments:
  - Hydrocarbon and PAH contamination;
  - Synthetic compound contamination (incl. pesticides, antifoulants, pharmaceuticals);
  - Transition element and organo-metal (e.g. TBT) contamination.

7.5.2.1. Construction/Decommissioning

The nature and magnitude of pressures associated with decommissioning activities and the sensitivity of the receptor groups are considered to be in line with those for construction phase impacts, although in practice they are likely to be reduced for decommissioning. Where there is a potential variation, this is presented below.

Temporary Habitat Loss/Disturbance/Alteration

Chapter 10: Fish and Shellfish Ecology provides detailed assessment of pressures of temporary habitat loss/disturbance/alteration on fish and shellfish receptors. Direct habitat

loss/disturbance/alteration will be limited to the direct footprint of Project activities. These are situated in coastal waters and within the approaches to Milford Haven. The limited geographical extent of these pressures mean that only certain life stages of migratory fish species may be affected.

Allis and twaite shad use the Pembrokeshire Marine SAC area as an access corridor between their freshwater spawning grounds in rivers and the open sea. As such, only juvenile fish migrating to open waters from estuarine feeding grounds, and adults in coastal waters or during migration back to their freshwater spawning grounds, may be affected by direct habitat loss/disturbance/alteration. Similarly, river and sea lamprey larvae remain in areas of clean river gravels before migrating to estuaries and inshore waters as juveniles. Therefore, assessment of this pressure for these species will be limited to juvenile and adult phases (i.e. excludes larval phase).

Through the various stages of the construction phase of the Project, there will be possible temporary habitat loss/disturbance/alteration. Under the worst-case scenario this has been estimated to be 1,354,504 m² (1.35 km²) from the installation of cables (by trenching, jetting, burial etc); anchoring of the floating offshore wind (FLOW) (from drag embedment anchors), barge and vessels, and sandwave levelling. In the design, options for both drag embedment anchors and drill piling have been considered in the array area. As such, small scale, long-term habitat loss during construction can also arise, at localised locations during piling, where 11,515 m² (0.012 km²) is lost under the footprint of the piles, and under the sediment deposited during piling. The construction period is expected to run over an 18 month period, however, disturbance at any one location will not be continuous during this period, and will be short-term.

The ECC footprint within the Pembrokeshire Marine SAC does not constitute a unique habitat for the Annex II species considered in this assessment. Although data from outside the SAC suggest that the salt wedge at the head of the tide and warm shallow inshore waters and estuaries comprise important habitat for shad species, only a small fraction of this will overlap with the Project pressures envelope. In their juvenile/adult stages all of the migratory fish species designated under the Pembrokeshire Marine SAC are widely distributed, providing capacity to adaptively exploit alternative areas if faced with localised and temporary habitat loss/disturbance/alteration. Chapter 10: Fish and Shellfish Ecology concluded that this pressure would result in a minor adverse effect on fish species.

With respect to conservation objectives for designated Annex II migratory fish populations of the Pembrokeshire Marine SAC, there is no evidence to suggest that the proposed project activities will negatively affect long-term population viability. Although activities may lead to temporary loss/disturbance of supporting habitats, these do not constitute key habitats and are not expected to adversely affect distribution within the natural range of designated populations. Any changes of supporting habitats will be small in terms of spatial extent and temporary in nature. It is expected that there will be subsequent full habitat recovery and any changes in the meantime will not result in a meaningful reduction in prey resources. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with temporary/long-term habitat loss/disturbance**.

Temporary Increases in Suspended Sediments/Smothering

Increased suspended sediment concentrations and sediment deposition is likely to arise during a wide range of construction and decommissioning activities, including installation of anchors/foundations, mooring line deployments, cable installation works, cable protection installation and landfall works including potential open-cut trenching and Project decommissioning activities (considered to be equivalent in nature and magnitude to installation works). Detailed assessment of these activities and modelling of the respective changes in suspended sediment concentration (SSC) is provided in Chapter 6: Marine and Coastal Processes and where relevant reference to its associated Technical Appendix 6.1: Marine and Coastal Processes Technical Report

Seabed habitats across the array area, ECC and intertidal areas comprise a mosaic of rocky platforms, boulders and sediments comprising variable proportions of different particle fractions. Plume dispersion in areas of fine sediment has the potential to extend up to 2 km downstream of activities at SSCs of 50 mg/l, when released at the water surface. A plume of this type may take up to 3 days to reduce to background concentrations. In areas of coarser sediment, plume extent and SSC levels are likely to be significantly reduced, with concentrations of 150 mg/l expected at distances of 500 m and 100 m for coarse sands and gravels respectively.

Under mean spring conditions the maximum tidal excursion for the Project is approximately:

- 10 km around the array area;
- 14-15 km around the middle of the ECC (approximately KP20);
- 18-19 km in the nearshore approaches to Milford Haven (approximately KP10);
- 5-8 km within Milford Haven.

However, in these instances SSC will rapidly reduce to near background levels. See Volume 2, Figure 6.4 (Chapter 6: Marine and Coastal Processes) for spatial variation in modelled tidal excursion and current speeds.

Sediment dispersal from disturbance occurring close to the seabed, i.e. during activities such as post-installation cable burial, is likely to be relatively low; however, at the point of release, SSC elevation may be very high (hundreds of thousands of mg/l). Where sediment is released at a height of 3 m above the seabed, dispersion distances are predicted to be 5 m, 30 m and up to 300 m for gravels, coarse sands and fines, respectively. In areas of exposed rock platform or particularly large sediment size (e.g. pebbles and cobbles), no sediment plume would be expected as particle suspension cannot occur. In areas nearer to shore, background concentrations of SSC are likely to be higher due to natural events including wave and surge effects, particularly during periods of stormy weather.

In summary, where sediment plume dispersal is far-reaching (i.e. surface release of fines), the associated increase in SSC is likely to be negligible. In cases where SSC increase is of a greater magnitude, the extent is likely to be limited to within the offshore cable corridor, and likely to exist over a limited temporal period.

Potential changes in SSC, can also occur from release of drilling fluid (containing bentonite (a non-toxic material) and drill cuttings) at Horizontal Directional Drilling (HDD) punch-out near the landfall. Release of drilling fluid can result in a temporary localised plume of elevated Directional

Drilling Compound (DDC) (bentonite clay). The HDD exit point is located near to the main channel and thus the majority of plume will be advected away. The bentonite in the drilling fluid is expected to remain in suspension for a minimum of a few hours or days, and will widely disperse prior to settlement.

Although Chapter 10: Fish and Shellfish Ecology identified that fish eggs and larvae have medium sensitivity to smothering from deposition of mobilised sediment, as outlined above only adult and juvenile stage Annex II migratory fish are expected to interact with the Project site. In areas with high proportions of fine sediment, and during periods of peak tidal flow, sediment plumes with increased SSC have the potential to extend up to 19 km downstream. However, the SSCs of plumes dispersed over this distance are likely to be considered negligible, with SSCs reaching 50 mg/l at approximately 2 km and settling through progressive dilution and dispersion over periods of up to 3 days. Plumes in areas of fine and medium sand have the potential to extend up to 5 km and 2 km respectively, at SSCs of up to 150 mg/l when released at the water's surface (see Chapter 6: Marine Coastal Processes). All of the designated migratory fish species considered in this assessment reproduce upstream in freshwater areas, and do not migrate into estuarine or marine waters until they reach juvenile stage. As such, there is no potential for increases in suspended sediments/smothering to impact early life stages of these designated populations.

Increased SSC can lead to a reduction in light levels within the water column, which may result in a reduction of predation success for species reliant on sight. However, the area in which SSC is increased to a level at which turbidity affects predation success is likely to represent very small proportion of available feeding grounds.

The pressures of elevated SSC levels will be short-term and highly localised. In addition, sediment deposition is not considered to present a risk to adult stages of Annex II migratory fish species considered here. As such, any changes related to Project activities will not have long-term effects on population viability and will have a negligible effect on population range or extent.

In addition to direct pressures on Annex II migratory fish receptors, increased SSC/smothering has potential to impact these receptors through indirect pressures on supporting habitats. Chapter 9: Marine and Coastal Ecology provides a detailed assessment of pressures from increases in SSC/smothering on the various benthic habitat types and species found within the Project directly, and secondary pressures envelope. It is concluded in this chapter that the magnitude of change is low, and sensitivity is low to medium for all benthic receptors. As such, it was concluded that increases in SSC and associated sediment deposition would result in a minor adverse effect on benthic species and habitats. Given the localised extent and temporary duration of these pressures, it would not be expected to adversely affect Annex II migratory fish populations.

With respect to conservation objectives for the Pembrokeshire Marine SAC site, there is no indication that temporary increases in suspended sediments/smothering will impact the natural range or extent of Annex II migratory fish populations or lead to long-term negative impacts on these migratory fishes. In view of the small-scale localised pressures on benthic habitats it is not expected that this pressure will impact supporting habitats or benthic prey resources sufficiently to diminish population distribution or abundance. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish**

features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering.

Underwater Noise

The impact of acoustic emissions on fish caused by Project construction activities has been assessed in detail within Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration. Modelling using the Simple Propagation Estimator and Ranking (SPEAR) model in conjunction with noise measurements collected by Subacoustech Environmental was conducted for fish with a swim bladder involved in hearing, as these species are most sensitive to underwater noise. Results are shown in Table 7.2.

Table 7.2: Summary of the impact ranges from Popper *et al.* (2014) for shipping and continuous noise, covering the different construction noise sources for fish (with a swim bladder involved in hearing)

Popper *et al.* (2014) Unweighted SPL_{RMS}	Recoverable injury 170 dB (48 hours)	Temporary Threshold Shift 158 dB (12 hours)
Vessel movement (large)	< 10 m	< 10 m
Vessel movement (medium)	< 10 m	< 10 m
Backhoe dredging	< 10 m	< 10 m
Suction dredging	< 10 m	30 m
Cable laying	< 10 m	10 m
Trenching	< 10 m	10 m
Rock placement	< 10 m	20 m
Drag embedment anchors	< 10 m	< 10 m
Suction pile installation	20 m	60 m
Drilling	< 10 m	< 10 m

For the majority of construction noise (low-level, non-impulsive acoustic emissions), fish with a swim bladder involved in hearing would only experience recoverable injury (recovery within 48 hours) if present within 10 m of the source, with the exception of suction piling installation which indicated a distance of 20 m. Temporary threshold shift (for 12 hours) would occur within a wider range of distances from between <10-60 m.

Should impact piling be required, a realistic worst-case scenario suggests a TTS within a range of up to 9.9 km for fleeing fish. All other effects including recoverable injury, and mortality and potential mortal injury would be limited to <100 m from the pile driving source (<0.1 km^2).

Based on the results of underwater noise modelling, and thresholds determined in Popper *et al.* (2014), it can be concluded that the spatial extent within which adverse effects may occur will constitute a tiny fraction of the overall extent of the highly mobile fish receptors considered within this assessment. Any disturbance pressures from noise associated with construction/decommissioning operations will be localised, temporary and transient. This is not expected to adversely affect the distribution of the Annex II migratory fish species considered within this assessment. In addition, these activities will not affect the population structure, spawning extent or habitat extent.

Assessment of underwater explosions caused by disposal of UXO is considered separately due to the greater risk associated with this pressure than other acoustic emissions associated with Project activities. Explosion of UXO would produce pressure waves capable passing through the body of a fish and potentially causing injuries. These injuries may result if damage is caused to surrounding tissues by rapid contraction and overextension of organs with air spaces, such as the body cavity, the pericardial sack and gut, and most commonly, the swim bladder. In extreme cases gas oscillations resulting from subsea explosions can cause the swim bladder to tear or rupture (Govoni *et al.*, 2003; Popper and Hastings, 2009). Species which do not possess a swim bladder, or which have small swim bladders, are likely to be more resistant to noise and pressure waves generated from explosions (Goertner *et al.*, 1994).

Allis and twaite shad possess swim bladders (classified as herrings, which are swim bladder hearing species) and therefore are likely to be sensitive to such disturbance. However, an explosion would be brief, with the shock waves attenuating rapidly in the water column, thus limiting the spatial extent of the lethal zone. Although there is the potential that individuals will be killed, the number affected would be so small it is unlikely that there will be any adverse effects on the viability of the species, populations or stocks.

It is possible that UXO are present within the boundary of the Project. Following identification, some of these devices will likely require clearance prior to construction of the site. The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. However, in line with the recommendations outlined within the recent position statement on UXO clearance (Defra *et al.*, 2021), this assessment also includes reference to high-order detonations, even though this is considered unlikely to occur in practice and is not part of the consent application. Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg.

The assessment made in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration indicates that mortality and potential injury to species of fish may occur at distances of up to 120 m for species of fish following the deflagration of a UXO device using a 2 kg charge. There is evidence that little, or no, damage occurs to fishes without a swim bladder except at very short ranges from an in-water explosive event (e.g., Goertner *et al.*, 1994; Halvorsen *et al.*, 2012), and that the effect range for a non-swim bladder fish is ≈100 times less than that for a swim bladder fish (Goertner, 1978). However, studies into these pressures have been highly variable in terms of subject species,

type of explosives and/or weight of charge (Popper *et al.*, 2014). In view of this variability, Popper *et al.* (2014) provide explosion effects thresholds for all species rather than dividing by swim bladder/non-swim bladder type.

As this noise will be instantaneous, fish species will not be able to flee. It is assumed that a single low-order UXO clearance event will occur during the construction of the Project. Due to the limited area of water within which mortality will occur (0.00724 km^3), the magnitude of this pressure is considered low. The number of fish likely to be in range of the mortality effect of the UXO clearance event is likely to be a negligible proportion of the fish population regionally.

With respect to the high-order scenario, the assessment made in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report indicates that mortality and potential injury to fish with a swim bladder involved in hearing may occur at distances of up to 810 m following the deflagration of a UXO device using a 525 kg charge. As this noise will be instantaneous, individuals will not be able to flee.

The volume of water within which mortality will occur is calculated as 0.10306 km^3, which is greater than that for the low order charge. Therefore, the magnitude of this impact is considered medium. Even so, the number of fish likely to be in range of the mortality effect of this high order event is likely still be a negligible proportion of the fish population within the wider study area.

With respect to conservation objectives for designated Annex II migratory fish populations of the Pembrokeshire Marine SAC, the highly limited spatial extent of all predicted pressures mean that underwater noise is unlikely to affect distribution or extent within the natural range of designated populations. There is no indication that this will produce a barrier to migration, therefore avoiding risk to population viability. The small spatial extent and temporary nature of pressures mean that any reduction in availability of supportive habitat will be temporary and localised. Risk of adverse effect on individual condition caused by injury is small, given the requirement for fish to be close to the activity source, and in most cases full recovery will occur. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with underwater noise**.

Electromagnetic Fields

EMFs are created by electricity transmission and as such will only be created during the operational phase. In view of this, there is no pressure pathway during the construction and/or decommissioning phases and it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with electromagnetic fields**.

Accidental Pollution

The presence of numerous works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A Marine Pollution Contingency Plan (MPCP) will be produced and agreed with stakeholders post-consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity in-combination with its physical environment. For example, fresh oil spills occurring directly into sheltered waters supporting spawning habitats are likely to have a greater impact than if spilled subtidally, where oil sinks and becomes emulsified and adsorbed onto particles. The strong hydrodynamic regime across the Study Area, means that should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential impact on the benthic environment. In consideration of the standard mitigation and adoption of best practice, it is expected if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to designated populations of Annex II migratory fish.

During construction and decommissioning Project phases there is a risk of accidental pollution events. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the long-term viability of Annex II fish populations, or the abundance, condition or diversity of supportive habitats. It is also considered that any pollution event that did occur would be rapidly contained, avoiding contamination of potential prey species and ensuring that if this did occur it would not exceed concentrations potentially harmful to physiological health, reproductive success or behaviour. As such, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with accidental pollution**.

Mobilisation of Contaminated Sediments

The installation of array cables and the main export cable using a plough, jetting or Mass Flow Excavator (MFE) tool(s) at the seabed, or cutting tools within the intertidal environment, will lead to sediment disturbance, and under worst-case scenario, 1.35 km² of seabed is predicted to be disturbed during installation. The associated sediment disturbance has the potential to re-mobilise sediments that contain chemical contaminants. However, subtidal sediment contamination across the array area and ECC is low (see Chapter 7: Marine Sediment and Water Quality for baseline information).

Arsenic was the most common contaminant, being recorded in excess of Cefas Action Level 1. Nickel, chromium and cadmium were also recorded in excess of this threshold. These limited number of

instances where concentrations of metals exceeded standard thresholds also showed no clear pattern of distribution. It is apparent that where contamination does occur, it is not concentrated in broad regions, but intermittently distributed throughout the footprint of the Project (see Chapter 7: Marine Seabed and Water Quality for full details).

Only one of these elevated results was recorded for a sample station close to a historic dredge disposal site, last in use in 1994. The absence of elevated contaminant levels in sediments collected close to the historic Milford Haven disposal site indicates that there is low risk that cable installation through this area will result in mobilisation of contaminated sediments. In view of the analysis results for sediments collected in this area, works within the footprint of the historic disposal ground are not considered to pose an increased risk to designated populations of Annex II migratory fish.

Hydrocarbons were generally recorded at relatively low concentrations, and with a general pattern of higher concentrations at nearshore stations compared to offshore stations, which is most likely due to the proximity to coastal urban settings. Threshold Effect Level (TEL) was exceeded at a limited number of stations for hydrocarbon compounds, but no samples exceeded Probable Effect Level (PEL), which means concentrations were below levels in which adverse effects may be expected in a wider range of organisms.

In consideration of the duration and scale of disturbance during Project construction, and the low concentrations and distribution of contaminants (heavy metals, hydrocarbons etc.) across the Study Area, the magnitude of pressures caused by mobilisation of contaminated sediments will be very low.

In terms of site conservation objectives, it is highly unlikely that contamination of potential prey species would occur above concentrations potentially harmful to the physiological health of designated Annex II migratory fishes, or sufficient to suppress reproductive success or long-term behaviour and populations. The low levels of contamination present in local sediments relative to guideline thresholds, inclusive of those for marine biota, mean that any contamination that did result from sediment mobilisation would be low. It is concluded that this would not adversely affect the function and quality of supportive habitats. There is no indication that the proposed works will negatively affect site conservation objectives. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with mobilisation of contaminated sediments**.

7.5.2.2. Operation and Maintenance

Temporary Habitat Loss/Disturbance/Alteration

As with other marine energy infrastructure, there will be a requirement for planned and unplanned maintenance activities throughout the operation phase of the Project. These activities may vary in nature, however the maintenance activities considered likely to cause temporary disturbance impacts are offshore export cable and array cable repairs, and cable remediation. It is expected that the nature of the repairs will cause a similar disturbance as those outlined under Section 7.5.2.1, however on a smaller spatial scale. As such, the impact assessment will mirror and summarise

construction-related assessment, but with consideration of differing scales between these two phases of works.

Temporary habitat disturbance will also arise via the catenary swept area of mooring lines and array cables over the lifetime of the Project.

As worst-case, the area of temporary habitat disturbance via cable repairs/remediation is predicted to occur across a 2,355,250 m² (2.35 km²) area, over the 25 year operating period. An area of 1,385,694 m^2 (1.28 km^2) is also predicted to be subject to temporary habitat disturbance via the movement of the mooring lines and array cables.

It is assumed that there will be up to 5 repairs anticipated in the array area and 5 within the ECC (total of 10 repairs). The mooring lines and array cables will exhibit movement in an intermittent fashion, depending on wave/tidal conditions. Therefore, due to the low frequency of these activities, the magnitude of effect on all associated receptors will be negligible as the amount of predicted temporary habitat disturbance will cover a very small extent of the Project area, for short, discrete periods.

As detailed in Section 7.5.2.1, the ECC footprint within the Pembrokeshire Marine SAC does not constitute a unique habitat for the Annex II migratory fish species assessed. In their juvenile/adult stages all of the migratory fish species designated under the Pembrokeshire Marine SAC are widely distributed, providing capacity to adaptively exploit alternative areas if faced with localised, small-scale and temporary habitat loss/disturbance/alteration. Chapter 10: Fish and Shellfish Ecology concluded that this pressure would not result in a minor adverse effect on fish species.

With respect to conservation objectives for designated Annex II migratory fish populations of the Pembrokeshire Marine SAC, there is no evidence to suggest that the proposed Project activities will negatively affect long-term population viability. Although activities may lead to temporary loss/disturbance of supporting habitats, these do not constitute key habitats and are not expected to adversely affect distribution within the natural range of designated populations. Any changes of supporting habitats will be small in terms of spatial extent and temporary in nature. It is expected that there will be subsequent full habitat recovery and any changes in the meantime will not result in a meaningful reduction in prey resources. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with temporary/long-term habitat loss/disturbance**.

Temporary Increases in Suspended Sediments/Smothering

It is assumed that a series of cable repairs and/or cable remediation will be required over the lifetime of the Project, with up to 5 repairs anticipated in the array area and 5 within the ECC and up to 12 remediation events along the export cable. Offshore export cable and array cable repairs and/or remediation activities are expected to result in some localised seabed disturbance accompanied by temporary increases in SSC. It is expected that equipment similar to that used to install the offshore export cable and array cables will be used for re-burial/remediation. Accordingly, the area of seabed impacted during the removal of the offshore export cable and array cables would be similar to (but no greater than) the area impacted during the installation of the offshore export

cable and array cables. The overall degree of impact will be less, in consideration of the scale of works required, and over the 25 year time frame.

As detailed in Section 7.5.2.1, the pressures of elevated SSC levels will be short-term and highly localised. In addition, sediment deposition is not considered to present a risk to juvenile or adult stages of Annex II migratory fish species assessed. As such, any changes related to Project activities will not have long term pressures on population viability and will have a negligible effect on population range or extent.

In addition to direct pressures on Annex II migratory fish receptors, increased SSC/smothering has potential to impact these receptors through indirect pressures on supporting habitats. Chapter 9: Marine and Coastal Ecology provides a detailed assessment of effects from increases in SSC/smothering on the various benthic habitat types and species found within the Project direct and secondary pressures envelope. It is concluded in this chapter that the magnitude of change is low, and sensitivity is low to medium for all benthic receptors. As such, it was concluded that increases in SSC and associated sediment deposition would result in a minor adverse effect on benthic species and habitats. Given the localised extent and temporary duration of these pressures, it would not be expected to adversely affect Annex II migratory fish populations.

With respect to conservation objectives for the Pembrokeshire Marine SAC site, there is no indication that temporary increases in suspended sediments/smothering will impact the natural range or extent of Annex II fish populations or lead to long-term negative impacts the on these migratory fishes. In view of the small-scale localised pressures on benthic habitats it is not expected that this pressure will impact supportive habitats or benthic prey resources sufficiently to diminish population distribution or abundance. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with temporary increases in suspended sediments/smothering**.

Underwater Noise

During operation, WTGs are known to produce noise in the form of mechanically generated vibrations from rotating machinery in the turbines. A full assessment of these underwater noises is provided in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration. The noise source for most operational wind turbines is the radiating area of the foundation in the water column. For a monopile, this is the surface area of the cylindrical pile in the water column. However, floating turbines have a significantly reduced radiating area which is limited by the volume of the weighted and buoyant infrastructure section that rests beneath the sea surface.

Assessment conducted in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration suggests an upper limit of 118 dB SPL_{RMS} at 150 m from the largest proposed turbine at Erebus. At 10 m, this would be 145 dB SPL_{RMS}, or 122 dB at 100 m. Based on the criteria from Popper *et al.* (2014) for continuous noise, the TTS threshold of 158 dB SPL_{RMS} would require an individual fish to be much closer than 10 m for 12 hours continuously, which, for a source near the surface in water depths of the order of 80 m would be very low risk. As studies have shown that fish populations have increased in the vicinity of offshore wind farms (Stenberg *et al.*, 2015), there appears to be a negligible risk to fish from operational turbines.

The assessment conducted within Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration also determined that the combined noise of multiple turbines within the array area was unlikely to lead to a more significant impact. When 100 m from a given turbine, the noise level produced via operation was determined as being 122 dB SPL_{RMS}. Using the predicted minimum separation of 1,000 m between WTGs, the predicted noise contribution of the next turbine was determined as being 23 dB lower than at 100 m, which combined would contribute less than 0.1 dB to the overall noise level from the closest turbine. At the centre-point between two turbines separated by 1,000 m, the theoretical noise level would be under 110 dB, well below any impact threshold. The contribution to a receptor's total noise exposure from any other turbine will therefore be negligible.

Cable snapping has been identified in previous FLOW projects and is thought to be a result of tension release from mooring lines. There is the potential for this pressure to occur during operation of the Project, and so the pressures have been considered within this assessment. The HYWIND 1 offshore wind farm (OWF) recorded up to 23 'snaps' per day, with fewer than 10 snaps per day exceeding 160 dB SPL_{peak} at the measurement position, 150 m from the turbine. A potential cumulative SEL of up to 157 dB re 1 μPa^2s over 24 hours caused by snapping chains from 6 turbines was determined by Xodus (2015) for the HYWIND Scotland Pilot Park Project. For 10 turbines, as is planned for the Project, this is determined to equate to approximately 160 dB SEL re 1 μPa^2s. This prediction makes a series of worst-case assumptions (e.g. all turbines producing the maximum number of snaps in a day, equivalent noise levels from multiple locations affecting a receptor to the same degree) and this level is below any PTS or injury criteria/threshold for fish receptors.

Due to the limits of subsea noise produced via operational activities being below the threshold for any PTS or injury criteria/threshold to fish, the magnitude of this impact is considered negligible. With respect to conservation objectives for designated Annex II migratory fish populations of the Pembrokeshire Marine SAC, the highly limited spatial extent of all predicted pressures mean that underwater noise is unlikely to affect distribution or extent within the natural range of designated populations. There is no indication that this will produce a barrier to migration, therefore avoiding risk to population viability. The small spatial extent and temporary nature of pressures mean that any reduction in availability of supportive habitat will be temporary and localised. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with underwater noise**.

Electromagnetic Fields

An EMF can arise in the immediate vicinity of electrical cables. EMF is created by the transmission of electricity and magnetic fields through power cables and comprises both electric and magnetic components. Some marine organisms are sensitive to EMF, particularly those that make use of electroreceptors for orientation, navigation and prey/predator detection. A full assessment of EMF likely to be associated with presence of Project infrastructure in the marine environment can be found in Volume 3, Technical Appendix 7.2: EMF Compliance Assessment.

The Project will include a maximum of 72.9 km of cables (23.9 km of array cables; 49.0 km of offshore export cable) around which EMF can arise. The majority of the offshore export cable will be buried to at least 1.5 m beneath seabed level, thus reducing the potential for EMF to affect marine

receptors. However, there is a greater potential for EMF pressures from cable that is free floating in the water column or surface laid, or where target burial depth could not be achieved. Installation of any cable protection, where required, will act similarly to burial of the cable, providing some shielding to EMF effects.

EMF will be associated with all Project transmission assets, inclusive of offshore export cables, array cables, and free-floating riser cable (hangoffs). Although only offshore export cable in inshore waters directly interacts with the Pembrokeshire Marine SAC, all transmission infrastructure must be considered in terms of potential impacts to designated migratory fish populations travelling to or from this site.

Volume 3, Technical Appendix 7.2: EMF Assessment provides detailed calculations of EMF field strength likely to be associated with the Proposed Development and contextualises these against background levels. The array cables have a worst-case footprint of 7,170 m² and a maximum voltage of 72.5 kV (with a standard operational voltage of 66 kV). The offshore export cable has a worst-case footprint of 78,400 m² and a maximum voltage of 66 kV.

A comparison of EMF field strength across 10 different cables and windfarms forms the basis for assessment as to the extent of EMF influence in this assessment (Normandeau *et al.*, 2011). This assessment noted that the magnetic field attenuates close to 0 µT around 4 m from the cables in a horizontal direction. However, in a vertical direction, 5 m of separation is required for attenuation. At one location the ECC crosses the GreenLink Interconnector route. Volume 3, Technical Appendix 7.2: EMF Assessment provides calculations to determine that the expected combined EMF field for both the Greenlink Interconnector and the export cable for the Proposed Development would be around 84.7 µT and would attenuate within 5 m.

For cables laid on the surface of the seabed, in the absence of cable protection half of the area of EMF influence will be present within the water column, and half will be within the seabed. A maximum of 3,300 m of cable will be present entirely within the water column in the form of hangoffs within the array area (a worst-case scenario of 22 hangoffs at 150 m length).

In 3 locations the Project offshore export cable corridor will cross other energy transmission assets. At these cable crossings cumulative EMF pressures will be increased from 4 m to 5 m for a length of 5 m.

Based on this information, the total area of EMF influence is calculated as:

$$V = \pi (r^2) \times h$$

Where:

V = Volume of EMF influence;

r = Radius of cable (0.15 m) + radius of EMF influence (4 or 5 m);

h = Cable length.

Volume of EMF pressures from cables excluding cable crossings: $\pi (4.15^2) \times 72,885 = 3,943,522$ m³

Volume of EMF pressures for 3 cable crossings: $\pi (5.15^2) \times 15 = 1,250$ m³

Total volume of EMF influence across the project: 3,943,522 + 1,250 = 3,944,772 m³

Volume of EMF pressures within the water column from hangoffs: $\pi(4.15^2) \times 3,300 = 178,550$ m³

Volume of EMF pressures within the sediment: ((3,944,772 - 178,550))/2 = **1,883,111 m³**

Volume of EMF pressures within the water-column: 1,883,111+178,550 = **2,061,661 m³**

Total volume of EMF influence: 3,944,772 m³ or 0.0039 km³, of which a maximum of 2,061,661 m³, or 0.0021 km³ will be entirely within the water column. Assuming a water depth of 50 m across the study area, this constitutes 0.00054 % of total available water volume.

The sensitivity of shad and lamprey species to EMF is not well understood and it is possible that changes in local EMF regime may influence behaviour through the disruption of access to natal rivers. However, these species are considered to have significantly reduced reliance on electrosensitivity when compared to sensitive species such as elasmobranchs. In addition, migratory fish species are typically highly mobile and have a degree of flexibility in terms of route selected within the water column. It is, therefore, likely that habitat available within the wider region will be both suitable and accessible for species if displaced by EMF pressures.

It is possible that changes in local EMF regime may influence the behaviour of migratory fishes if they create a barrier to access to natal rivers or cause disorientating effects on migratory fish using EMFs for navigation purposes. Migration corridors and feeding areas for life stages of Annex II Migratory Fish species are generally poorly understood and therefore the location of these EMFs relative to migration routes, cannot be predicted with any degree of confidence. However, given the small volume of water that will be affected, and the location, to one side of the estuary mouth, it is considered that their migratory urge to return to freshwater environments to spawn would be sufficient to find a route round/past this potential barrier.

The majority of EMF pressures will be limited to within 4-5 m of the seabed, with a lower proportion associated with the free-floating riser cables that connect the floating turbines to the bed. Both allis shad and twaite shad are pelagic fishes within the marine environment, found at depths of 10-150 m

and 10-110 m respectively (Aprahamian *et al.*, 2003; Maitland and Hatton-Ellis, 2003). This indicates that they do not have specific affinity to near bed environments and are likely to have capacity to avoid the near-bed EMF. Little is known of lamprey distribution within the marine environment. However, the prominence of pelagic species in the known prey targets for adult lamprey (river lamprey: Atlantic herring and sprat; sea lamprey: Atlantic herring, Atlantic salmon *Salmo salar*, Atlantic cod *Gadus morhua* and haddock *Melanogrammus aeglefinus* (Maitland, 2003)) suggests these fishes are also commonly found in open waters.

In view of the highly localised extent of EMF pressures (predominantly limited to the near-bed environment), the small proportion of total available water column affected, and the mobile nature of the designated Annex II migratory fish species considered in this assessment, it is considered there is a low probability of migratory fish species interacting with Project EMF fields. It is possible that some individuals may be affected but it is considered unlikely that this would be sufficient to significantly impact populations.

With respect to conservation objectives for the site, any reductions in available habitat caused by avoidance of EMFs are expected to be so small they will not adversely affect the distribution and extent of designated Annex II fish populations within their natural range. Similarly, the localised nature of these pressures means that they would not be expected to affect fish abundance or condition of the designated population. Given the small size of any barrier that may be created, both in terms of location relative to the estuary mouth and height within the water column, it is considered there is negligible risk that EMFs would disrupt migration to the extent that it would affect long-term population viability. In view of these points, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with electromagnetic fields**.

Accidental Pollution

Planned and unplanned operation and maintenance activities (mooring, sub-structure inspection, cable repairs etc) throughout the O&M phase of the Project may be required, that may increase the risk of spillage or chemical contamination. Accidental spillage of lubricants, oils or chemicals may occur directly from the WTGs themselves, or from vessels present on site during maintenance activities.

It is expected that vessel presence for O&M activities will not exceed 2x 12h periods per year and thus vessels on site will be less frequent than required during the shorter construction period. As detailed in Section 7.5.2.1, best practice will be employed at all times to reduce the risk of a pollution event and a MPCP will be produced and agreed with stakeholders, post-consent. As determined in Section 7.5.2.1, in consideration of the strong hydrodynamic regime of the area and adoption of best practice to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale pressures. There is no evidence to suggest that accidental pollution would adversely affect the long-term viability of Annex II migratory fish populations, or the abundance, condition or diversity of supportive habitats. It is also considered that any pollution event that did occur would be rapidly contained, avoiding contamination of potential prey species and ensuring that if this did occur it would not exceed concentrations potentially harmful to physiological health, reproductive success or behaviour. As

such, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with accidental pollution**.

Mobilisation of Contaminated Sediments

Cable repair and remediation works will necessitate localised disturbance of seabed sediments. It is assumed that a series of cable repairs and/or cable remediation will be required over the lifetime of the Project, with up to 5 repairs anticipated in the array area and 5 within the ECC.

However, the spatial extent of seabed disturbance will be less during O&M than during construction works. In addition, the disturbance events that do occur will be intermittent as opposed to a single sustained construction programme. As such, any effects from this pressure during O&M works will be less than that determined for construction (see Section 7.5.2.1 for details), for which no adverse effect on site integrity was determined. Accordingly, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with mobilisation of contaminated sediments**.

7.5.3. Assessment of Adverse Effects In-combination

The potential for in-combination pressures on designated features of the Pembrokeshire Marine SAC is limited to those associated with projects that either spatially overlap with the SAC site, result in secondary pressures envelopes which overlap with the site, or affect migratory fish populations migrating to or from the SAC. These parameters were applied to the Project long-list provided in Volume 3, Technical Appendix 30.1: Cumulative Long List, and the following Projects have been identified as requiring assessment within the in-combination assessment:

- Greenlink Interconnector;
- Marine Energy Test Area (META) - Dale Roads;
- META - Warrior Way;
- Project Valorous.

Although localised work on the Pembroke Dock Slipway was identified within the cumulative pressures long list, this has been excluded from further assessment as it is expected to be completed before works on the Proposed Development commence, and it is not expected that there will be any additional operational pressures that require consideration within the in-combination assessment.

Table 7.3 provides a summary of the relevant parameters for the Projects.

Table 7.3: Developments considered within the Annex II Migratory fish in-combination assessment. Erebus Project details included for reference

Development Type	Project	Tier	Distance from Array (km)	Distance from ECC (km)	Development Footprint (km^2)	Construction Timings
Marine Energy (FLOW)	Erebus	n/a	n/a	n/a	5.15	May 2026 – September 2027
Interconnector	Greenlink	2	17.8	0	0.16	2021-2024
Marine Energy (Wave power)	META Dale Roads	2	39.6	2.3	0.195	As test sites deployment and recovery will be dictated by client bookings. There is no programme, and activity will be managed by NtM and stakeholder updates.
Marine Energy (Wave power)	META Warrior Way	2	12.6	12.6	0.093	
Marine Energy (FLOW)	Valorous	2	3.3	9.7	4.7	2026-2028

7.5.3.1. Temporary Habitat Loss/Disturbance/Alteration

Cable laying activities required for installation of the Greenlink Interconnector will cause short term localised disturbance to benthic substrata. This introduces potential for in-combination habitat loss/disturbance/alteration, together with the Proposed Development on fish and shellfish receptors. The RIAA for the Greenlink Interconnector (GIL, 2020) notes that although cable laying activities may lead to a fractional coarsening of sediments, due to suspension of as finer silts, this "*is unlikely to have any significant effect, given the narrow trench size (1m)*". The habitats likely to be affected by cable burial are characterised by short-lived, fast-growing, opportunistic epifauna which rapidly colonise any additional habitat that becomes available (GIL, 2020). This is expected to ensure that any area of disturbance recovers rapidly following cessation of works.

The ES produced for the META projects specifies that temporary disturbance is likely where seabed clearance activities occur, e.g. boulder and debris clearance, however, this will be limited to ≤10 m

from each device/mooring footprint. It should be noted that construction of these developments will proceed without the requirement for seabed levelling. The total combined temporary habitat disturbance predicted to occur at any one time, across all three META test sites, is ≤124,679 m². The worst-case design scenario for these projects allows for up to 150 installation events during the META project lifetime (15 years).

This therefore introduces potential for repeat disturbance to areas of seabed previously affected by installation activities. It is considered that many of the characterising species of affected sediments and habitats are infaunal and will therefore be largely unaffected by seabed disturbance during project works. It is predicted that recovery will occur within 2 years following cessation of works. In terms of supportive habitats for Annex II migratory fish species, the highly localised nature of these works means that any pressures that do occur will correspond with a very proportion of total habitat that is available to these fishes. In their juvenile/adult stages all of the migratory fish species designated under the Pembrokeshire Marine SAC are widely distributed, providing capacity to adaptively exploit alternative areas if faced with localised and temporary habitat loss/disturbance/alteration.

Interaction between Project Valorous and the Pembrokeshire Marine SAC will be limited to cable installation, remediation, reburial and decommissioning activities associated with its ECC. The methodology proposed for Project Valorous activities is expected to be similar to those for the Proposed Development (MarineSpace, 2020). Due to the early stage of project development, the precise export cable route is not yet known for Project Valorous. Accordingly, it is not known which, if any, supportive habitats for migratory fish species will be intersected by this route. However, in accordance with the assessment of likely effects for cable installation, remediation, reburial and decommissioning of the Proposed Development, it is likely that any impacts that do occur will be highly localised around the cable route and of limited temporal extent.

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 7.3), This ensures that only O&M works at these sites have potential to contribute to in-combination pressures. Cable reburial/remediation O&M works are expected to occur infrequently. For example, the Greenlink Interconnector ES indicated that up to 5 cable repair operations would be required within Welsh jurisdiction during the 40-year operational lifetime of the cable. Although the META projects have not indicated how many interventions would be expected, it is expected to be lower still due to their proximity to the coast. Industry used ‘rule of thumb’ is that one fault should be expected each 10 years per 100 km of cable. Given the expected infrequent occurrence of O&M activities at this site, it is considered the risk of temporal overlap with Project construction activities is small.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 7.3). This ensures that only O&M works at these sites have potential to contribute to in-combination pressures. Conversely, construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. Cable repair/remediation O&M activities are only expected to be required infrequently. For example, the Greenlink Interconnector ES indicated that up to 5 cable repair operations would be

required within Welsh jurisdiction during the 40-year operational lifetime of the cable. Although the META projects have not indicated how many interventions would be expected, it is expected to be lower still due to their proximity to the coast. Industry used 'rule of thumb' is that one fault should be expected each 10 years per 100 km of cable. Given the relatively low number of O&M activities that are expected, the spatial extent of any pressures will be very small relative to the extent of similar habitat available within the SAC.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination pressures with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. O&M activities will only occur infrequently (see details above). The current application allows for an estimated 10 repair events (5 along the ECC and 5 within the array area) and up to 12 remediation events along the export cables. The 10 O&M cable repair and up to 12 remediation events covered in this application are required to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between construction and any one O&M event, and between each of the O&M events themselves. With respect to temporary habitat disturbance from cable burial, recovery is expected to occur rapidly in all benthic habitats (see Chapter 9: Marine and Coastal Ecology for details). Given the likely temporal separation between individual repair events it is likely that any affected habitat will have recovered to baseline conditions ahead of any other potential disturbance.

Although it is highly likely there will be both temporal separation between O&M works for the Proposed Development and O&M activities for the other projects considered, in order to maintain a precautionary approach it is necessary to consider the worst-case scenario, i.e. O&M activities occurring for all of these projects concurrently, within the Pembrokeshire Marine SAC. However, any disturbance within the O&M phase will be smaller in magnitude than those caused during construction, and even where there is concurrent disturbance this would be expected to fall within the parameters described for the Project construction phase.

The greatest potential for in-combination pressures with Project O&M activities will be with construction activities for Project Valorous. However, O&M activities for the Proposed Development are expected to predominantly be required for soft sediment environments, where magnitude of pressure will be small, and recovery will occur rapidly (see Section 6.5.2.2). As such, it is expected that this will result in a negligible increase above the pressures expected for Project Valorous alone.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and magnitude to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and, as such, these projects will be decommissioned before completion of the 25-year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects as assessed for construction. As such, risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

With respect to conservation objectives for designated Annex II migratory fish populations of the Pembrokeshire Marine SAC, there is no evidence to suggest that the combined pressures from the projects considered will negatively affect long-term population viability. Although activities may lead to temporary loss/disturbance of supporting habitats, these only constitute a small extent of available habitat regionally, and full recovery is expected. It is not expected that this small-scale temporary change will adversely affect the natural range of these designated populations. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of temporary/long-term habitat loss/disturbance from these projects**.

7.5.3.2. Temporary Increases in Suspended Sediments/Smothering

The Greenlink Report to Inform Appropriate Assessment (RIAA) did not include specific consideration of pressures from temporary increases in suspended sediments/smothering. However, given the proximity of these two developments and similarity between the installation techniques proposed for Greenlink and those proposed for the Project, (i.e. MFE jetting and trenching), it is expected that the associated pressures will be similar.

Sediment disturbance at the META sites may occur following gravity base installation or drilling required for pile installation (RPS, 2019a). All activities proposed at each of the META sites are of a temporary and intermittent nature, with the Warrior Way and Dale Roads sites being limited to a single device testing at any one time.

As determined for the Proposed Development, any coarse sediment disturbed by installation of META devices is predicted to settle relatively quickly to the seabed in the immediate vicinity of the works, i.e., within the boundaries of the META sites. At Warrior Way, all but the finest material is predicted to settle within 1 hour. Any plume would result in an SSC uplift of 40 mg/l, although this would settle within 2 hours. This fine sediment plume may travel up to 100 m from the site. Due to the high silt components in sediment at the Dale Roads site, it is expected that any fine sediment plume would increase ambient SSC by up to 50 mg/l and extend approximately 600 m from source.

The methodology proposed for Project Valorous activities is expected to be similar to those for the Proposed Development (MarineSpace, 2020). Accordingly, it is expected that any temporary elevation in SSC will be highly localised in terms of spatial effect and would disperse within a short period. It is predicted for the Proposed Development that any SSC plume will be limited to a few tens of metres at the time of disturbance, with concentrations increasing to very high values (>thousands of mg/l). However, the duration of increased SSC will only last as long as the active disturbance period, plus 30 minutes post event. It is assumed that pressures associated with Valorous will be similar in terms of extent and residency.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 7.3). Construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway

for in-combination pressures between Project Valorous and Project construction works. As detailed for Section 7.5.3.1, cable repair/remediation O&M activities are only expected to be required infrequently. In view of the relatively low occurrence of associated elevations in SSC, the spatial extent of any pressures will be very small relative to the wider SAC.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination pressures with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. Although the precise number and frequency of vessel activities is not known, O&M activities will only occur infrequently. The current application allows for an estimated 10 repair and up to 12 remediation events to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between O&M events. Additional in-combination pressures may result from construction activities for Project Valorous and from placement of additional artificial (turbine) structures within the marine environment during construction of Project Valorous. However, given the spatial scale of any pressures will be negligible relative to wider SAC extent.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and extent to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and as such these projects will be decommissioned before completion of the 25 year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

As outlined in Section 7.5.2.1, the adult stage designated Annex II migratory fish species within the Pembrokeshire Marine SAC have low sensitivity to this pressure. Consideration of this, in light of the expected short residency of any plumes that are created by each of these developments, it is not expected that the combined pressure of temporary increases in suspended sediments/smothering from these projects would be sufficient to result in adverse effects on the integrity of the Pembrokeshire Marine SAC.

With respect to conservation objectives for the Pembrokeshire Marine SAC site, there is no indication that the in-combination temporary increases in suspended sediments/smothering from the projects considered will impact the natural range or extent of Annex II fish populations or lead to long-term negative impacts the on these migratory fishes. In view of the small-scale localised pressures on benthic habitats it is not expected that this pressure will impact supportive habitats or benthic prey resources sufficiently to diminish population distribution or abundance. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any**

pressures associated with the combined effect of temporary increases in suspended sediments/smothering from these projects.

7.5.3.3. Underwater Noise

There is no temporal overlap in expected construction windows for projects screened into in-combination assessment. Although Table 6.6 states that the Proposed Development will be constructed in 2026-2027 and Project Valorous in 2026-2028, both of these have the same developer, and it is expected that construction timings will be specified to ensure there is no overlap. The greatest potential for adverse impacts from acoustic emissions is associated with construction activities for all projects considered. Sub-sea noise associated with O&M activities will result from vessel traffic and activity and will be of a very low magnitude relative to piling operations or UXO clearance required during construction. As such, given the lack of temporal overlap between construction operations it is considered that pressures in-combination will not be elevated above the level determined for project activities alone. It is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of underwater noise from these projects**.

7.5.3.4. Electromagnetic Fields

The total length of cable in the offshore environment (array cables and offshore export cable) with the potential to cause EMF effects from the Project has been assessed as 72.9 km. The length of Greenlink Interconnector cable within UK waters is estimated at 73.9 km. An estimated 0.33 km of cable is currently suggested for the META projects. Both the Pembrokeshire Demonstration Zone and Project Valorous will require export cables and inter-array cables, however the length of these cables has not yet been determined. These projects are likely to be situated up to 21 km from the Pembrokeshire coast, and these distances have therefore been used for calculating expected spatial extent of pressure. Not accounting for potential inter-array cables, the estimated area of EMF pressure across projects, assuming a 4 m radius for all cables, is determined to be 0.010 km^3 (calculated in accordance with the formulae provided in Section 7.5.2.2). Even when considering the additional area of EMF pressure likely to result from the inter-array cables for both the Pembrokeshire Demonstration Zone and Project Valorous, this volume is considered negligible in the context of the extent of available water column habitat. Therefore the combined EMF pressures from these projects is considered to be very small.

Project EMF pressures will only occur during the operational phase, as such, construction and decommissioning activities will not be included within this in-combination assessment.

As discussed in Section 7.5.2.2, it is possible that changes in local EMF regime may influence the migratory behaviour of Annex II fish species designated within the Pembrokeshire Marine SAC. Given the uncertainty over the specific routes followed by these fishes it is not possible to ascertain which development location will create the greatest risk to these species, i.e. whether these cable routes will intersect any migration routes. However, given the small volume of water that will be affected, and the location of all these cable routes, at the edge of the estuary mouth, it is considered that their migratory urge to return to freshwater environments to spawn would be sufficient to find a route round/past this potential barrier

With respect to conservation objectives for the site, any in-combination reductions in available habitat caused by avoidance of EMFs are expected to be so small they will not adversely affect the natural range of designated Annex II migratory fish populations. Similarly, the localised nature of these pressures means that they would not be expected to affect fish abundance or distribution. Given the small size of the barriers that may be created, and the height of effect within the water column (i.e. ≤4 m), it is considered there is negligible risk that EMFs would disrupt migration to the extent that it would affect long-term population viability. In view of these points, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of electromagnetic fields from these projects**.

7.5.3.5. Accidental Pollution

The Greenlink RIAA scoped potential pressures on Annex I habitats from accidental pollution out of the Stage 2 Assessment within the HRA. However, it did note that:

"*Control measures and shipboard oil pollution emergency plans (SOPEPs) will be in place and adhered to under MARPOL Annex I requirements for all project vessels*."

Assessment of accidental pollution events within the ES for the META developments notes that the associated risk will be addressed through implementation of an EMP during installation, which will include an MPCP, providing measures to address any potential contaminant releases and include key emergency contact details. As with the Proposed Development, any lubricants used at the META sites will be EU/internationally approved for use in marine environments. It is expected that adherence to the measures outlined in the EMP, in addition to standard best practice guidance will minimise the likelihood of an accidental pollution event occurring and allow rapid containment if any did occur. As noted in Section 6.5.2.1, the META ES also acknowledges that any contaminants that are released will be rapidly dispersed by the high energy waters and twice daily tidal flushing.

The scoping report for Project Valorous notes that mitigation measures for dealing with the risk of accidental spills will be adopted and risks will be managed through the implementation of industry standard best practice guidelines (MarineSpace, 2020). Examples are provided such as establishment of spill response procedure, appropriate use of chemicals, adoption of marine pollution contingency plans and pollution prevention guidelines (PPGs). In addition, project vessels will comply with the International Maritime Organisation (IMO) International Convention for the Prevention of Pollution from Ships (MARPOL) standards. It is expected that adoption of these mitigation measures will minimise the risk of pollution events occurring and allow effective control in the unlikely event that they do.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 7.3). However, vessel activity required for O&M works at these sites will still introduce risk of accidental pollution events. Construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. It is considered that the mitigation measures that will be employed by the Proposed

Development and the other projects considered will be sufficient to reduce risk of accidental pollution events occurring, and to contain any that do occur.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination pressures with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. Although the precise number and frequency of vessel activities is not known, O&M activities will only occur infrequently. The current application allows for up to 10 repair and 12 remediation events to provide contingency for the entire Project operational lifespan, i.e. 25 years. As such, it is likely that there will be substantial temporal separation between O&M events. Additional in-combination pressures may result from construction activities for Project Valorous. However, given the mitigation measures that will be put in place to reduce the likelihood of pollution events occurring, and contain any that do, it is expected there is minimal risk of adverse effects on designated Annex I features.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and extent to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and as such these projects will be decommissioned before completion of the 25-year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

There is no evidence to suggest that accidental pollution would adversely affect the long-term viability of Annex II fish populations, or the abundance, condition or diversity of supportive habitats. It is also considered that any pollution event that did occur would be rapidly contained, avoiding physical, biological, and chemical structure and functions necessary for long-term habitat quality, or would lead to degradation in the abundance or condition of typical species. Given the low magnitude of pressure expected for all of these sites, and the level to which the mitigation measures proposed for the projects are expected to reduce the likelihood of such events, and contain any that do occur, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of accidental pollution from these projects**.

7.5.3.6. Mobilisation of Contaminated Sediments

Although the ECC of the Proposed Development intersects the Greenlink Interconnector route and overlaps with the Bombora Wave Energy project, construction of these developments is expected to be complete by 2024. As such there will be no temporal overlap with construction associated with the Proposed Development. However, combined effects may occur, if operational cable reburial works required for these sites occur during construction of the proposed development. The Greenlink Interconnector route will pass close to the historic Milford Haven dredge disposal ground,

and the ECC for the Proposed Development will intersect the footprint of this disused spoil area. However, as described in Chapter 7: Marine Sediment and Water Quality, the absence of elevated contaminant levels in sediments collected close to the historic disposal site suggest that there is low risk that cable installation through this area will result in mobilisation of contaminated sediments. However, sediment samples collected by Intertek (GIL, 2019) demonstrate that contaminant levels in sediments surrounding the Greenlink Interconnector are largely below the limits of detection. The risk associated with disturbance of these sediments is further decreased given the low chance of interaction between, and small SSC increase associated with respective sediment plumes.

Potential for sediment contamination for META Phase Two project sites is determined to be very low (RPS, 2019a). Although site-specific sediment sample data are not available for Project Valorous at the time of assessment, given the proximity, they can be assumed to be similar to that of the Proposed Development.

Project Erebus Construction Phase

Both the Greenlink Interconnector and META projects are expected to be completed ahead of starting Project construction works (Table 7.3). This ensures that only O&M works at these sites have potential to contribute to in-combination pressures. Conversely, construction of Project Valorous will not commence until after construction of the Proposed Development is complete. Accordingly, there is no pathway for in-combination pressures between Project Valorous and Project construction works. O&M activities associated with seabed disturbance are only expected to be required infrequently. For example, the Greenlink Interconnector ES indicated that up to 5 cable repair operations would be required within Welsh jurisdiction during the 40-year operational lifetime of the cable. Although the META projects have not indicated how many interventions would be expected, it is expected to be lower still due to their proximity to the coast. Industry used 'rule of thumb' is that one fault should be expected each 10 years per 100 km of cable. Given the expected infrequent occurrence of O&M activities at these sites, and the low levels of contaminants present in seabed sediments, it is expected that any uplift in contamination will be dispersed rapidly within the water column.

Project Erebus O&M Phase

Project O&M activities have potential to result in-combination pressures with O&M activities for the Greenlink Interconnector and META projects and both construction, and later O&M activities associated with Project Valorous. O&M activities will only occur infrequently (see details above). The current application allows for up to 10 repair and 12 remediation events. Although it is theoretically possible for O&M activities to be required at all projects simultaneously within the Pembrokeshire Marine SAC, this is considered to be highly unlikely. However, even if this did occur, given the low contamination levels in local sediments, any elevated levels of contamination will be temporary and rapidly disperse within the water column. In addition, the scale of works required, and therefore extent of pressures during the O&M phase will be smaller in magnitude than those caused during construction. Even where there is concurrent disturbance this would be expected to fall within the parameters described for the Project construction phase.

The greatest potential for in-combination pressures with Project O&M activities will be with construction activities for Project Valorous. However, given the temporary nature of predicted

pressures, and low levels of contaminants present, it is expected that this will result in a negligible increase above the pressures expected for Project Valorous alone.

Project Erebus Decommissioning

Project decommissioning activities are expected to be similar in nature and magnitude to those required for construction. In addition, unlike during construction, during decommissioning there is potential that these will be combined with O&M activities required for Project Valorous. However, the expected lifetime of the META projects is 15 years (RPS, 2019b) and as such these projects will be decommissioned before completion of the 25 year Project lifetime. It is considered that additional risk of pressures from Project Valorous O&M will not exceed the potential combined pressures of META projects as assessed for construction. As such risk of in-combination pressures during decommissioning will not be greater than that assessed for the construction phase.

Conclusion

It is considered unlikely that there will be sufficient temporal and spatial overlap for interaction between sediments mobilised during the construction activities required for these projects. However, these may all combine to affect spatially distinct parts of the Pembrokeshire Marine SAC. Nevertheless, even if this does occur, the low contaminant levels in underlying sediments ensures that the magnitude of any increase would be low. Due to the large volume of the receiving water and the capacity for dilution and flushing, it is unlikely that these modest introductions of contaminants will affect the site. It is notable that the low levels of chemical contaminants in Project water samples indicate that any contaminants that are mobilised from benthic sediments are unlikely to lead to failure, relative to water quality EQS.

As detailed in Section 7.5.2.1, site conservation objectives require that contamination levels are maintained within outlined thresholds and that there should be no increase in contamination within sediment or biota, in order to prevent contamination of potential prey species reaching concentrations potentially harmful to their physiological health. In view of the low levels of contamination present in local sediments relative to guideline thresholds, inclusive of those for marine biota, there is no indication that the combined pressure of these proposed works will negatively affect site conservation objectives. It is therefore determined there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with the combined effect of mobilisation of contaminated sediments from these projects**.

7.5.4. Summary

The screening process indicated that LSE on the Annex II migratory fish features of the Pembrokeshire Marine SAC could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of this sites has been undertaken.

The assessment has considered the potential impacts of the Project during construction, operation and maintenance, and decommissioning, alone and in-combination with other relevant plans and projects, with respect to the site's conservation objectives.

With respect to the conservation objectives, there is no indication that the Proposed Development would prevent the favourable condition of any designated Annex II migratory fish species for which the Pembrokeshire Marine SAC is designated from being maintained. On this basis, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Pembrokeshire Marine SAC from any pressures associated with the Project (alone or in-combination)**.

7.6. Afonydd Cleddau/Cleddau Rivers Special Area of Conservation

7.6.1. Site Details

The Afonydd Cleddau/Cleddau Rivers SAC (hereafter referred to as the Afonydd Cleddau SAC) is a 7.51 km^2 site designated in 2004. The SAC encompasses the River Cleddau, located upstream of Milford Haven, and is associated with several other domestic statutory sites. The river is 1 of the westernmost rivers in Britain and can be divided into an eastern and western arm.

The overarching site conservation objectives are outlined by NRW (2017):

"*The ecological status of the watercourse is a major determinant of FCS* [favourable conservation status] *for all features. The required conservation objective for the watercourse* [the Afonydd Cleddau/Cleddau Rivers SAC] *is defined below.*

4.1.1 The capacity for the habitats in the SAC to support each feature at near-natural population levels, as determined by predominantly unmodified ecological and hydromorphological processes and characteristics, should be maintained as far as possible, or restored where necessary.

4.1.2 The ecological status of the water environment should be sufficient to maintain a stable or increasing population of each feature. This will include elements of water quantity and quality, physical habitat and community composition and structure. It is anticipated that in most instances these limits will concur with the standards used by the Review of Consents process.

4.1.3 Flow regime, water quality and physical habitat should be maintained in, or restored as far as possible to, a near-natural state, in order to support the coherence of ecosystem structure and function across the whole area of the SAC.

4.1.4 All known breeding, spawning and nursery sites of species features should be maintained as suitable habitat as far as possible, except where natural processes cause them to change.

4.1.5 Flows, water quality, substrate quality and quantity at fish spawning sites and nursery areas will not be depleted by abstraction, discharges, engineering or gravel extraction activities or other impacts to the extent that these sites are damaged or destroyed.

4.1.6 The river platform and profile should be predominantly unmodified. Physical modifications having an adverse effect on the integrity of the SAC, including, but not limited to, revetments on active alluvial river banks using stone, concrete or waste materials, unsustainable extraction of gravel, addition or release of excessive quantities of fine sediment, will be avoided.

4.1.7 River SSSI [Site of Special Scientific Interest] *features should be in favourable condition.*

4.1.8 Artificial factors impacting on the capability of each species feature to occupy the full extent of its natural range should be modified where necessary to allow passage, eg. weirs, bridge sills, acoustic barriers. The reservoir dams on the Syfynwy are excluded.

4.1.9 Natural factors such as waterfalls, which may limit the natural range of a species feature or dispersal between naturally isolated populations, should not be modified.

4.1.10 Flows during the normal migration periods of sea and river lamprey will not be depleted by abstraction to the extent that passage upstream to spawning sites is hindered.

4.1.11 Water Quality targets follow those in the revised Common Standards Monitoring Guidance for Rivers (JNCC 2016). These are detailed in Appendix 1 [of NRW, 2017] *with targets for organic pollution (DO, BOD and ammonia), phosphate, trophic diatom index and acidification.*

4.1.12 Potential sources of pollution not addressed in the review of contents, such as contaminated land, will be considered in assessing plans and projects.

4.1.13 Levels of suspended solids will be agreed by NRW for each Water Framework Directive water body in the Afonydd Cleddau SAC. Measures including, but not limited to, the control of suspended sediment generated by agriculture, forestry and engineering works, will be taken to maintain suspended solids below these levels".

Where available, feature-specific conservation objectives are outlined in the following subsections.

The SAC is designated for the protection of 3 Annex I terrestrial habitats, as well as 5 Annex II species. The migratory Annex II fish species that are considered in this assessment include (species that are a primary reason for site selection in **bold**):

- **River lamprey *Lampetra fluviatilis* (S1099)**;
- Sea lamprey *Petromyzon marinus* (S1095).

A description of each qualifying feature is provided in the following subsections.

7.6.1.1. River Lamprey *Lampetra fluviatilis* and Sea Lamprey *Petromyzon marinus*

Feature Summary

Both species (river and sea lamprey) pass through the Pembrokeshire Marine SAC (see previous section) in order to access clean river gravels in upstream freshwater. The species utilise the Afonydd Cleddau SAC to spawn in October-December (river lamprey) and March-June (sea lamprey)

and juveniles of both species remain in the river for several years before migrating back to estuarine and nearshore coastal waters (NRW, 2018a). Therefore, this SAC is intrinsically linked to the Pembrokeshire Marine SAC, and thus included in the assessment.

River and sea lamprey are considered to be sympathetic features of the SAC (NRW, 2017). 'Sympathetic' features are defined by NRW (2017) as features that may: be of less conservation importance, have lower population/range, or have broader management requirements than the key feature (brook lamprey *Lampetra pleneri*); or those that are closely associated with the key feature (e.g. a symbiotic relationship), and the conservation of the key feature requires appropriate management of the sympathetic feature. Although not considered key features, river and sea lamprey are qualifying features of the Afonydd Cleddau SAC and therefore are both afforded the same legal protection as the key feature (NRW, 2017).

Feature Condition and Conservation Objectives

River lamprey initially failed on all 3 population attributes (density, distribution, and age structure) and failed to reach the environmental target for river flow. During the second reporting cycle, the feature met all population targets, but still did not pass the river flow target. Therefore, whilst the feature has been classified as in **unfavourable** condition, it is considered to be recovering.

Sea lamprey was also assessed, taking the 3 population attributes as well as river flow into consideration. In the first and second (most recent) reporting cycle, sea lamprey failed to meet the distribution and density targets, as no individuals were recorded, and spawning activity was not assessed. The feature also failed to meet river flow targets. Therefore, the condition of the feature is considered to be **unfavourable**.

NRW (2017) outlines the same feature-specific conservation objectives for river and sea lamprey:

"*The vision for* [these] *feature*[s] *is for* [them] *to be in favourable conservation status, where all the following conditions are satisfied:*

- *The conservation objective for the watercourse as defined…above is met.*
- *The population of the feature in the SAC must be stable or increasing over the long term.*
- *The natural range of the feature*[s] *in the SAC is neither being reduced nor is likely to be reduced for the foreseeable future. The natural range is taken to mean those reaches where predominantly suitable habitat for each life stage exists over the long term. Suitable habitat is defined in term of near-natural hydrological and geomorphological processes and forms e.g., suitable flows to allow upstream migration, depth of water and substrate type at spawning sites, and ecosystem structure and functions e.g., food supply. Suitable habitat need not be present throughout the SAC but where present must be secured for the foreseeable future.*
- *Passage of the feature*[s] *through the SAC is not to be hindered by artificial barriers such as weirs.*
- *The characteristic channel morphology provides the diversity of water depths, current velocities and substrate types necessary to fulfil the habitat requirements of the features. The close proximity of different habitats facilitates movement of fish to new preferred habitats with age*".

7.6.2. Assessment of Adverse Effects Alone and In-combination

The Afonydd Cleddau SAC is designated for the protection of river lamprey and sea lamprey. As lamprey do not display site fidelity (i.e. they do not necessarily return to their natal (same) river to spawn), populations using the Afonydd Cleddau SAC are likely to be a component of a wider population that covers the Bristol Channel. Populations present in the River Wye/Afon Gwy SAC, River Usk/Afon Wysg SAC, Afon Tywi/River Tywi SAC, Afon Teifi/River Teifi SAC, Severn Estuary/Môr Hafren SAC, Afonydd Cleddau/Cleddau Rivers SAC, and Carmarthen Bay and Estuaries/Bae Caerfyrddin ac Aberoedd SAC are considered to be linked to the Afonydd Cleddau SAC population. Extent and density juvenile lamprey monitoring data from the Afonydd Cleddau site is used to inform assessment of these features for the Pembrokeshire Marine SAC. This is considered appropriate because the Afonydd Cleddau SAC is upstream of the Pembrokeshire Marine SAC and as such individuals must pass through the Pembrokeshire Marine SAC to reach open coastal waters.

Given this linkage between the two populations it is likely that effects on the Afonydd Cleddau SAC lamprey populations would be similar in nature to those at the Pembrokeshire Marine SAC. In addition, given the greater degree of geographic separation, it should be considered that the magnitude of any adverse effect would be no greater for the Afonydd Cleddau SAC than the Pembrokeshire Marine SAC. Section 7.5 concluded that there would be no impacts on the integrity of the Pembrokeshire Marine SAC from Project activities. In view of the similar nature of impacts on the Afonydd Cleddau SAC and smaller magnitude of pressure expected, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Afonydd Cleddau/Cleddau Rivers SAC from any pressures associated with the Project (alone or in-combination)**.

7.7. Summary

The screening process indicated that LSE on the Annex II migratory fish features of the Afonydd Cleddau SAC could not be discounted and so a systematic assessment of the potential for an adverse effect on the integrity of this sites has been undertaken.

The assessment has considered the potential impacts of the Erebus Project during construction, operation and maintenance and decommissioning, alone and in-combination with other relevant plans and projects with respect to the site's conservation objectives.

With respect to the conservation objectives, there is no indication that the Proposed Development would prevent the favourable condition of any designated Annex II migratory fish species for which the Afonydd Cleddau SAC is designated from being maintained. On this basis, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of migratory fish features of the Afonydd Cleddau SAC from any pressures associated with the Project (alone or in-combination)**.

8. Annex II Marine Mammals Assessment

8.1. Introduction

This section covers the assessment of adverse effects on Special Areas of Conservation (SACs) designated for Annex II marine mammals. The section provides information to determine whether there is an adverse effect on the integrity of the conservation objectives of the SACs screened into assessment resulting from the potential pressures of the proposed Project. The chapter is structured as follows:

- A summary of Habitat Regulations Assessment (HRA) screening results and potential pressure pathways;
- A summary of the proposed Project Design Envelope, outlining the worst-case scenario used to inform the assessment;
- For each SAC screened into the assessment:
    - A description of each SAC, its conservation objectives, and baseline information gathered to aid the assessment;
- For each feature of each SAC screened into the assessment:
    - A summary of the ecology of the species;
    - An assessment of the effects during construction and operation of the Project alone;
    - An assessment of adverse effects when considering the Project in-combination with other developments.

8.1.1. Summary of Screening

Screening was conducted in order to identify potential exposure pathways for Annex II marine mammal populations (refer to Volume 3, Technical Appendix 8.2: HRA Screening Report). The Annex II marine mammal qualifying features screened into Stage 2 assessment are:

- Harbour seal *Phoca vitulina*;
- Grey seal *Halichoerus grypus*;
- Harbour porpoise *Phocoena phocoena*;
- Bottlenose dolphin *Tursiops truncatus*.

Harbour seal were screened out of the assessment as tagging showed that they do not use the waters off the coast of Wales and there are no known haul out/breeding sites along the Welsh coast for this species.

8.1.2. Summary of Potential Pressure Pathways

Several potential pressure pathways were identified for the remaining features in the screening process. No Likely Significant Effect (LSE) was determined for several of these pathways (accidental pollution, temporary increases in suspended sediments/smothering and habitat loss) and, therefore, these pressures have been screened out of requiring assessment at this stage. No LSE could not be concluded for the remaining pressures and, thus, these are assessed within this report:

- Underwater noise (from unexploded ordnance (UXO) detonation, piling, drilling, construction activities or vessel movement);
- Disturbance/displacement;
- Collision risk (with construction, operation and maintenance (O&M), or decommissioning vessels);
- Entanglement with mooring lines or ghost fishing gear;
- Barrier effects.

8.2. Project Design Envelope Parameters Relevant to Annex II Marine Mammals

Table 8.1 provides parameters for use as the realistic worst-case scenario within assessment. It should be noted that these parameters are not limited to those for which there is spatial overlap between the direct or indirect area of effect and an SAC site. Due to the highly mobile nature of marine mammals, it is necessary to consider pressure pathways outside SAC boundaries in order to consider potential for adverse effects on designated Annex II features during transit to or from an SAC site. As such, the parameters provided in Table 8.1 describe the full range of marine activities associated with the Project, and are not limited to those in any specific spatial extent associated with any particular SAC boundary.

Table 8.1: Project realistic worst case scenario parameters for use in assessment of potential for adverse effects on designated Annex II marine mammal populations

Potential Pathway Change/Impact	Realistic Worst-case Scenario	Justification
Construction		
Permanent Threshold Shift (PTS) from UXO	Clearance of 1 UXO Low order detonation: • 2 kg NEQ, 5 km Effective Deterrent Radius (EDR).	The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. *High order detonation of up to 525 kg device also modelled and assessed, in line with*[14]
Disturbance from UXO	High order detonation • 525 kg device	

[14] DEFRA Policy Paper: Marine environment: unexploded ordnance clearance joint interim position statement. Published 16 November 2021

Potential Pathway Change/Impact	Realistic Worst-case Scenario	Justification
		although judged to be a unrealistic worst case scenario
PTS from pile driving **Disturbance from pile driving**	35 piled anchors • Diameter: 2.5 m; • Length: 55 m; • Penetration depth: 52 m; • Hammer energy: 800 kJ; • Piling duration: 150 min; • Total piling time for 35 anchors: 49 hours. Overall offshore construction duration: 8 months. Installation of moorings and anchors: 30 days. Hookup of semi-submersible floating platform s: 30 days. Main offshore array works: 60 days total.	Maximum number of piles and hammer energy used to install piles represents the PTS and disturbance maximum design scenario.
PTS from other construction activities **Disturbance from other construction activities**	Mooring installation: • 35 mooring lines; • Drag embedment anchors: 12 hours per mooring line; • Suction pile: 12 hours per mooring line. 10 inter-array cables: • Surface lay: duration 7 days (200 m/hr); • Post lay burial: 9 days; • Protection installation: 47 days Export cable: • Methods: surface lay, plough,	Maximum potential methods and durations for underwater noise impacts.

Potential Pathway Change/Impact	Realistic Worst-case Scenario	Justification
	MFE[15], jetting, TSHD[16], rock cutting, trenching; • Total duration of the offshore export cable installation: 152 days (based on sandwave levelling, boulder clearance, PLGR, multipass, installation, post-lay burial and protection installation); Landfall HDD: • Dredging for offshore trench section; • Option for sheet piles and cofferdam installed by impact driving (300 kJ), vibro-driving or pressing. Source levels (SEL_{cum} dB re 1 µPa @ 1 m RMS): • Vessel movement (large): 168; • Vessel movement (medium): 161; • Backhoe dredging: 165; • Suction dredging: 186; • Cable laying: 171; • Trenching: 172; • Rock placement: 172; • Drag embedment anchors: 171; • Suction pile installation: 192; • Drilling: 170.1. Overall offshore construction duration: 8 months	

[15] Mass flow excavator

[16] Trailer suction hopper dredger

Potential Pathway Change/Impact	Realistic Worst-case Scenario	Justification
Disturbance from vessels **Collision with vessels**	Vessel movements for cables: • 4,032 hrs/168 days HDD; • 420 hrs for mooring + hook up alone, no transit; • 2,640 hrs/110 days for hangoff hook up, no transit; • Cable lay: export - 1,128 hrs/47 days; array - 540 hrs/22 days; • Burial: export - 940 hrs/40 days; array - 450 hrs/19 days (24 hr days); • Rock protection: export – 940 hrs/40 days, array – 450 hrs/19 days (24 hr days). Vessels for semi-submersible floating platform : • Max. 4 at any one time (anchor handling vessel, installation vessel, feeder barge, DP vessel, tugboat, escort vessel); • Total time onsite: 60 days. Overall offshore construction duration: 8 months.	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.
Disturbance at seal haul-outs	Landfall: • Options: open-cut trench and HDD; • Cofferdam/sheet piles installed by impact driving, vibro-driving or pressing; • Cofferdam piling: max. 300 kJ per blow; • Cofferdam duration: 12 weeks. Vessels: • See Disturbance from vessels. Overall offshore construction duration: 8 months.	Construction activity located near seal haul-out sites.
Indirect impacts on prey	Assessment is based on the maximum design scenario (MDS) presented in Chapter 10: Fish and Shellfish Ecology.	
Operation and Maintenance		
Barrier effects **Entanglement and collision**	10 WTG • Array area 43.5 km^2; • 35 catenary mooring lines; • 870 m length mooring line; • 800 m mooring radius (hull to	The maximum scale of the mooring lines and inter-array cables represents the maximum potential for barrier effects, entanglement and

Potential Pathway Change/Impact	Realistic Worst-case Scenario	Justification
	anchor); • 60m length mooring rope; • 810 m mooring chain; • 25 mooring clumps per line. 10 inter-array cables • Formation: Lazy Wave; • Length: 6.022 km each; • Length: 23.9 km total; • Diameter: 300 mm.	collision.
Disturbance from vessels	Vessel quantities per year: 2 x 12 hr day (CTV) (transit 1.5-2 hrs).	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.
Collision with vessels		
Disturbance at seal haul-outs	See Disturbance from vessels.	O&M activity located near seal haul-out sites.
Indirect impacts on prey	Assessment is based on the MDS presented in Chapter 10: Fish and Shellfish Ecology.	
Decommissioning		
Disturbance from removal of structures	Assumed to be the same or less than installation.	
Disturbance from vessels	Assumed to be the same or less than installation.	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.
Collision with vessels		
Disturbance at seal haul-outs	Assumed to be the same or less than installation.	Decommissioning activity located near seal haul-out sites.
Indirect impacts on prey	Assessment is based on the MDS presented in Chapter 10: Fish and Shellfish Ecology.	

8.3. Approach to Assessment

NRW guidance (NRW,2020) states that when considering impacts on the marine mammal features of SACs, the fact that marine mammals are mobile species results in the potential for them to be impacted outside the boundaries of the given SAC for which they are a designated feature. Therefore, NRW advises that the relevant Marine Mammal Management Unit (MMMU) should be used as the scale at which to assess the potential impact. If credible impact pathways are identified, or there is reasonable doubt as to absence of an effect from the relevant impact to a marine

mammal Annex II feature, in view of the conservation objectives, then all sites with that feature within the relevant MMMU for that species should be screened in for Appropriate Assessment (AA) (NRW, 2020a).

In line with NRW (2020a) guidance, all sites within the appropriate MMMU were screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the closest site to the Project footprint. If an Adverse Effect On Site Integrity (AEOSI) was determined, then assessment was carried out for the next closest site. If no AEOSI was determined, more distant sites were not considered further.

NRW (2020) outlines further guidance relating to species that are features of Welsh SACs and advised the following:

- For bottlenose dolphin: an Appropriate Assessment should be carried out on both bottlenose dolphin SACs: Pen Llŷn a'r Sarnau and Cardigan Bay;
    - Due to the high level of connectivity between the SACs and the strong evidence that there is a single population of bottlenose dolphins using both sites an impact that causes AEOSI to one site will likely cause AEOSI to the other and *vice versa*;
- For harbour porpoise: An Appropriate Assessment should be carried out on the closest site to the proposed plan or project location first. If AEOSI cannot be ruled out, a sequential/iterative assessment should be carried out considering the next closest site;
    - SAC documentation specifies that the population of porpoise associated with the site is that of the MMMU reference population, there is no specific number of porpoises associated with the site. The site conservation objectives for all harbour porpoise SACs in the MMMU are the same and the sites are of equal importance to the species but vary by season;
- For grey seal: An Appropriate Assessment should be carried out on the closest site to the proposed plan or project location first. If AEOSI cannot be ruled out, a sequential/iterative assessment should be carried out considering the next closest site. Pembrokeshire Marine SAC is also likely to require assessment depending on the specifics of the case;
    - Pembrokeshire Marine SAC is the key SAC which supports most grey seal pupping. As such, this site may need to be routinely assessed. It is predicted that animals from further away from the source of an impact are less likely to travel to that location, and therefore be affected, than those in closer proximity.

This assessment is provided to determine whether Project activities can reasonably be expected to result in an adverse effect on the integrity of the following sites, based on consideration of the respective conservation objectives:

- West Wales Marine/Gorllewin Cymru Forol SAC (harbour porpoise);
- Pembrokeshire Marine/Sir Benfro Forol SAC (grey seal);
- Cardigan Bay/Cae Ceredigion SAC (bottlenose dolphin);
- Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC (bottlenose dolphin).

The subsequent sections of assessment of pressures on Annex II Marine Mammals comprise of the following:

- A summary of baseline surveys completed to date, and the key findings relevant to Annex II marine mammal species;
- A description of each SAC considered in the assessment, details of the Annex II marine mammal features for which they have been designated, the conservation objectives and their current conservation status;
- A description of the potential pressures associated with the Proposed Development and how these may interact with the designated features and conservation objectives for this site alone;
- An assessment of in-combination pressures when considering the Proposed Development, together with other developments;
- Proposed mitigation measures to avoid adverse effects on the SAC features, over and above embedded mitigation;
- A summary of potential for adverse effects on the integrity of the relevant SACs.

8.4. Digital Aerial Surveys and Modelling

In October 2019, HiDef Aerial Surveying Limited (HiDef) was commissioned to undertake high-resolution digital video aerial surveys for marine megafauna over the offshore site (HiDef Aerial Surveying Ltd, 2020). A total of 24 months of data was collected. These surveys were designed to place transects 1 km apart across the Proposed Development, including a 4 km buffer around the offshore site, comprising a total survey area of 200.11 km^2. All 24 surveys were conducted in sea states 1-5, with 12% of the effort records being at sea state 1, 33% at sea state 2, 33% at sea state 3, 20% at sea state 4, and 3% at sea state 5.

Surveys were conducted using an aircraft equipped with 4 HiDef Gen II cameras, which included sensors set to a resolution of 2 cm Ground Sample Distance. Each of these cameras sampled 125 m wide strips, separated from the next camera by approximately 25 m, providing a combined sampled width of 500 m within a 575 m overall strip. To ensure that sufficient footage was available for a design-based or model-based analysis, only footage from 2 out of the 4 cameras was analysed, with the remaining footage remaining available for analysis at a later stage, if needed. Data analysis for these surveys involved a two-stage process, including a review of video footage with a 20% random sample used for audit. Following this, the detected individuals were identified to species and/or species group level, also with 20% selected at random for auditing. For both stages in this process, the audits required 90% agreement to be achieved.

For the full 24 months of data (October 2019 to September 2021), surveys recorded 2,028 marine mammal sightings across 6 species. The identification rate achieved to species level for both marine mammal and bird species combined as 97.57% across the whole survey programme.

8.4.1. Underwater Noise Modelling

Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report provides an assessment of the subsea acoustic emissions expected to result from Project activities, uses underwater noise modelling software to predict the distribution of noise around the Project array area and ECC, and estimates ranges at which various thresholds dictated by relevant guidance would be exceeded. The guidance is based primarily on Southall *et al.* (2019) for marine mammal species,

and provides noise thresholds within which potential injury and onset of effects on hearing, both permanent (Permanent Threshold Shift (PTS) and temporary (Temporary Threshold Shift (TTS), could occur in relevant species. These are based on both instantaneous and longer duration exposure to the noise.

Noise sources expected during the construction phase include ground preparation activities such as dredging, trenching, cable laying, and rock placement, turbine mooring activities such as the installation of ground embedment anchors, drilling and suction piling, and vessel movements. Impact piling is considered unlikely but has been included to cover the worst-case scenario. Clearance of UXO may also be required.

The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst case scenario throughout the Environmental Statement and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals.

Deflagration (low-order) is the Project's preferred method for UXO clearance and, based on current industry knowledge and precedent set by other offshore wind farms, e.g. Sofia Offshore Wind Farm (Sofia Offshore Wind Farm UXO Clearance Marine Licence Application (GoBe, 2021) MLA/2020/00489) and Greenlink Interconnector (Marine Licence application reference: CML1929), is considered the realistic worst case scenario. High order UXO detonation, as an absolute worst case, has been modelled and reported in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration; however this has been considered for completeness, and is not deemed realistic as the Project intends to employ deflagration (low-order) as the clearance method.

This approach is informed by the UXO Threat and Risk Assessment (6-Alpha Associates, 2020), completed to inform project specific geotechnical surveys, which provides an assessment of potential threat sources and the likelihood of contamination across the Project array area and export cable corridor. The Project is also cognisant of the recently consented Marine Licence for the Greenlink Interconnector and the UXO approach adopted for the cable route in Welsh waters, i.e. the same as proposed for the Project.

Ground preparation, vessels and mooring installation (other than by impact piling) are relatively low-level noise sources, and have been assessed using a simple propagation model alongside the impact criteria from Southall *et al* (2019). Assuming the most plausible scenario for modelling, that a receptor swims away from the noise source when it is operating, any marine mammal species would need to be within 20 m of the source to receive sufficient exposure for a potential recoverable injury or permanent hearing impairment.

A temporary, recoverable hearing impairment to harbour porpoise could potentially occur up to 990 m from the source. All other species categories would need to be within 100 m of any of these sources to acquire a noise exposure sufficient to incur a temporary effect on hearing.

UXO deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a Trinitrotoluene (TNT) equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. Using a low order-technique for clearance would lead

to PTS-onset impact ranges of up to 990 m (Very High Frequency (VHF)) and 230 m (Low Frequency (LF)).

However, in line with the recommendations outlined within the recent position statement on UXO clearance (Defra *et al.* 2021), the impact assessment also includes an assessment for high-order detonations, though this is considered unlikely to occur in practice and represents an absolute worst case. The site specific UXO Threat and Risk Assessment Report carried out for Erebus (6-Alpha Associates, 2020) concluded that the maximum realistic worst case charge weight that can be expected to be presented in the Erebus study area is 331 kg (ferrous mass).

In the event that impact piling is required, the maximum PTS onset range is 2.7 km for LF Cetaceans using worst-case piling parameters. All other species would need to be within 280 m at the start of piling for any such effect to occur.

When operational, predictions of the continuously present underwater noise have been made for the proposed turbines , based on extrapolations from measurements of other turbines installed in the UK and USA. No significant adverse impacts from noise from operational turbines are expected to any species of fish or marine mammal.

8.5. Cetaceans

8.5.1. West Wales Marine/Gorllewin Cymru Forol Special Area of Conservation

The West Wales Marine/Gorllewin Cymry Forol SAC (hereto referred as the West Wales Marine SAC) is a large (7,376.1 km^2) site that runs from the Llŷn Peninsula in the north to the Pembrokeshire coastline in the south, encompassing Cardigan Bay. The SAC is designated solely for harbour porpoise (S1351) and was designated in 2019, along with several other harbour porpoise SACs in the UK (JNCC, 2021g). Most of the site is shallower than 50 m water depth, however the site ranges from the low water mark along the eastern boundary to depths >100 m in the west. The site boundaries were determined based upon harbour porpoise density modelling, using 18 years' worth of data (Heinänen and Skov, 2015).

8.5.1.1. Conservation Objectives

JNCC and NRW (2019b) outline conservation objectives for the site:

"*To ensure that the integrity of the site is maintained and that it makes the best possible contribution to maintaining Favourable Conservation Status (FCS) for Harbour Porpoise in UK waters.*

In the context of natural change, this will be achieved by ensuring that:

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

Conservation Objective 1: The species is a viable component of the site

The intent of the objective is to minimise risk of injury and killing, or other factors that could reduce the survival/reproductive success of harbour porpoise. The objective relates to operations that may result in unacceptable levels of impacts, where unacceptable levels relate to impacts on the FCS of the species population within its natural range. Assessments against this objective use the Management Unit (MU) population as the reference population (IAMMWG, 2015).

Harbour porpoise is a European Protected Species (EPS), listed under Annex IV of the Habitats Directive and protected under the Habitats Directive Article 12 and associated regulations from deliberate killing or injury, capture and disturbance. Article 12 (4), in relation to capture and killing, states that Member States "*shall establish a system to monitor the incidental capture and killing of the species listed on Annex IV (all cetaceans). In the light of the information gathered, Member States shall take further research or conservation measures as required to ensure that incidental capture and killing does not have a significant negative impact on the species concerned*". Site based measures should be congruent with the existing strict protection measures in place in UK waters.

Conservation Objective 2: There is no significant disturbance of the species

The SAC was designated due to the persistent high densities of harbour porpoises within the area in relation to the rest of the MU, due to the presence of habitats providing enhanced foraging opportunity (Heinanen and Skov, 2015). Operations carried out within the site should, therefore, be managed to ensure that harbour porpoise use of the site is maintained.

Disturbance primarily originates from underwater noise sources including seismic surveys, pile driving and sonar. Underwater noise may incur physiological and/or behavioural responses. Disturbance is considered a behavioural response where harbour porpoise may be displaced from the area of works, and is deemed significant if it leads to displacement from a significant area of the site. Draft guidance for the assessment of noise disturbance to a site considers that:

Noise disturbance within an SAC, from a plan/project individually or in combination, is significant if it excludes harbour porpoises from more than:

1. 20% of the relevant area[17] of the site in any given day[18];
2. An average of 10% of the relevant area of the site over a season[19,20].

[17] The relevant area is defined as that part of the SAC that was designated based on higher persistent densities for that season (summer defined as April to September inclusive, winter as October to March inclusive).

[18] Applicable only in Habitats Regulations Assessments (HRA) due to impracticality of daily noise limit management of activities, but retrospective compliance analysis is advised.

[19] Summer defined as April to September inclusive, winter as October to March inclusive.

[20] For example, a daily footprint of 19% for 95 days would result in an average of footprint of:
(19 × 95) ÷ 183 (summer) days = 9.86%.

Conservation Objective 3: The supporting habitats and processes relevant to harbour porpoises and their prey are maintained

In the context of this objective, supporting habitats refer to the characteristics of the seabed and water column, whilst processes refer to the movements and physical properties of the habitat. The maintenance of these habitats is required in order to ensure that harbour porpoise prey is maintained and available within the site. The species is thought to be highly dependent on a consistent year-round supply of food sources due to a high metabolic rate and, therefore, feeding rate. Densities of harbour porpoise within the site are, therefore, strongly linked to density and presence of prey within the site.

Whilst some plans/projects are unlikely to have a significant effect alone on this conservation objective, an effect might become significant when considered in combination with other plans/projects and against the existing activities/pressures associated with the site. There is therefore a need for further work to assess historic, existing and planned levels of plans/projects in the site and to better understand their impacts on the habitats and prey within the site.

8.5.1.2. Advice on Operations

JNCC (2019) has provided advice on activities that specifically occur within or near to the West Wales Marine SAC site, that could be expected to impact on the site's integrity. The key impacts and activities that JNCC and Natural England (2019) consider to have the greatest impact on the population of UK harbour porpoise and, therefore, the SAC are:

- Commercial fisheries with by-catch of harbour porpoise;
- Discharge of contaminants/run-off from land fill, terrestrial and offshore industries;
- Anthropogenic underwater noise from shipping, drilling, dredging and disposal, aggregate extraction, pile driving, acoustic surveys, underwater explosion, military activity, acoustic deterrent devices and recreational boating;
- Death or injury by collision with, shipping, recreational boating and tidal energy installations;
- Reduction in prey resources by commercial fisheries.

JNCC (2019) states:

"The aim is that the advice should help identify the extent to which existing activities are, or can be made, consistent with the Conservation Objectives, and thereby focus the attention of Relevant and Competent Authorities and surveillance programmes to areas that may need management measures."

This assessment considers the potential pressures in relation to the SAC conservation objectives; as outlined in Table 8.2.

Table 8.2: Potential pressures from the Project in relation to the conservation objectives of the West Wales Marine/Gorllewin Cymru Forol SAC

Conservation Objective	Potential Effect
The species is a viable component of the site	Disturbance and displacement as a result of increased underwater noise levels (from activities such as UXO clearance, piling, other construction activities, vessels, and noise associated with operational and decommissioning phase) have the potential to have an effect on the site and will be considered further.
	Increased collision risk with vessels during construction, operation and decommissioning phases has the potential to have an effect on the site and will be considered further.
There is no significant disturbance of the species	Significant disturbance and displacement as a result of increased underwater noise levels (from activities such as UXO clearance, piling, other construction activities, vessels, and noise associated with operational and decommissioning phase) have the potential to have an effect on the site and will be considered further.
The supporting habitats and processes relevant to harbour porpoises and their prey are maintained	Changes in prey availability have potential to affect the site and will be considered further.

8.5.1.3. Harbour Porpoise *Phocoena phocoena*

Feature Summary

Harbour porpoise density modelling was used to identify areas around the UK which are of importance to the species and to determine which areas should be designated as SACs for its protection (Heinanen and Skov, 2015). The West Wales Marine SAC is one of these areas, with the species using large areas of the SAC during summer and winter months (JNCC, 2021g). The majority of the SAC is used throughout the summer, with increased usage of the inshore areas around Cardigan Bay observed in the winter months.

The abundance of harbour porpoise in the site varies, however is estimated at approximately 5,222 individuals, noting that seasonal differences are likely to occur (JNCC and NRW, 2017). This population estimate represents around 8.4% of the population of harbour porpoise within the Celtic and Irish Seas Management Unit, and therefore is considered a Grade B population (>2-15% of the relevant UK management unit population).

Due to data available on species distribution, over a 2 decade monitoring period, habitat preference within the SAC is assumed to be high and associated with good foraging opportunities and prey availability. Due to the wide ranging nature of the species, the SAC is not considered to contain an

isolated population, but a component of the wider management unit population (JNCC and NRW, 2017).

Feature Condition and Conservation Objectives

As the SAC is designated specifically for harbour porpoise, the conservation objectives previously noted are directly applicable to this species.

Feature condition assessments have not been conducted since the site was formally designated in 2019 and, therefore, the most recent assessment completed was during the site selection process. Due to its wide ranging population and sufficient food resources assumed to be present within the SAC, harbour porpoise was considered to be in **favourable** condition (JNCC and NRW, 2017) and restoration possibilities were not required to be considered.

8.5.1.4. Assessment of Adverse Effects Alone

The potential pressures during construction, operation and maintenance, and decommissioning for the proposed Project include:

- Auditory injury caused by underwater noise (from UXO detonation, piling, drilling, construction activities or vessel movement);
- Underwater noise - disturbance/displacement;
- Collision risk (with construction, O&M or decommissioning vessels);
- Entanglement with mooring lines or ghost fishing gear;
- Barrier effects;
- Accidental pollution.

Potential Effects Resulting from Auditory Injury Caused by Underwater Noise

Construction Phase

UXO Clearance

The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. However, in line with the recommendations outlined within the recent position statement on UXO clearance, this impact assessment includes an assessment for high-order detonations, though this is considered unlikely to occur in practice.

Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an Effective Deterrent Radius (EDR) of 5 km (based on a 2 kg detonation) is applied when considering the potential for disturbance from an individual UXO clearance event. Recent UXO clearance licence applications have assumed an effective deterrence range of 5 km around the source location to determine the impact area from low-order UXO clearance (e.g. GoBe, 2021). In the absence of agreed metrics, and given a lack of empirical data on the likelihood of response to low-order detonations, this 5 km radius (area of 78.5 km^2) has been

applied for all species. Since the array area boundary is approximately 11.1 km from the West Wales Marine SAC, any UXO detonation would not overlap spatially with the SAC; however, due to the mobility of harbour porpoise there is the potential for harbour porpoise features of the West Wales Marine SAC to be present within the Project area.

The PTS-onset impact ranges for low-order UXO detonations are negligible (Table 8.3) and the number of harbour porpoise expected to experience PTS-onset is <1 for all charge sizes, apart from 2 kg NEQ which could impact 1 single harbour porpoise (Table 8.3). Despite this, given the evidence available that suggests harbour porpoise are likely to be temporarily displaced by vessel activity (e.g. Benhemma-Le Gall *et al.* 2021), it is highly likely that on average, less than 1 individual would be present within the maximum 1.9 km PTS-onset impact range.

Table 8.3 details the number of harbour porpoise that could potentially be affected, based on the maximum potential PTS impact ranges of UXO clearance. The assessment has been based on the worst-case scenarios for the unweighted SPL_{peak} predicted PTS impact ranges (Table 8.3), in line with a precautionary approach.

As a realistic worst-case scenario, based on a 2 kg NEQ UXO detonation, the maximum area for potential risk of auditory injury in harbour porpoise outlined by the Volume 2, Appendix 12.2: Underwater Noise and Vibration Technical Report, without any mitigation, is 11.34 km^2 (corresponding with 0.15% of the West Wales Marine SAC area), which could affect up to 5 individuals (0.008% for the MU reference population). This is considered to be the realistic worst-case scenario for UXO detonation for the Project.

Table 8.3: PTS-onset impact ranges and number of harbour porpoise predicted to experience PTS-onset for low order UXO detonation

Threshold	Species	Metric	0.1 kg NEQ	0.25 kg NEQ	0.5 kg NEQ	2 kg NEQ
Unweighted SPL_{peak}						
202 dB (VHF)	Harbour porpoise	Range km	0.73	0.99	1.2	1.9
		#	<1	<1	<1	1
Weighted SEL_{ss}						
155 dB (VHF)	Harbour porpoise	Range km	0.05	0.08	0.11	0.2
		#	<1	<1	<1	<1

In line with the recommendations outlined within the recent position statement on UXO clearance (Defra *et al.* 2021), the impact assessment includes an assessment for high-order detonations (below), though this is considered unlikely to occur in practice.

The site specific UXO Threat and Risk Assessment Report carried out for Erebus (6-Alpha Associates, 2020) concluded that the maximum realistic worst case charge weight that can be expected to be presented in the Erebus study area is 331 kg (ferrous mass).

For a UXO charge weight of 525 kg NEQ, the predicted PTS-onset impact range is 13 km for harbour porpoise, which equates to disturbance to 283 individual porpoises (Table 8.4), which is 0.45% of the MU. Given that the maximum expected UXO charge weight expected in the study area is only 331 kg, then the PTS-onset impact range for harbour porpoise would be between 9.8 km (for a 240 kg charge) and 13 km (for a 525 kg charge).

As stated in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report, there are considerable assumptions behind this calculation: "*assumes no degradation of the UXO and no smoothing of the pulse over that distance, which is very precautionary… it is likely that the long-range smoothing of the pulse peak would reduce its potential harm and the maximum 'impulsive' range for all species is very precautionary*".

Subacoustech therefore advises that "*it is likely that the long-range smoothing of the pulse peak would reduce its potential harm and the maximum 'impulsive' range for all species is very precautionary and unlikely in practice*". Given this, the impact range of up to 12 km for harbour porpoise is considered to be unrealistic.

As an absolute worst-case scenario, based on a 525 kg NEQ UXO detonation, the maximum area for potential risk of auditory injury in harbour porpoise outlined by the Volume 2, Appendix 12.2: Underwater Noise and Vibration Technical Report, without any mitigation, is 530.93 km^2 (corresponding with 7.20% of the West Wales Marine SAC area), which could affect up to 222 individuals (3.55% for the MU reference population). It should be noted that this is to be considered an extreme worst case scenario, included to ensure a highly precautionary assessment in line with current advice, and is not expected to occur in practice.

Table 8.4: PTS-onset impact ranges and number of harbour porpoise predicted to experience PTS-onset for high order UXO detonation

Threshold	Species	Metric	25 kg	55 kg	120 kg	240 kg	525 kg
Unweighted SPL_{peak}							
202 dB (VHF)	Harbour porpoise	Range km	4.6	6.0	7.7	9.8	13
		#	27	45	75	121	212
Weighted SEL_{ss}							
155 dB (VHF)	Harbour porpoise	Range km	0.56	0.74	0.95	1.1	1.4
		#	<1	1	1	2	2

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project

UXO clearance would lead to a reduction in the viability of harbour porpoise populations designated at this site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with auditory injury from UXO clearance**.

Pile Driving

Predictive underwater noise modelling was completed to estimate the noise levels likely to arise from pile driving carried out during construction of the Project (Volume 3, Annex 12.2: Underwater Noise and Vibration). This has been used to determine the potential for pressures on harbour porpoise.

Underwater noise modelling results indicated that the largest instantaneous PTS-onset impact range (unweighted SPL_{peak}) for impact piling would be 280 m for harbour porpoise at both wind turbine generator (WTG) locations selected for model analysis. In modelled scenarios, <1 animal is expected to be within its respective PTS-onset impact range (0.002% of the MU reference population). The estimated maximum number of harbour porpoise that could potentially be at risk of PTS from cumulative SEL is also <1 harbour porpoise (up to 0.002% of the North Sea MU reference population). It should be noted that the array area boundary is approximately 11.1 km from the West Wales Marine SAC and, due to this spatial separation, the PTS-onset ranges do not overlap with the SAC.

PTS-onset impact range predictions (Table 8.5) assume that all animals within the PTS-onset range are impacted, which will overestimate the true number of impacted animals as only 18-19% of the animals within this range are predicted to actually experience PTS (see Volume 3, Chapter 12: Marine Mammals). Consequently, the low numbers predicted are already highly conservative. In addition, the sound is modelled as being fully impulsive irrespective of distance from the pile, which is highly precautionary and results in predictions that are unlikely to be realised. The Project will also be adhering to a piling Marine Mammal Mitigation Plan (MMMP) which will further reduce the risk of PTS to negligible levels.

Table 8.5: PTS-onset impact ranges for impact piling – worst-case (800 kJ)

Threshold	Species	Parameter	WTG01 (NW)	WTG10 (E)
Instantaneous PTS: Unweighted SPL_{peak}				
202 dB (VHF)	Harbour porpoise	Area	0.25 km^2	0.25 km^2
		Max Range	280 m	280 m
		# Porpoise	<1	<1
Cumulative PTS: Weighted SEL_{cum}				
155 dB (VHF)	Harbour porpoise	Area	< 0.1 km^2	< 0.1 km^2
		Max Range	< 100 m	< 100 m
		# Porpoise	<1	<1

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project piling activities would lead to a reduction in the viability of harbour porpoise populations designated at this site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with auditory injury from pile driving**.

Other Construction Activities

A simple assessment of the noise impacts from non-piling noise is presented in Volume X3 Technical Appendix 12.2: Underwater Noise and Vibration. The expected or potential noise sources at the Proposed Development, considered in this assessment as other construction activities are:

- Vessel movements – large and medium vessels;
- Seabed preparation – 2 types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles.

The Environmental Statement (ES) concluded that the impact of non-piling construction noise under the maximum design scenario is not considered to have a significant effect on any marine mammal species considered in this assessment. Using the non-impulsive weighted SEL_{cum} PTS-onset

thresholds for stationary receptors from Southall *et al.* (2019) resulted in estimated PTS impact ranges that were variable between non-piling construction activities (Table 8.6). PTS impact ranges were from <10 m-820 m for VHF cetaceans (i.e. harbour porpoise). These noise sources will have a local spatial extent, short-term duration and are intermittent; meaning that, with the most precautionary estimates, a marine mammal would have to remain within close proximity (<820 m) for a 24-hour period for PTS-onset to occur. This is an extremely unlikely scenario, as it is far more likely that any marine mammal within the injury zone would move away from the vicinity of the vessel and the construction activity.

As a worst-case scenario, based on rock placement and the presence of 2 large vessels, the maximum area for potential risk of auditory injury in harbour porpoise, without any mitigation, is 175.68 km^2, which could affect up to 70 individuals (0.112% for the relevant MU reference population). This area represents up to 3.02% of the West Wales Marine SAC.

There is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project construction activities would negatively impact conservation objectives for the West Wales Marine SAC site. The spatial area at risk is very low and the percentage of the MU reference population that may be affected is small. As such, it is considered highly unlikely that this would lead to a reduction in the viability of harbour porpoise populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with auditory injury from other construction activities**.

Table 8.6: Summary of the source level (SEL_{cum} dB re 1 µPa @ 1 m RMS) and PTS-onset impact ranges (m) for the different construction noise sources using the non-impulsive criteria from Southall *et al.* (2019) for marine mammals assuming a stationary receptor or a fleeing receptor

Noise source	Source Level	PTS Stationary Receptor (m)	PTS Fleeing Receptor (m)
Vessel movement (large)	168	<10	<10
Vessel movement (medium)	161	<10	<10
Backhoe dredging	165	<10	<10
Suction dredging	186	400	<10
Cable laying	171	40	<10
Trenching	172	40	<10
Rock placement	172	530	<10
Drag embedment anchors	171	70	<10
Suction pile installation	192	820	<10
Drilling	170.1	<10	<10

Potential for Disturbance from Underwater Noise

Construction Phase

UXO Clearance

As outlined above, the Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an EDR of 5 km (based on a worst-case scenario 2 kg detonation) is applied when considering the potential for disturbance from an individual UXO clearance, with 1 detonation anticipated during the construction period. Recent UXO clearance licence applications have assumed an effective deterrence range of 5 km around the source location to determine the impact area from low-order UXO clearance (e.g. GoBe 2021). In the absence of agreed metrics and given a lack of empirical data on the likelihood of response to low-order detonations, this 5 km radius (area of 78.5 km^2) has been applied for all species. Since the array area boundary is approximately 11.1 km from the West Wales Marine SAC, any UXO detonation would not overlap spatially with the SAC, however due to the mobility of harbour porpoise there is the potential for harbour porpoise features of the West Wales Marine SAC to be present within the Project area and to also be impacted by UXO clearance activities should they occur in this area.

An EDR of 5 km would contribute to a total of 0.09% of the total West Wales Marine SAC (7,376 km^2) and therefore displacement of harbour porpoise would not exceed 20% of the relevant area at any one time during UXO clearance at the Project. Assuming an EDR of 5 km (impact area of 78.5 km^2) the assessment indicates that 31 harbour porpoise (78.5*0.4 density, or 0.050% of the Celtic and North Seas MU reference population) could be temporarily disturbed during any low-order UXO clearance in the offshore site, based on the worst-case scenario (Table 8.7).

Under the assumption that a high-order detonation has a 26 km EDR (JNCC, 2020), the number of individuals impacted is predicted to be approximately 849 harbour porpoise, which represents 1.36% of the MU. This is considered to be an absolute worst-case, is highly precautionary and is not expected to occur in practice. The potential for impact is further reduced as the array area is located 11.1 km from the West Wales Marine SAC, and therefore spatial overlap between the SAC and the total area of impact (2,123.7 km^2, assuming an EDR of 26 km) is further reduced.

It is noted by JNCC *et al.* (2020) guidance that "*…a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement…*". Therefore, it is not expected that disturbance from a single high-order UXO detonation would result in any significant impacts, and that disturbance from a single noise event would not be sufficient to result in any changes to the vital rates of individuals.

Therefore, given the low proportion of the MU predicted to be impacted, and the very short-term duration of the impact (1 clearance event on a single day), the magnitude of impact is assessed as a low, where short-term and/or intermittent and temporary behavioural effects are expected in a

small proportion of the population, any impact to vital rates of individuals may occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

Table 8.7: Estimated area of West Wales Marine SAC that harbour porpoise could potentially be disturbed from during UXO clearance

UXO Scenario	Density (#km^2)	Area (km^2) % Area of SAC	#Disturbed	MU	% MU Disturbed
Low-order	0.4	78.5 0% (no overlap)	31	62,517	0.050%
High-order	0.4	2,123.7 3.8% (283 km^2 overlap)	849		1.36%

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project UXO clearance activities would lead to a significant level of disturbance to harbour porpoise populations designated at this site. Disturbance effects are not expected to extend to the SAC site, avoiding risk of exceeding the 10% and 20% disturbance thresholds detailed in Section 8.5.1.1. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with disturbance from UXO clearance**.

Pile Driving

The ES predicted that, in the worst-case scenario (800 kJ at WTG10 (E)), 1,967 harbour porpoise may experience disturbance from impact piling, equating to 3.15% of the MU reference population. Using the maximum most likely scenario (600 kJ at WTG10 (E)), this is reduced to 1,706 animals, at 2.73% of the MU reference population.

In order to assess the extent of the disturbance effect on the SAC, the 5 dB SEL_{ss} noise contours were used, alongside the dose-response curve to estimate the area of the SAC that would be impacted. The total area of West Wales SAC impacted, according to dose response calculations is 469.55 km², which corresponds with 6.37% of the total SAC extent (Table 8.8; Table 8.9; Figure 8.1).

Table 8.8: Interaction between 5 dB SEL_{ss} noise contours and West Wales Marine SAC; dose-response curve values provided to allow determination of area of the SAC impacted

Impact contour SELss	Area overlap with SAC (km^2)	Dose Response	Area of SAC impacted (km^2)
180+	0	0.9994	0
175<180	0	0.9973	0
170<175	0	0.9898	0
165<170	0	0.9685	0
160<165	0	0.9192	0
155<160	4.59	0.8266	3.79
150<155	156.11	0.6849	106.92
145<150	313.58	0.5090	159.61
140<145	405.66	0.3312	134.35
135<140	266.69	0.1852	49.39
130<135	133.10	0.0878	11.69
125<130	89.01	0.0349	3.11
120<125	59.25	0.0115	0.68
Total	**1,427.99**		**469.55**

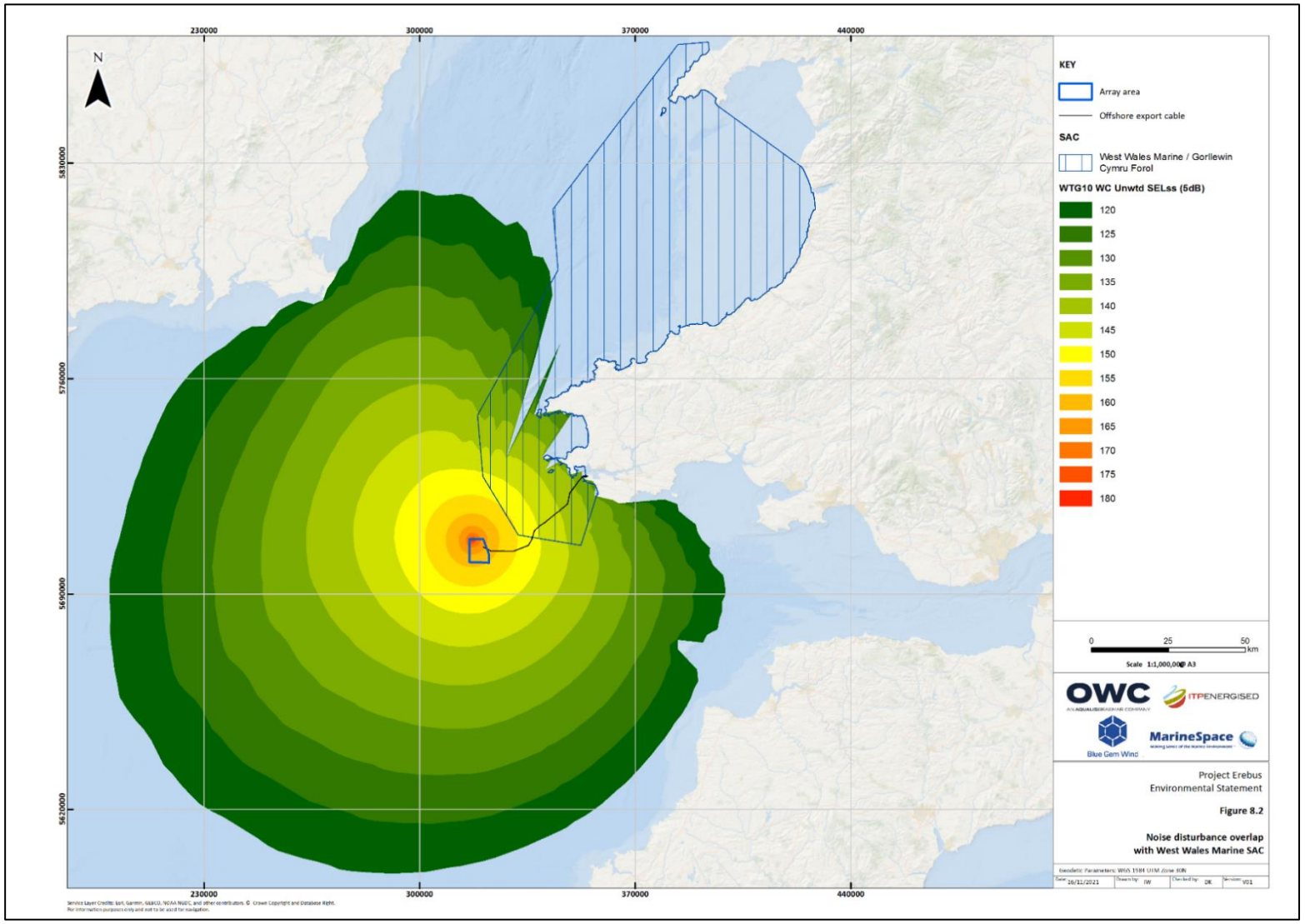
With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project pile driving activities would lead to a significant level of disturbance to harbour porpoise populations designated at this site. The extent of disturbance from piling activities remains below the 10% and 20% disturbance thresholds detailed in Section 8.5.1.1. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with disturbance from pile driving**.

Table 8.9: Disturbance impact for impact piling using the dose-response approach

Species	Worst-case (800 kJ)		Most likely (600 kJ)	
	WTG01 (NW)	WTG10 (E)	WTG01 (NW)	WTG10 (E)
Harbour porpoise	1,879	1,967	1,628	1,706
MU: 62,517	3.00%	3.15%	2.60%	2.73%

Figure 8.1: Overlap between 5 dB SELss noise contours and the West Wales Marine SAC

Spatial area of overlap detailed in Table 8.2



Other Construction Activities

A simple assessment of the noise impacts from non-piling noise is presented in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration. The expected or potential noise sources at the Project, considered in this assessment as other construction activities are:

- Vessel movements – large and medium vessels;
- Seabed preparation - two types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles.

The ES concluded that the predicted level of disturbance from other construction activity (dredging, cable laying, rock placement, drag embedment anchors, suction pile anchors, drilling and sheet piling) was negligible to minor (adverse) significance, which is not significant in terms of the EIA regulations.

Table 8.10 shows that suction dredging, cable laying, trenching and drilling activities will elicit the highest levels of disturbance for harbour porpoise. However, disturbance from these activities will only affect 31 individuals, which relates to 0.05% of the MU reference population.

There is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project construction activities would negatively impact conservation objectives for the West Wales Marine SAC site. The spatial area at risk is very low and the percentage of the MU reference population that may be affected is small. As such, it is considered highly unlikely that this would lead to a significant level of disturbance to the harbour porpoise populations designated at this site. Disturbance effects are not expected to extend to the SAC site, avoiding risk of exceeding the 10% and 20% disturbance thresholds detailed in Section 8.5.1.1. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with disturbance from other construction activities**.

Table 8.10: Potential disturbance to harbour porpoise associated with other construction activities at Project Erebus

Potential Effect	Suction Dredging	Cable Laying	Trenching	Rock Placement	Drag embedment anchors	Suction pile installations	Drilling
Maximum area of disturbance for harbour porpoise	5 km range; 78.5 km².	5 km range; 78.5 km².	5 km range; 78.5 km².	100 m range; 0.03 km².	200 m range (based on vessel disturbance); 0.13 km².	500 m range; 0.79 km².	5 km range; 78.5 km².
Maximum number of harbour porpoise and % of MU and SACs	31 individuals. 0.05% of the MU reference population. 1.06% of the SAC area.	31 individuals. 0.05% of the MU reference population. 1.06% of the SAC area.	31 individuals. 0.05% of the MU reference population. 1.06% of the SAC area.	<1 individual. <0.002% of the MU reference population. 0.001% of the SAC area.	20 individuals. 0.032% of the MU reference population. 0.68% of the SAC area.	<1 individual. <0.002% of the MU reference population. 0.007% of the SAC area.	31 individuals. 0.05% of the MU reference population. 1.06% of the SAC area.

Operational Phase

Vessel Traffic

It is anticipated there will be 2 crew transfer vessels on site per day (one per 12-hour period) conducting round trips throughout the operational lifetime, so this will not result in a significant increase in vessel traffic in the area.

Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 80 per day (within a 5 km^2 area). It is not anticipated that vessel traffic in the offshore site, will exceed this figure, even considering the addition of Project O&M traffic, which will be less than during the construction phase.

The worst-case scenario, based on disturbance of all harbour porpoise within the Project array area and ECC (63.82 km^2), would be associated with disturbance effects, which could impact 26 individuals, equating to 0.042% of the MU reference population.

With respect to the conservation objectives of the West Wales Marine SAC, disturbance associated with operational vessel traffic will be low and will present no risk of significant disturbance to harbour porpoise populations designated at this site. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with disturbance from vessel traffic**.

Disturbance Effects from Presence of Operating Turbines and Associated Infrastructure

Operational WTGs will produce underwater noise as a result of vibration from the rotating machinery in the turbines. This will be emitted into the marine environment through the floating structure and mooring infrastructure. However, acoustic emissions from floating WTGs will be lower than that of traditional fixed bottom WTGs, due to the absence of pile structures.

In a review of post-construction monitoring at offshore wind developments, both within the UK and abroad, the MMO (2014) reported that acoustic emissions from operational offshore windfarms (OWFs) were low, and that any behavioural effects or potential impacts would be limited to the immediate vicinity of the turbine structure. Noise emissions from operating wind turbines are of low frequencies and low intensity (Nedwell *et al.*, 2007) and are likely to be inaudible to marine mammals over distances greater than tens of metres, as the acoustic fovea of these animals is within the higher frequencies. The conclusion that operational OWF structures cause minimal disturbance on marine mammal receptors is supported by various publications reporting the regular presence of harbour porpoise within operational OWFs (see Scheidat *et al.* (2011) and review by Diederichs *et al.* (2008)).

With regards to the conservation objectives of the West Wales Marine SAC, it is considered that any disturbance would be minor and highly localised, and would not cause significant disturbance to the designated population. It is considered that there is no risk of injury for operational noise and, as such, no potential for adverse effects to population viability.

It is therefore concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC**

from any pressures associated with disturbance from presence of operating turbines and associated infrastructure.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressure during the decommissioning phase**.

Collision Risk

Construction Phase

As outlined in previous sections, during the construction of the Project, there will be an increase in vessel traffic, within the offshore site and the wider region. This increased vessel presence, and movements associated with the construction of the Project, could have the potential to increase the collision risk with harbour porpoise using the site. Collision with a boat or ship may result in physical trauma injuries such as blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision of marine mammals with vessels would be directly influenced by the type of vessel and the speed at which it is travelling (Laist *et al.,* 2001). It is also indirectly influenced by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

It is anticipated that there will be a maximum of 4 vessels for semi-submersible floating platform on site at any one time for 60 days, and that vessel movements for cable installation will occur on 228 days of the 8 month construction period. In addition, vessels will follow established shipping routes, where possible, when transiting between the Project and other ports to minimise vessel traffic.

Harbour porpoises are relatively small and highly mobile, and given observed behavioural responses to noise, are expected to detect vessels in close proximity and largely avoid collision. Predictability of vessel movement is known to be a key aspect in minimising the potential risks imposed by vessel traffic to marine mammals (Nowacek *et al.* 2001, Lusseau 2003, 2006).

Furthermore, the UK Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. The CSIP data show that very few strandings have been attributed to vessel collisions[21], therefore, while there is evidence that mortality from vessel collisions can and does occur, data from post-mortem examinations do not suggest it is a key source of mortality.

The Project has committed to the implementation of a Vessel Management Plan (VMP) which adopts best practice vessel handling protocols in order to reduce the risk of collision to negligible levels (e.g. following the Codes of Conduct provided by the WiSe Scheme, the Scottish Marine Wildlife Watching Code, or the Guide to best practice for watching marine wildlife). In addition,

[21] (CSIP, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

vessels will follow established shipping routes where possible when transiting between the Project and other ports to minimise vessel traffic.

Consequently, it is not expected that the level of vessel activity during construction would cause a perceptible increase in the risk of mortality from collisions. In addition, the embedded mitigation of a vessel management plan will ensure that vessel traffic follow predictable routes and will define how vessels should behave in the presence of marine mammals.

With respect to the conservation objectives of the West Wales Marine SAC, considering the very low percentage of the MU reference population potentially at increased risk of collision, and in view of the mitigation measures outlined above there is no indication that any increase in collision risk would impact the viability of designated harbour porpoise populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with subsea collision during the construction phase**.

Operational Phase

Chapter 12: Marine Mammals concluded it is not expected that the low level of vessel activity required during the O&M phase would cause any increase in the risk of collision mortality. The adoption of a vessel management plan during operations will further minimise the potential for any adverse effect.

In response to the Project HRA Screening Report, NRW advised that assessment of collision risk should include consideration of potential for collision with Project infrastructure (NRW, 2021c). There is no information available on the potential for marine mammals to collide with floating WTG sub-structures; however, given the relative spatial scale of devices, the low number of devices at the array area, the water depth and the size of marine mammals, it is expected that the risk of collisions would be negligible. In addition, turbine sub-structures remain relatively stationary, and it is therefore expected that these could easily be avoided by marine mammals present in the area.

Garavelli (2020) suggests that the relative spatial scale of devices and their associated mooring lines, the water depth and the size of marine mammals indicates that the likelihood of encounter is low, given the very small cross section of the water column occupied by the subsea mooring lines and cables. It is important to note that, while floating wind farms are relatively new in the offshore wind industry, the oil and gas industry has used offshore floating oil rig platforms for decades.

In view of this, it is considered there is negligible risk of collisions between marine mammals and floating wind structures. With respect to the conservation objectives of the West Wales Marine SAC, this does not constitute a risk to the viability of designated harbour porpoise populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with subsea collision during the O&M phase**.

Decommissioning Phase

During decommissioning, it is anticipated that there will be a similar number, or fewer, vessels on site than during construction. As such, this would not be expected to result in a significant increase in vessel traffic in the area. These vessels are also anticipated to be stationary or slow moving for significant periods of time during Project decommissioning operations. Therefore, as determined for construction activities, it is not expected that the level of vessel activity during decommissioning would cause an increase in the risk of mortality from collisions.

As determined for the construction phase, the level of vessel activity associated with decommissioning activities will not adversely affect the conservation objectives of the West Wales Marine SAC. The low associated risk of collision will not adversely affect viability of harbour porpoise populations designated at this site. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with subsea collision during the decommissioning phase**.

Entanglement

Construction Phase

There is no pathway for entanglement pressures to occur during the construction phase.

Operational Phase

The mooring lines, inter-array and export cables present in the water column during the operational phase of the Project may represent an entanglement risk for marine mammals. Entanglement is defined as the unintentional capture/restraint of marine animals by strong, flexible, anthropogenic materials such as stationary ropes, lines, cables and other mainly linear structures, including lines associated with fishing gears (Benjamins *et al.*, 2014).

Typically, smaller cetaceans such as dolphins and porpoises are not as likely to become entangled in subsea structures, with these species being typically more vulnerable to bycatch (Benjamins *et al.*, 2014).

There is nothing in the existing literature to suggest that entanglement of marine mammals in catenary or tensioned mooring lines is likely to pose a significant risk, however Garavelli (2020) suggests that the relative spatial scale of devices and their associated mooring lines, the water depth, and the size of marine mammals, indicates that the likelihood of encounter is low because the subsea structures (mooring lines and cables) occupy a very small cross section of the water column. It is important to note that, while floating wind farms are relatively new in the offshore wind industry, the oil and gas industry has used offshore floating oil rig platforms for decades. The impact of entanglement with floating oil rigs is considered to be negligible (Morandi *et al.*, 2018) and, thus, a similar level of risk can be expected from floating wind structures.

The mooring lines and array cables will be under tension, and thus there is no pathway under which a marine mammal could become entangled directly in the mooring lines or array cables. Likewise, the offshore export cable will be buried or protected if surface lain, and thus there is no pathway under which a marine mammal could become entangled directly in the offshore export cable. There

is, however, the potential for entanglement if derelict gear/marine litter attaches to mooring lines and cables.

The Applicant will consider the option for monitoring and reporting on this impact pathway as part of the Project MMMP, a draft/outline of which has been produced and included as part of the application submission. Should monitoring suggest that the likelihood of this impact occurring is higher than expected, contingency measures will be put in place. The exact measures within the contingency plan are yet to be determined, and consultation and agreement with stakeholders will be sought. Measures could, for example, involve more regular monitoring of lines and cables to remove snagged gear/marine litter as quickly as possible to minimise the chance of entanglement.

Therefore, in light of the existing literature suggesting that entanglement will not pose a significant risk to marine mammals and mitigation in the form of monitoring and reporting as part of the MMMP it is concluded that the potential for entanglement will not prevent the conservation objectives for this site from being obtained. The low associated risk of adverse effects will not lead to a reduction in the viability of harbour porpoise populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. It is therefore concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with entanglement**.

Decommissioning Phase

There is no pathway for entanglement pressures to occur during the decommissioning phase.

Barrier Effects

Construction Phase

Underwater noise during construction could have the potential to create a barrier effect to harbour porpoise, preventing movement or migration between important foraging and/or breeding areas resulting in avoidance of the offshore site.

The worst-case scenario in relation to barrier effects as a result of underwater noise is based on the maximum spatial scenarios. This assumes the maximum potential disturbance there could be at any one time. This is assessed for the maximum area of potential disturbance for underwater water noise from any construction activities, maintenance and repowering activities and vessels, based on the worst-case scenarios and maximum potential ranges for:

- UXO detonation;
- Vessel movements – large and medium vessels;
- Seabed preparation - two types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles (Table 8.10).

As a worst-case scenario, up to 1,967 individuals could be experience behavioural disturbance as a result of pile driving (3.15% of the MU reference population) (Table 8.10) during the construction phase. At any one time the maximum area of potential disturbance and any barrier effects from underwater noise could be up to 0.6% of the West Wales Marine SAC area. This is however highly precautionary as the assessment assumes construction activities will all be occurring concurrently which, in reality, will not be the case.

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential barrier effects would be of sufficient magnitude as to lead to a reduction in the viability of harbour porpoise populations designated at this site, or to constitute significant disturbance, in accordance with the thresholds set out in Section 8.5.1.1. The spatial extent of any barrier will be very small and the percentage of the MU reference population that may be affected is low. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with barrier effects during construction**.

Operational Phase

During the operational phase of the Project the presence of the floating WTGs and substructures has the potential to result in barrier effects for marine mammals.

A number of recent studies have reported the presence of marine mammals within wind farm footprints. For example, at the Horns Rev and Nysted offshore wind farms in Denmark, long-term monitoring showed that both harbour porpoise and harbour seals were sighted regularly within the operational OWFs, and within 2 years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.*, 2008). Similarly, a monitoring programme at the Egmond aan Zee OWF in the Netherlands reported that significantly more porpoise activity was recorded within the OWF, compared with the reference area during the operational phase (Scheidat *et al.*, 2011) indicating the presence of the windfarm was not adversely affecting harbour porpoise presence. Other studies at Dutch and Danish OWFs (Lindeboom *et al.*, 2011) also suggest that harbour porpoise may be attracted to increased foraging opportunities within operating offshore wind farms.

There is no information available on the potential for floating WTG sub-structures to result in barrier effects for marine mammals. However, given the relative spatial scale of devices, the low number of devices at the array area, the water depth, and the size of marine mammals, it is expected that marine mammals would be unlikely to perceive the sub-structures at the array area as a barrier to movement.

The estimated maximum area taken up by the project array, is up to 43.5 km^2.The number of harbour porpoise that could be at risk of potential barrier effects based on the maximum area of 43.5 km^2 is 17 individuals (0.027% of the MU reference population). At any one time, the maximum area of potential disturbance as a result of potential physical barrier effects could be up to 0.59% of the West Wales Marine SAC area.

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the predicted barrier effects would be of sufficient magnitude as to lead to a reduction in the viability of harbour porpoise populations designated at this site, or to constitute significant disturbance, in accordance with the thresholds set out in Section 8.5.1.1. The spatial extent of any barrier will be very small and the percentage of the MU reference population that may be affected is low. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with barrier effects during the O&M phase**.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with the construction phase. As such, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with barrier effects during the decommissioning phase**.

Potential Effects on Prey Resources

Construction Phase

Given that harbour porpoise are dependent on fish prey, there is the potential for indirect pressures on harbour porpoise as a result of impacts upon fish species or the habitats that support them.

During construction activities, there is the potential for disturbance to both herring and sandeels, both of which have had potential spawning grounds identified within the Project Study Area and are considered a key prey species for harbour porpoise (Santos *et al.*, 2004; Hernadez-Milian, 2011; Berrow and Rogan, 1995). The spawning grounds of both of these species are highly sensitive to disturbance, however, Chapter 10: Fish and Shellfish concluded that there was no significant predicted impact from construction activities, since the footprint of construction was unlikely to result in a significant change to overall stock abundance of these species. Furthermore, while there may be certain species that comprise the main part of their diet, harbour porpoise are considered to be generalist feeders and are, thus, not reliant on a single prey species.

As outlined in Chapter 10: Fish and Shellfish, the worst-case scenario for temporary habitat loss during construction could be up to 1.35 km^2. As a worst-case scenario, up to 2 individuals could be temporarily affected (0.003% of the MU reference population) (Table 8.11). At any one time the maximum area of potential displacement of harbour porpoise as a result of changes in prey availability and temporary habitat loss could be up to 0.0007% of the West Wales Marine SAC area.

As outlined in Chapter 10: Fish and Shellfish, the worst-case scenario for long-term habitat loss as a result of project infrastructure could be up to 0.16 km^2. As a worst-case scenario, up to 0.64 individuals could be affected (0.002% of the MU reference population) (Table 8.11).

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential pressures on prey availability will be of sufficient magnitude as to affect harbour

porpoise activity/metabolic rate. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with construction phase effects on prey resources**.

Table 8.11: Summary of the maximum areas of displacement of harbour porpoise due to pressures on prey resources resulting from temporary and long-term habitat loss

Effect	Temporary habitat loss during construction	Long-term habitat loss
Maximum area of displacement for harbour porpoise	4.04 km^2.	1.68 km^2.
Maximum number of individuals and % of MU	1.54 individuals. 0.00003% of the MU reference population.	0.64 individuals. 0.00001% of the MU reference population.
Area of West Wales Marine/Gorllewin Cymru Forol SAC	0.0007% of 5,850 km^2 SAC Area.	0.0003% of 5,850 km^2 SAC Area.

Operational Phase

During O&M activities, there is the potential for loss of existing habitat which currently provides foraging/spawning/nursery habitat for fish species. However, Chapter 10: Fish and Shellfish Ecology concluded that there are no significant impacts to fish species predicted during O&M.

With respect to the conservation objectives of the West Wales Marine SAC, any potential pressures on prey availability during the operational phase will be of lower magnitude than during construction. As such, the potential indirect pressures on harbour porpoise through reduction in resource availability will be negligible. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with O&M phase effects on prey resources**.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of**

the West Wales Marine SAC from any pressures associated with decommissioning phase effects on prey resources.

Accidental Pollution

The presence of numerous works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is the potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A Marine Pollution Contingency Plan (MPCP) will be produced and agreed with stakeholders, post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity in combination with its physical environment. The strong hydrodynamic regime across the Study Area, means that, should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential impact on the marine environment. In consideration of the standard mitigation and adoption of best practice, it is expected that if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to designated harbour porpoise.

During all phases of the construction, O&M, and decommissioning there is a risk of accidental pollution events. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the viability of harbour porpoise as a component of the site or the condition of supporting habitats and processes, and the availability of prey. It is also considered that any pollution event that did occur would be rapidly contained, avoiding physical, biological, and chemical structure and functions necessary for long-term habitat quality, or would lead to degradation in the abundance or condition of typical species. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with decommissioning phase effects on prey resources**.

8.5.1.5. Assessment of Adverse Effects In-combination

The screening of potential in-combination pressures for marine mammals identified a number of plans and projects within the relevant harbour porpoise MU that were considered to have the potential to have ‘in-combination’ pressures for harbour porpoise with the Project (Table 8.12).

The plans and projects selected as relevant to the in-combination assessment of impacts to marine mammals are based on an initial screening exercise undertaken on a long list prepared for the ES cumulative effects assessment (see Chapter 30: Cumulative Effects Assessment and Volume 3, Technical Appendix 30.1: Cumuative Effects Assessment Zones of Influence and Long List]). Consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales has been given to select projects for a topic-specific short-list. For the potential pressures for marine mammals, projects were screened into the assessment based on the spatial extent of the relevant marine mammal reference population area (MU).

Table 8.12 details the potential for effects considered for the Project alone and identifies which are considered to have the potential to result in in-combination adverse effects on site integrity in relation to the conservation objectives for harbour porpoise.

A number of in-combination pressures have been identified to have the potential to adversely affect the integrity of SACs, in relation to the conservation objectives for harbour porpoise. These include:

- Underwater noise and disturbance;
- Collision risk;
- Effects to prey resources.

The long-list of projects was screened to remove the following:

- All projects that are located outside of the relevant species MU;
- All projects that are already operational/active as they are considered to be existing impacts included within the baseline (this includes all shipping ports, shipping routes and oil and gas pipelines);
- All projects where there is no expected temporal overlap with construction of the Project;
- All projects where the timing of construction activities is unknown.

The offshore plans or projects considered included:

- Marine renewables (wind, wave and tidal);
- Port and harbour developments;
- Marine aggregate extraction and dredging;
- Licensed disposal sites;
- Oil and gas exploration and extraction;
- Subsea cables and pipelines.

The assessment is based on the in-combination pressures of projects using the tiered approach as described in Table 8.13**.** The tiered approach is based on guidance from JNCC and NE (2013) and PINS (2019) Advice Note 17. The tiers reflect the likely degree of certainty and level of information associated with each development.

Table 8.12: Assessment of potential for pressure pathways to result in in-combination adverse effects

Potential Effect	Project Phase	Inclusion in In-combination Assessment?
Potential effects resulting from auditory injury caused by underwater noise.	Construction.	Any risk of potential auditory injury as a result of underwater noise would be mitigated through the MMMP, as outlined in Section 8.5.1.4, therefore there would be no potential for any in-combination effects, and this is not included in in-combination assessment.
	Operational.	
	Decommissioning.	
Potential for disturbance from underwater noise.	Construction.	Potential for in-combination effects.
	Operational.	Disturbance from underwater noise during the operational phase will be limited to acoustic disturbance from the associated increase in vessel activity. As stated in Section 8.5.1.4, any increase in vessel movements associated with operation and maintenance will be small in relation to regional background levels of vessel traffic. As such, it is considered there is negligible potential for in-combination effects, and this is not included in in-combination assessment.
	Decommissioning.	Decommissioning of Project infrastructure is scheduled for 2052. Given the high degree of uncertainty as to which other development activities will be taking place at this time, it is not considered feasible to carry out an in-combination assessment of disturbance from underwater noise.
Collision risk.	Construction.	Potential for in-combination effects.
	Operational.	As stated in Section 8.5.1.4, any increase in vessel movements during the operation and maintenance is determined to be lower than that of the construction

Potential Effect	Project Phase	Inclusion in In-combination Assessment?
		phase and relatively small in relation to regional background levels of vessel traffic. Therefore, it is considered there is no potential for in-combination effects, and this is not included in in-combination assessment.
	Decommissioning.	Decommissioning of Project infrastructure is scheduled for 2052. Given the high degree of uncertainty as to which other development activities will be taking place at this time, it is not considered feasible to carry out an in-combination assessment of collision risk from decommissioning vessel activity.
Entanglement.	Construction.	There is no existing literature to suggest that entanglement of marine mammals in catenary or tensioned mooring lines is likely to pose a significant risk, and there have been no recorded instances of entanglement with the mooring systems of renewable energy or floating oil platforms recorded to date. Therefore, taking into account the assessment of potential entanglement and the proposed ongoing monitoring and mitigation as part of the MMMP to reduce any risk, there is no potential for in-combination effects.
	Operational.	
	Decommissioning.	
Barrier effects.	Construction.	No effects pathway. It is determined that there is the no potential for in-combination barrier effects with other projects, based on the location and distances of the projects and the potential for overlap in construction timeframes.
	Operational.	
	Decommissioning.	

Potential Effect	Project Phase	Inclusion in In-combination Assessment?
Potential effects on prey resources.	Construction.	Potential for in-combination effects.
	Operational.	Potential effects on prey resources during the operational phase will be limited to temporary habitat disturbance. Given the diminutive extent of habitat disturbance relative to overall area of similar habitat available, and the rapid recovery expected following cessation of disturbance (see Chapter 9: Marine and Coastal Ecology) it is expected that any reduction will be negligible. Accordingly, it is considered there is no potential for in-combination effects, and this pathway is not included in in-combination assessment.
	Decommissioning.	Decommissioning of Project infrastructure is scheduled for 2052. Given the high degree of uncertainty as to which other development activities will be taking place at this time, it is not considered feasible to carry out an in-combination assessment of effects on prey-resource from decommissioning activity.
Accidental pollution.	Construction.	It is expected that the mitigation measures proposed will successfully mitigate the risk of accidental pollution, i.e. by reducing the risk that pollution events will occur, and through containment if any such event did occur. In view of this it is considered there is no potential for accidental pollution to impact on harbour porpoise species in and around the project area, therefore it is determined there is no risk of in-combination effects with other projects.

Potential Effect	Project Phase	Inclusion in In-combination Assessment?
	Operational.	As stated in Section 8.5.1.4 the level of vessel activity associated with operation and maintenance works will considerably lower than that of the construction phase and relatively small in relation to regional background levels of vessel traffic. It is considered that the risk of accidental pollution in this phase is negligible and there is no potential for in-combination effects; accordingly, this is not included in in-combination assessment.
	Decommissioning.	Decommissioning of Project infrastructure is scheduled for 2052. Given the high degree of uncertainty as to which other development activities will be taking place at this time, it is not considered feasible to carry out an in-combination assessment of accidental pollution effects from decommissioning activities.

Table 8.13: Tiers for projects considered in the in-combination assessment

Tier	Consenting/Construction Phase
Tier 1	Operational projects that were not operational when baseline data were collected (e.g. environmental characterisation surveys); Operational projects that could have any ongoing or residual impact.
Tier 2	Projects under construction.
Tier 3	Projects that have been consented, but construction has not yet commenced.
Tier 4	Projects that have an application submitted to the appropriate regulatory body that have not yet been consented; Projects that have been consented, construction has not yet commenced and there is the potential for changes in what was consented and timelines.
Tier 5	Projects that the regulatory body are expecting an application to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects).
Tier 6	Projects that have been identified in relevant strategic plans or programmes

Table 8.14 outlines the projects and plans considered in the in-combination assessment. This includes all projects that are located within the Celtic and Irish Sea MU for harbour porpoise and are scheduled to conduct offshore construction activities before, or at the same time, as the Project.

Table 8.14: Projects screened into the in-combination assessment for harbour porpoise

Blue shading denotes the offshore construction windows

Project	Offshore Construction Starts	Full Commissioning	2021				2022				2023				2024				2025				2026			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus	Q2 2026	Q4 2026																								
Codling (Relevant Project)	01-Sep-24	01-Jan-27																								
Oriel (Relevant Project)	01-Jan-23	01-Jan-25																								
Dublin Array (Relevant Project)	01-Jun-25	01-Jan-27																								
TwinHub	02-Jul-10	01-Jan-26																								
Holyhead Deep (Minesto)	2022	2022																								
Greenlink Interconnector	2024	2024																								
META – East Pickard Bay (Bombora)	Q2 2022	Q3 2023																								
Atlantic Marine Energy Test Site	2021	2021																								

Underwater Noise and Disturbance

The assessment of underwater noise and disturbance in-combination pressures assumes the following:

- The Project – disturbance impact based on maximum numbers presented in this impact assessment (worst-case from pile driving);
- Other windfarms: Pinpile - assume construction related impacts are limited to a 15 km radius around the array area based on JNCC (2020);
- Other windfarms: Monopile - assume construction related impacts are limited to a 26 km radius around the array area based on JNCC (2020)[22];
- Other windfarms: Floating - assume no pile driving. Assume construction related impacts are limited to a 5 km radius (as discussed in Section 8.5.1.4);
- Other windfarms: Gravity base - assume no pile driving. Assume construction related impacts are limited to a 5 km radius;
- Wave/tidal projects - assume no pile driving. Assume construction related impacts are limited to a 5 km radius.

The in-combination assessment assumes offshore construction timeline at the offshore site to be:

- Offshore pre-construction surveys: 01-Apr-26 to 02-May-26;
- Floater and mooring installation: 01-Jun-26 to 30-Oct-26;
- Cable installation: Bulk of offshore cable installation activity anticipated May – Sept 2026.

Many of the offshore projects screened into the assessment for harbour porpoise (located within the Celtic and Irish Seas MU and constructing before or concurrently with the Project) are planned to conduct offshore construction work prior to the Project offshore construction window and, thus, the predicted impacts do not overlap (see Table 8.15). However, since they are planning offshore construction activities after the Project site-specific baseline surveys were completed, they are considered in this impact assessment. This means that the impact across these projects between 2021-2025 would occur irrespective of, and independent of, the Project.

Of the offshore projects screened into the in-combination assessment for harbour porpoise (Table 8.14), it is the projects that may include pile driving construction work (Codling, Oriel, Dublin Array and the Project) that have the highest level of predicted disturbance impact (Table 8.15). The maximum level of impact predicted to occur is when the Project, Codling and Dublin Array are all conducting pile diving at the same time, resulting in potential impacts to up to 6,215 porpoise per piling day, which equates to 9.9% of the MU reference population (though it is important to note that piling at the Proposed Development is restricted to 18 days within this period). A simulation

[22] Although it is acknowledged that NRW does not agree with the use of the 26 km threshold, this has been used in EIA of the majority of other UK offshore renewable developments. As such, this represents the best information available for the in-combination assessment.

modelling exercise carried out by Booth *et al.* (2017), using the interim Population Consequences of Disturbance (iPCoD) model framework to predict the long-term consequences of planned offshore wind developments in the eastern North Sea, concluded that, even with a total of 15% of the population being predicted to be disturbed over a period of 12 years, there was no evidence for any significant risk to the long-term health of the North Sea harbour porpoise population. Since the level of impact predicted here is less than that assumed in Booth *et al.* (2017), it is not expected that there would be any significant risk to the long-term population health. While this level of impact is predicted to result in temporary changes in behaviour and/or distribution of individuals at a scale that would result in potential reductions to lifetime reproductive success to some individuals, it is not expected to affect the population trajectory over a generational scale.

With respect to the conservation objectives of the West Wales Marine SAC, there is no indication that the potential levels of disturbance from underwater noise associated with Project and other in-combination developments would lead to a significant level of disturbance to harbour porpoise populations designated at this site. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is determined that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with disturbance from underwater noise**.

Table 8.15: In-combination assessment of disturbance to harbour porpoise feature of West Wales Marine/Gorllewin Cymru Forol SAC.

Values indicate the number of individual harbour porpoise impacted. Total values across all projects provided at foot of table, with totals also expressed as a proportion of the Celtic and Irish Sea Management Unit reference population

Project	2021				2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus																						1967	1967	1967
Codling (Relevant Project)															2124	2124	2124	2124	2124	2124	2124	2124	2124	2124
Oriel (Relevant Project)									2124	2124	2124	2124	2124	2124	2124	2124								
Dublin Array (Relevant Project)																		2124	2124	2124	2124	2124	2124	2124
TwinHub	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17				
Holyhead Deep (Minesto)					37	37	37	37																
Greenlink Interconnector													9	9	9	9								
META – East Pickard Bay (Bombora)						11	11	11	11	11	11													
Atlantic Marine Energy Test Site	27	27	27	27																				
Total Number Impacted	44	44	44	44	54	65	65	65	2152	2152	2152	2141	2150	2150	4274	4274	2141	4265	4265	4265	4248	6215	6215	6215
% of MU Ref. Pop.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	3.4	3.4	3.4	3.4	3.4	3.4	6.8	6.8	3.4	6.8	6.8	6.8	6.8	9.9	9.9	9.9

Note: to calculate the number of harbour porpoise disturbed by each project, the density estimate used were either: SCANS III Block D (0.118 porpoise/km^2), ObSERVE Stratum 1 (0.085 porpoise/km^2) or ObSERVE Stratum 5 (0.883 porpoise/km^2)

Collision Risk

Construction Phase

As outlined in Section 8.5.1.4, the increased vessel presence during the construction phase of offshore wind farm projects can pose the potential for increased collision risk with harbour porpoise.

The assessment assumes that during the construction of offshore windfarms, and other plans within the region, that vessel movements to and from any port will be restricted to existing vessel routes and, therefore, the increased risk for any vessel interaction is considered only within the offshore site. Harbour porpoise in the area would be accustomed to the presence of vessels and therefore be expected to be able to detect and avoid construction vessels.

The precautionary in-combination assessment has determined the number of harbour porpoise that could have a potential increased collision risk with vessels in offshore windfarm sites in the Management Unit during construction. Table 8.16 presents the interactions assessed.

With respect to the conservation objectives of the West Wales Marine SAC, considering the low percentage of the MU reference population potentially at increased risk of collision, and in view of the mitigation measures outlined above, there is no indication that any increase in collision risk would impact the viability of designated harbour porpoise populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the harbour porpoise feature. It can therefore be concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with subsea collision, in-combination**.

Table 8.16: In-combination assessment of increased collision for harbour porpoise feature of West Wales Marine/Gorllewin Cymru Forol SAC

Values indicate the number of individual harbour porpoise impacted. Total values across all projects provided at foot of table, with totals also expressed as a proportion of the Celtic and Irish Sea Management Unit reference population

Project	2021				2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus																						1	1	1
Codling (Relevant Project)															11	11	11	11	11	11	11	11	11	11
Oriel (Relevant Project)									2	2	2	2	2	2	2	2								
Dublin Array (Relevant Project)																		5	5	5	5	5	5	5
TwinHub	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				
Holyhead Deep (Minesto)					<1	<1	<1	<1																
Greenlink Interconnector													<1	<1	<1	<1								
META – East Pickard Bay (Bombora)						<1	<1	<1	<1	<1	<1													
Atlantic Marine Energy Test Site	<1	<1	<1	<1																				
Total Number Impacted	<1	<1	<1	<1	<1	<1	<1	<1	3	3	3	3	3	3	14	14	11	16	16	16	16	17	17	17
% of MU Ref. Pop.	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002	0.004	0.004	0.004	0.004	0.004	0.004	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3

Note: to calculate the number of harbour porpoise disturbed by each project, the density estimate used were either: SCANS III Block D (0.118 porpoise/km²), ObSERVE Stratum 1 (0.085 porpoise/km²) or ObSERVE Stratum 5 (0.883 porpoise/km²)

Effects on prey resources

Construction Phase

The in-combination assessment on potential changes to prey availability has assumed that any potential effects on harbour porpoise prey species from underwater noise, including piling, would be of similar magnitude to those for harbour porpoise. Therefore, there would be no additional effects, other than those already assessed for harbour porpoise. For example, the area in which prey are disturbed as a result of underwater noise will be the same or smaller than the area of disturbance for harbour porpoise, therefore any changes to prey availability would not affect harbour porpoise, as they would already be disturbed/displaced from the given area. Furthermore, pressures on prey species are likely to be intermittent, temporary and highly localised, and anticipated to recover quickly following cessation of the disturbance activity. Operations such as cable trenching will cause temporary habitat loss, and the combined effect of these changes, together with similar disturbance at other projects considered has potential to affect the SAC conservation objective of protecting the habitat and processes of porpoise and their prey. However, Chapter 9: Marine and Coastal Ecology assessed the potential pressures of benthic habitat disturbance and determined that any changes would be highly localised and temporary. It is expected that recovery would occur rapidly following completion of works. It is unlikely that disturbance at multiple projects would occur concurrently. However, to provide a worst-case assessment it must be assumed that this would occur. Although this would result in an increase in pressure magnitude, the reduction in prey availability would quickly return toward baseline levels following completion of works. Furthermore, the assumption that disturbances occur concurrently reduces potential for additional disturbance in the future. It is therefore considered that any increase in magnitude would be counter-balanced by a reduction in disturbance frequency. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential foraging habitat in the surrounding area.

Consequently, there is no indication that the potential effects on prey availability will be of sufficient magnitude as to affect harbour porpoise activity/metabolic rate. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the harbour porpoise feature. In view of these factors, it is concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with in-combination construction phase effects on prey resources**.

Operational and Decommissioning Phase

It is determined that the in-combination effect of any of the above pressures during the operational and decommissioning phases of the project would be no worse than the in-combination pressures assessed for the Project construction period. During times where there is limited or no construction in the region, impacts will be intermittent, temporary and highly localised to the source project. Consequently, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the harbour porpoise feature of the West Wales Marine SAC from any pressures associated with in-combination with operation or decommissioning phases effects on prey resources**.

8.5.1.6. Summary

There is **no potential for any adverse effects on the integrity of the West Wales Marine SAC from the Project alone or in-combination in relation to the conservation objectives for harbour porpoise**.

8.5.2. Cardigan Bay/Bae Ceredigion Special Area of Conservation

The Cardigan Bay/Bae Ceredigion SAC (hereto referred as Cardigan Bay SAC) is a 958.6 km^2 site designated in 2004. The SAC, located on the north coast of Pembrokeshire and the Cardiganshire coast, encompasses a range of marine and coastal habitats. It spans from Molygrove in the southwest to Aberarth in the northeast, stretching to approximately 20 km offshore.

The SAC is a multiple feature site which has been selected for the presence of several interest features that qualify under Annex I and Annex II of the Habitats Directive, namely:

- Bottlenose dolphin *Tursiops truncatus*;
- Reefs;
- Submerged or partially submerged sea caves;
- Sandbanks which are slightly covered by seawater all the time;
- Grey seal *Halichoerus grypus*;
- River lamprey *Lampetra fluviatilis*;
- Sea lamprey *Petromyzon marinus*.

The above features are distributed throughout the SAC with no single feature occupying the entire SAC and with features overlapping in some locations (NRW, 2018d).

8.5.2.1. Conservation Objectives

NRW (2018d) outline the conservation objectives for the SAC, some of which are specific to the bottlenose dolphin feature:

With reference to populations: "*The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements include:*

- *population size*
- *structure, production*
- *condition of the species within the site.*

*As part of this objective it should be noted that for **bottlenose dolphin** and **grey seal**;*

- *Contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression*".

With reference to range: "*The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.*

*As part of this objective it should be noted that for **bottlenose dolphin** and **grey seal**:*

- *Their range within the SAC and adjacent inter-connected areas is not constrained or hindered*

- *There are appropriate and sufficient food resources within the SAC and beyond*
- *The sites and amount of supporting habitat used by these species [grey seals] are accessible and their extent and quantity is stable or increasing".*

With reference to supporting habitat and species: "*The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include;*

- *distribution*
- *extent*
- *structure*
- *function and quality of habitat*
- *prey availability and quality.*

As part of this objective it should be noted that;

- *The abundance of prey species subject to existing commercial fisheries needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term.*
- *The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term.*
- *Contamination of potential prey species should be below concentrations potentially harmful to their physiological health.*
- *Disturbance by human activity is below levels that suppress reproductive success, physiological health or long-term behaviour*".

And with reference to restoration and recovery: "*As part of this conservation objective it should be noted that for the **bottlenose dolphin** populations should be increasing*".

Qualifying features of the SAC include 3 Annex I marine habitats and 4 Annex II marine and migratory fish species. Assessed in this section is the bottlenose dolphin feature of the SAC.

8.5.2.2. Advice on Operations

NRW (2018d) identifies operations or activities where there exists the potential for an adverse effect on a feature or component of a feature. The advice states that the potential for, and magnitude of, any pressure will be dependent on many variables, such as the location, extent, scale, timing and duration of operations or activities, as well as proximity to features that are sensitive to one or more factors induced or altered by the operation (NRW, 2018d). A summary of operations and activities included in the advice and relevant to grey seal feature of the Cardigan Bay SAC are listed in Table 8.17.

Table 8.17: Operations which may cause deterioration or disturbance to the features of the Cardigan Bay SAC (Source: NRW, 2018d)

Activity	Relevant Factors	Most likely relevant components and effects	Advice as to likely required action
Shipping: vessel traffic (commercial) - widespread and common	Geophysical regime: • Vessel wash (substrate erosion, local modification of wave exposure regime). Fundamental environmental parameters: • Turbidity Physical disturbance: • Collision; • Noise; • Visual.	**Structure and function:** local effects to sediment habitat structure; noise/visual disturbance affecting mobile species particularly mammals; potential for collision with marine mammals; local modification of physical processes with elevated levels of suspended sediments effecting benthic flora, and smothering sessile benthic fauna; modification to biological processes including food availability; and changes to biological interactions due to modification of habitat and physical factors. **Conservation status of typical species and species features**: particularly affecting the diversity, health and extent of wave sheltered communities and the distribution of communities along physical gradients. Also an alteration/reduction in quality of communities/populations containing species sensitive to changes in turbidity, light, oxygen and smothering (particularly shallow subtidal algal and eelgrass communities, species-rich sediment infaunal communities, and sessile faunal turf communities). **Operation specific information required:** location, frequency and duration of operation; scale of effect of wash and water movement from vessel movement dependent on vessel size, activity, speed and proximity to sensitive (sheltered, intertidal and /or shallow subtidal) habitats/communities and species (seals); relevant location-specific biotic and abiotic information.	Continue to monitor shipping movement within port limits. Determine effects of vessel movement on sediment transport, mobilisation and turbidity. Review, revise or establish management practices and spatial, temporal and technical operational limits suitable to secure features at favourable conservation status (FCS); monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters to minimise risk to features FCS
Alternative energy production: wind - none at present.	Geophysical regime: • Modification of wave and tidal regimes;	**Extent and distribution:** potential habitat loss within footprint of generating structures. Structure and function: potentially highly variable dependent on nature, construction and scale of structures. Modification of	Treat as plan or project as appropriate.

Activity	Relevant Factors	Most likely relevant components and effects	Advice as to likely required action
	• Modification to substrate. Environmental quality: • Possible toxic and non-toxic contaminants. Physical disturbance: • General physical effects; • Possible collision.	sedimentology and sediment processes, hydrodynamic regime. **Conservation status of typical species and species features:** modification of species variety, and distribution; modification of species ranges (disturbance; artificial reef effects) **Operation specific information required:** type, construction and size; location and extent; timing and duration of installation; permanence; cabling requirements; maintenance requirements and frequency; relevant location-specific biotic and abiotic information	
Power/communication cables: Present	Geophysical regime: • Addition of artificial substrate; • Local modification of water movement. Physical disturbance: • Displacement; • Visual; • Noise. Potential electromagnetic effects of electrical cables.	**Structure and function:** dependent on depth of cable burial in seabed –modification of sediment transport processes and local hydrodynamic regime. Scour effect on benthic habitats from cables due to wave action. **Conservation status of typical species and species features:** dependent on depth of cable burial in seabed – localised modification of species composition, variety. Modification of behaviour caused by electro-magnetic effects. **Operation specific information required:** location, extent, scale, frequency, timing and duration; maintenance requirements and frequency; relevant location-specific biotic and abiotic information.	Treat as plan or project as appropriate, taking into account long term management requirements and likely effects.

8.5.2.3. Common Bottlenose Dolphin *Tursiops truncatus*

Feature Summary

Bottlenose dolphin are considered to primarily be an inshore species, with most reported sightings within 10 km of land (JNCC, 2021g). Some inshore bottlenose dolphins may move offshore during winter months. There are two main areas within the UK which support semi-resident groups of bottlenose dolphin: Cardigan Bay and the Moray Firth (JNCC, 2021g); however, smaller groups are also present away from these areas. In addition, certain groups of bottlenose dolphins are transient, ensuring that the species is widespread around the UK.

The closest SAC site to the Project designated for bottlenose dolphin is Cardigan Bay/Bae Ceredigion SAC, situated >85 km from the Project. The Cardigan Bay SAC bottlenose dolphin population has been estimated to consist of around 125 individuals, which appear to use the inshore waters of Cardigan Bay for feeding and reproduction (JNCC, 2021g). The site is 1 of only 2 sites in UK waters to hold substantial semi-resident populations. Dolphins are present within the site throughout the year, although individuals may range further afield during certain times of the year.

Bottlenose dolphin monitoring work was conducted by the Sea Watch Foundation between 2014 and 2016, on behalf of Natural Resources Wales. Monitoring was conducted due to a requirement to monitor and report on the condition of SAC features by providing information on distribution and abundance, population dynamics, life history parameters, and health of the species. Lohrengel *et al.* (2018) calculated abundance estimates based on distance sampling for Cardigan Bay SAC and produced the following:

- 64 individuals (CI = 19-220; CV = 0.65) in 2015;
- 84 (CI = 44-160; CV = 0.33) in 2016;
- For the wider Cardigan Bay, 277 (CI = 138-555; CV = 0.36) in 2015;
- And 289 (CI = 184-453; CV = 0.23) in 2016.

Trend analysis showed a significant decline in abundance for the period of 2001-2016 for Cardigan Bay SAC, however no significant decline was identified within recent years (2007-2016) (Lohrengel *et al.*, 2018).

Bottlenose dolphin do not form a discrete site-based population within the 2 SACs but are part of the wider Offshore Channel, Celtic Sea and SW England management unit. Dolphins associated with the Cardigan Bay SAC move into and through the Pen Llyn a'r Sarnau SAC (Feingold and Evans, 2013). Bottlenose dolphin have been observed within the Proposed Development (at densities of 0.063 animals per km^2) and, as the species is highly mobile, it is possible that animals from the two sites might be present during the planned Project-related activities.

Feature Condition

Although the extent and distribution, structure, and function of supporting habitats, and prey availability and quality are all unknown, the bottlenose dolphin population size and structure, and the species range within the SAC are both considered to be in favourable condition (NRW, 2018e). Therefore, the overall feature condition is **favourable**. Overall confidence in the assessment is considered to be medium.

8.5.2.4. Assessment of Adverse Effects Alone

The potential pressures during construction, operation and maintenance, and decommissioning for the Project include:

- Auditory injury caused by underwater noise (from UXO detonation, piling, drilling, construction activities or vessel movement);
- Underwater noise - disturbance/displacement;
- Collision risk (with construction, O&M or decommissioning vessels);
- Entanglement with mooring lines or ghost fishing gear;
- Barrier effects;
- Accidental pollution.

Potential Effects Resulting from Auditory Injury Caused by Underwater Noise

Construction Phase

UXO Clearance

The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. However, in line with the recommendations outlined within the recent position statement on UXO clearance, this impact assessment includes an assessment for high-order detonations, though this is considered unlikely to occur in practice.

Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an EDR of 5 km (based on a worst-case scenario 2 kg detonation) is applied when considering the potential for disturbance from an individual UXO clearance, with 1 detonation anticipated during the construction period. Since the Project array area and ECC are >49 km from the Cardigan Bay SAC, any UXO detonation would not overlap spatially with the SAC, however due to the mobility of bottlenose dolphin there is the potential for bottlenose dolphin features of the Cardigan Bay SAC to be present within the Project area.

The number of bottlenose dolphin that could potentially be affected, based on the maximum potential PTS-onset impact ranges from low-order UXO clearance are presented in Table 8.18. The assessment has been based on the worst-case scenarios for the unweighted SPL peak predicted PTS impact ranges (Table 8.18), in line with a precautionary approach. The PTS-onset impact ranges for low-order UXO detonations are negligible (Table 8.18), with the number of bottlenose dolphin expected to experience PTS-onset <1 for all charge sizes. It is highly unlikely that any individuals would be present within the maximum PTS-onset impact range.

As a realistic worst-case scenario, based on a 2 kg NEQ UXO detonation, the maximum area for potential risk of auditory injury in bottlenose dolphin, without any mitigation, is 0.038 km^2, which could affect up to <1 individual (0.009% of the MU reference population).

Table 8.18: PTS-onset impact ranges and number of bottlenose dolphin predicted to experience PTS-onset for low order UXO detonation

Threshold	Species	Metric	0.1 kg NEQ	0.25 kg NEQ	0.5 kg NEQ	2 kg NEQ
Unweighted SPL_{peak}						
230 dB (HF)	Bottlenose dolphin	Range km	0.04	0.06	0.07	0.11
		#	<1	<1	<1	<1
Weighted SEL_{ss}						
185 dB (HF)	Bottlenose dolphin	Range km	<0.01	<0.01	<0.01	<0.01
		#	<1	<1	<1	<1

In line with the recommendations outlined within the recent position statement on UXO clearance (Defra *et al.* 2021), this impact assessment includes an assessment for high-order detonations, though this is considered unlikely to occur in practice.

The site specific UXO Threat and Risk Assessment Report carried out for Erebus (6-Alpha Associates, 2020) concluded that the maximum realistic worst case charge weight that can be expected to be presented in the Erebus study area is 331 kg (ferrous mass).

For a UXO charge weight of 525 kg NEQ, the predicted PTS-onset impact range is 0.73 km for bottlenose dolphin, which equates to disturbance to <1 individual dolphin (Table 8.19), which is 0.009% of the MU. Given that the maximum expected UXO charge weight expected in the study area is only 331 kg, then the PTS-onset impact range for harbour porpoise would be between 0.56 km (for a 240 kg charge) and 0.73 km (for a 525 kg charge).

As stated in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report, there are considerable assumptions behind this calculation: "*assumes no degradation of the UXO and no smoothing of the pulse over that distance, which is very precautionary… it is likely that the long-range smoothing of the pulse peak would reduce its potential harm and the maximum 'impulsive' range for all species is very precautionary*".

Subacoustech therefore advises that "*it is likely that the long-range smoothing of the pulse peak would reduce its potential harm and the maximum 'impulsive' range for all species is very precautionary and unlikely in practice*". Given this, the impact range of up to 0.73 km for bottlenose dolphin is considered to be a precautionary estimate.

As an absolute worst-case scenario, based on a 525 kg NEQ UXO detonation, the maximum area for potential risk of auditory injury in bottlenose dolphin, without any mitigation, is 1.67 km^2, which could affect up to <1 individual (0.009% of the MU reference population).

Table 8.19: PTS-onset impact ranges and number of bottlenose dolphin predicted to experience PTS-onset for high order UXO detonation

Threshold	Species	Metric	25 kg	55 kg	120 kg	240 kg	525 kg
Unweighted SPL_{peak}							
230 dB (HF)	Bottlenose dolphin	Range km	0.26	0.34	0.45	0.56	0.73
		#	<1	<1	<1	<1	<1
Weighted SEL_{ss}							
185 dB (HF)	Bottlenose dolphin	Range km	0.01	0.02	0.03	0.04	0.05
		#	<1	<1	<1	<1	<1

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project UXO clearance would lead to a reduction in the long-term viability of bottlenose dolphin populations designated at this site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with auditory injury from UXO clearance**.

Pile Driving

Predictive underwater noise modelling was carried out to estimate the noise levels likely to arise during construction of the Project (Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration) and, hence, determine the potential effects on bottlenose dolphin.

Underwater noise modelling results indicated that the largest instantaneous PTS-onset impact range (unweighted SPL_{peak}) for impact piling is estimated at 50 m for bottlenose dolphin at both WTG locations selected for model analysis. In modelled scenarios, <1 animal was expected to be within its respective PTS-onset impact range (0.009% of the MU reference population). The estimated maximum number of bottlenose dolphin that could potentially be at risk of PTS from cumulative SEL is also <1.

PTS-onset impact range predictions assume that all animals within the PTS-onset range are impacted, which will overestimate the true number of impacted animals, as only 18-19% of the animals are predicted to actually experience PTS at the PTS-onset threshold level, meaning that the low numbers predicted are already highly conservative (see Chapter 12: Marine Mammals). In addition, the sound is modelled as being fully impulsive, irrespective of distance from the pile, which is highly precautionary and results in predictions that are unlikely to be realised. The Project will also

be adhering to a piling mitigation plan (see Volume 3, Technical Appendix 12.3: Draft MMMP) which will further reduce the risk of PTS to negligible levels.

Table 8.20: PTS-onset impact ranges for bottlenose dolphin from impact piling – worst-case (800 kJ)

Threshold	Species	Parameter	WTG01 (NW)	WTG10 (E)
Instantaneous PTS: Unweighted SPL_{peak}				
230 dB (HF)	Bottlenose dolphin	Area	< 0.01 km^2	< 0.01 km^2
		Max Range	< 50 m	< 50 m
		# Bottlenose dolphin	<1	<1
Cumulative PTS: Weighted SEL_{cum}				
185 dB (HF)	Bottlenose dolphin	Area	< 0.1 km^2	< 0.1 km^2
		Max Range	< 100 m	< 100 m
		# Bottlenose dolphin	<1	<1

The largest instantaneous TTS-onset impact range (unweighted SPL_{peak}) for impact piling is estimated at 50 m for bottlenose dolphin at both WTG locations selected for model analysis. The cumulative TTS-onset impact range was 100 m. In all modelled scenarios, <1 animal is expected to be within its respective TTS-onset impact range (Table 8.20), equating to (0.009% of MU).

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project piling activities would lead to a reduction in the long-term viability of bottlenose dolphin populations designated at this site. The spatial area at risk is very low and the percentage of the MU reference population that may be affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with auditory injury from pile driving.**

Other construction activities

A simple assessment of the noise impacts from non-piling noise is presented in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration. The expected or potential noise sources from Project activities considered in this assessment are:

- Vessel movements – large and medium vessels;
- Seabed preparation - two types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;

- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles.

Using the non-impulsive weighted SEL_{cum} PTS impact ranges, from <10 m to 50 m for HF cetaceans, suction pile installation had the largest estimated PTS impact range. These worst-case scenario PTS impact ranges are highly precautionary and likely to be an overestimation. These values are based on an assumption that animals would have to stay within these very small ranges for 24 hours before they experienced injury; this is an extremely unlikely scenario, and it is far more likely that any marine mammal within the injury zone would move away from the vicinity of the vessel and the construction activity. This resulted in PTS impact ranges of <10 m for HF cetaceans for all non-piling construction activity; a bottlenose dolphin would have to be within 10 m of the continuous noise source at the start of the activity to acquire the necessary exposure to induce PTS.

Chapter 12: Marine Mammals concluded that the impact of non-piling construction noise under the maximum design scenario would not have a significant effect on any marine mammal species. These noise sources will have a local spatial extent, short-term duration and are intermittent, meaning that, with the most precautionary estimates, a bottlenose dolphin would have to remain within close proximity (<10 m) for a 24-hour period for PTS-onset to occur (Table 8.21).

As a worst-case scenario, based on suction pile installation and 2 large vessels, the maximum area for potential risk of auditory injury in bottlenose dolphin, without any mitigation, is 70 km^2, which could affect up to 4 individuals (0.037% for the MU).

There is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project construction activities would negatively impact conservation objectives for the Cardigan Bay SAC site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. As such, it is considered highly unlikely that this would lead to a reduction in the long-term viability of bottlenose dolphin populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with auditory injury from other construction activities**.

Table 8.21: Summary of the source level (SEL_{cum} dB re 1 µPa @ 1 m RMS) and PTS-onset impact ranges (m) for the different construction noise sources using the non-impulsive criteria from Southall *et al.* (2019) for HF cetaceans (dolphins) assuming a stationary receptor (S)

Noise Source	Source Level	PTS S (m)
Vessel movement (large)	168	<10
Vessel movement (medium)	161	<10
Backhoe dredging	165	<10
Suction dredging	186	<10
Cable laying	171	<10
Trenching	172	<10
Rock placement	172	<10
Drag embedment anchors	171	<10
Suction pile installation	192	50
Drilling	170.1	<10

Potential Effects from Underwater Noise and Disturbance

Construction Phase

UXO Clearance

As outlined above, the Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. However, in line with the recommendations outlined within the recent position statement on UXO clearance (Defra *et al.*, 2021), this assessment also includes reference to high-order detonations, even though this is considered unlikely to occur in practice and is not part of the consent application.

Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an EDR of 5 km (based on a worst-case scenario 2 kg detonation) is applied when considering the potential for disturbance from an individual UXO clearance, with 1 detonation anticipated during the construction period. Recent UXO clearance licence applications have assumed an effective deterrence range of 5 km around the source location to determine the impact area from low-order UXO clearance (e.g. GoBe 2021). In the absence of agreed metrics, and given a lack of empirical data on the likelihood of response to low-order detonations, this 5 km radius (area of 78.5 km^2) has been applied for all species. Since the Project array area and ECC are >49 km from the Cardigan Bay SAC, any UXO detonation would not overlap spatially with the SAC, however due to the mobility of bottlenose dolphin there is the potential for populations designated for the Cardigan Bay SAC to be present within the Project area.

Assuming an EDR of 5 km, the assessment indicates that 5 bottlenose dolphin, equating to 0.05% or less of the MU reference population, could be temporarily disturbed during any UXO clearance in the offshore development area, based on the worst-case scenario (Table 8.22).

Under the assumption that a high-order detonation has a 26 km EDR (JNCC, 2020), the number of individuals impacted is predicted to be approximately 134 bottlenose dolphin, which represents 1.22% of the MU. This is considered to be an absolute worst-case and is highly precautionary.

It is noted by JNCC *et al.* (2020) guidance that "*…a one-off explosion would probably only elicit a startle response and would not cause widespread and prolonged displacement…*". Therefore, it is not expected that disturbance from a single high-order UXO detonation would result in any significant impacts, and that disturbance from a single noise event would not be sufficient to result in any changes to the vital rates of individuals.

Therefore, given the low proportion of the MU predicted to be impacted, and the very short-term duration of the impact (1 clearance event on a single day), the magnitude of impact is assessed as a low, where short-term and/or intermittent and temporary behavioural effects are expected in a small proportion of the population, any impact to vital rates of individuals may occur only in the short term (over a limited number of breeding cycles, <1 in this case) and where any changes to

individual vital rates are very unlikely to occur to the extent that the population trajectory would be altered.

Table 8.22: Estimated area of Cardigan Bay SAC that bottlenose dolphin could potentially be disturbed from during UXO clearance

UXO scenario	Density (#km^2)	Area (km^2) % Area of SAC	#Disturbed	MU	% MU Disturbed
Low-order	0.063	78.5 0% (no overlap)	5	10,947	0.05%
High-order	0.063	2,123.7 0% (no overlap)	134		1.22%

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project UXO clearance activities would lead to a level of disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour of bottlenose dolphin populations designated at this site. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with disturbance from UXO clearance**.

Pile Driving

Table 8.23 shows the dose response approach with the worst-case scenario (800 kJ at WTG10 (E)), showing 310 bottlenose dolphin may experience disturbance from impact piling, equating to 2.8% of the MU reference population. Using the maximum most likely scenario (600 kJ at WTG10 (E)), this is reduced to 269 animals at 2.5% of the MU reference population (Table 8.23).

In order to assess the extent of the disturbance effect on the SAC, the 5 dB SEL_{ss} noise contours were used, alongside the dose-response curve, to estimate the area of the SAC that would be impacted. The piling disturbance contours did not extend to the Cardigan Bay SAC area. As such, according to dose response calculations there will be no adverse effects from pile driving on the SAC area (Figure 8.2).

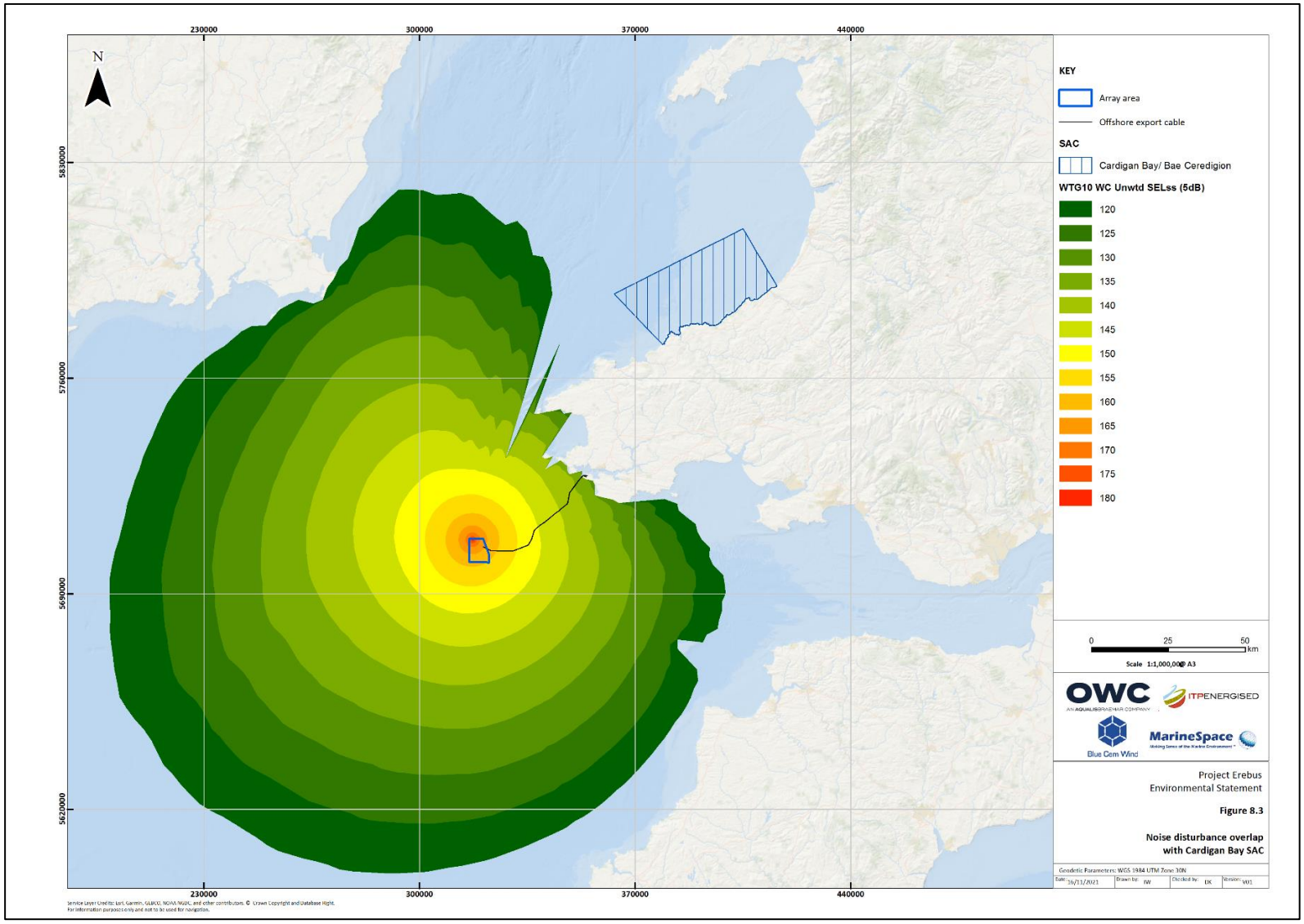
With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project pile driving activities would lead to a significant level of disturbance to bottlenose dolphin populations designated at this site. It is expected that any disturbance would not be sufficient to suppress reproductive success, physiological health or long-term behaviour of bottlenose dolphin populations. In addition, the spatial area at risk is very low and the percentage of the MU reference

population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with disturbance from pile driving**.

Table 8.23: Disturbance impact for impact piling using the dose-response approach

Species Population	Worst-case (800 kJ)		Most likely (600 kJ)	
	WTG01 (NW)	WTG10 (E)	WTG01 (NW)	WTG10 (E)
Bottlenose dolphin	296	310	256	269
MU: 10,947	2.7%	2.8%	2.3%	2.5%

Figure 8.2: Spatial extent of 5 dB SEL_{ss} noise contours and the Cardigan Bay SAC. Note: there is no direct overlap with the SAC.



Other construction activities

A simple assessment of the noise impacts from non-piling noise is presented in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration. The expected or potential noise sources at the offshore site considered in this assessment as other construction activities are:

- Vessel movements – large and medium vessels;
- Seabed preparation - two types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles.

The ES concluded that the predicted level of disturbance from other construction activity (dredging, cable laying, rock placement, drag embedment anchors, suction pile anchors, drilling and sheet piling) was negligible to minor (adverse) significance, which is not significant in terms of the EIA regulations.

Table 8.24 shows that suction dredging, cable laying, trenching and drilling activities will elicit the highest levels of disturbance for bottlenose dolphin. However, disturbance from these activities will only affect 5 individuals, which relates to 0.05% of the MU reference population.

There is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project construction activities would negatively impact conservation objectives for the Cardigan Bay SAC site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small, as such it is considered highly unlikely that this would lead to a level of disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour of bottlenose dolphin populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with disturbance from construction phase activities**.

Table 8.24: Disturbance to bottlenose dolphin associated with the other construction activities at Project Erebus

Potential Effect	Suction Dredging	Cable Laying	Trenching	Rock Placement	Drag embedment anchors	Suction pile installations	Drilling
Maximum area of disturbance for bottlenose dolphin	5 km 78.5 km²	5 km 78.5 km²	5 km 78.5 km²	100 m 0.03 km²	200 m (based on vessel disturbance) 0.13 km²	500 m 0.79 km²	5 km 78.5 km²
Maximum number of bottlenose dolphin and % of MU and SACs	5 individuals. 0.05% of the MU reference population.	5 individuals. 0.05% of the MU reference population.	5 individuals. 0.05% of the MU reference population.	<1 individual. <0.009% of the MU reference population.	3 individuals. 0.03% of the MU reference population.	<1 individual. <0.009% of the MU reference population.	5 individuals. <0.05% of the MU reference population.

Operational Phase

Vessel Traffic

It is anticipated there will be two crew transfer vessels on site per day (one per 12-hour period) conducting round trips throughout the operational lifetime, so this will not result in a significant increase in vessel traffic in the area.

Previous modelling of bottlenose dolphin in the Moray Firth, in response to increased vessel traffic from offshore wind development, found it to have no negative impact on the local population (Lusseau *et al.*, 2011). There is also evidence of bottlenose dolphins becoming habituated to increased boat traffic, particularly larger commercial vessels which have predictable patterns of movement and do not actively disrupt feeding behaviour, as a recreational or tourist vessel may (Sini *et al.*, 2005). In addition, the generalised hearing range of HF cetaceans, 150 Hz-160 kHz (Southall *et al.*, 2019), is also above the anticipated frequency range of much of the vessel noise.

Using the worst-case scenario, of the disturbance of all bottlenose dolphin over the entire array area and offshore cable corridor, potential disturbance effects could impact 3 individuals, equating to 0.0027% of the MU reference population.

With respect to the conservation objectives of the Cardigan Bay SAC, disturbance associated with operational vessel traffic will be low and will present no risk of suppressing reproductive success, physiological health or long-term behaviour. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with disturbance from vessel traffic**.

Disturbance Effects from Presence of Operating Turbines and Associated Infrastructure

Operational WTGs will produce underwater noise as a result of vibration from the rotating machinery in the turbines. This will be emitted into the marine environment through the floating structure and mooring infrastructure. However, acoustic emissions from floating WTGs will be lower than that of traditional fixed bottom WTGs due to the absence of pile structures.

In a review of post-construction monitoring at offshore wind developments both within the UK and abroad, the MMO (2014) reported that acoustic emissions from operational OWFs were low, and that any behavioural effects or potential impacts would be limited to the immediate vicinity of the turbine structure. Noise emissions from operating wind turbines are of low frequencies and low intensity (Nedwell *et al.*, 2007) and are likely to be inaudible to marine mammals over distances greater than tens of metres, as the acoustic fovea of these animals is within the higher frequencies. The conclusion that operational OWF structures cause minimal disturbance on marine mammal receptors is supported by various publications reporting their regular presence of marine mammals within operational OWFs (see Scheidat *et al.* (2011) and review by Diederichs *et al.* (2008)).

With regards to the conservation objectives of the Cardigan Bay SAC, it is considered that any disturbance would be minor and highly localised, and would not cause levels of disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour. It is considered that there is no risk of injury for operational noise and, as such, no potential for adverse effects to long-term population viability.

It is therefore concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with disturbance from presence of operating turbines and associated infrastructure.**

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressure during the decommissioning phase**.

Collision Risk

Construction Phase

As outlined in previous sections, during the construction of the Project there will be an increase in vessel traffic, within the site and the wider region. This increased vessel presence, and movements associated with the construction of the Project, could have the potential to increase the collision risk with bottlenose dolphin using the site. Collision with a boat or ship may result in physical trauma injuries such as blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision with vessels for bottlenose dolphin would be directly influenced by the type of vessel and the speed at which it is travelling (Laist *et al.* 2001). It is also indirectly influenced by ambient noise levels underwater and the behaviour the bottlenose dolphin is engaged in.

It is anticipated that during semi-submersible floating platform installation there will be a maximum of 4 vessels on site at any one time for 60 days, and that vessel movements for cable installation will occur on 228 days of the 8 month construction period. In addition, vessels will follow established shipping routes where possible when transiting between the Project and other ports to minimise vessel traffic.

The ES concluded that bottlenose dolphin are expected to detect vessels in close proximity and largely avoid collision due to their high mobility, relatively small size and observed behavioural response to marine acoustic emissions. 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).

Furthermore, the UK Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. The CSIP data show that very few strandings have been attributed to vessel collisions[23]; therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted in post-mortem examinations.

[23] (CSIP, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

Consequently, it is expected that the level of vessel activity during construction would cause a negligible increase in the risk of mortality from collisions. In addition, the embedded mitigation of a vessel management plan will ensure that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals.

With respect to the conservation objectives of the Cardigan Bay SAC, considering the very low percentage of the MU reference population potentially at increased risk of collision, and in view of the mitigation measures outlined above, there is no indication that any increase in collision risk would impact the viability of designated bottlenose dolphin populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with subsea collision during the construction phase**.

Operational Phase

Chapter 12: Marine Mammals concluded that it is not expected that the level of vessel activity during operations would cause an increase in the risk of mortality from collisions. The adoption of a vessel management plan during operations will minimise the potential for any adverse effect.

In response to the Project HRA Screening Report, NRW advised that assessment of collision risk should include consideration of potential for collision with Project infrastructure. There is no information available on the potential for marine mammals to collide with floating WTG sub-structures. However, given the relative spatial scale of devices, the low number of devices at the array area, the water depth, and the size of marine mammals, it is expected that the risk of collisions would be negligible. In addition, turbine sub-structures remain relatively stationary, and it is therefore expected that these could easily be avoided by marine mammals present in the area.

Garavelli (2020) suggests that the relative spatial scale of devices and their associated mooring lines, the water depth, and the size of marine mammals indicates that the likelihood of encounter is low, given the very small cross section of the water column occupied by the subsea mooring lines and cables. It is important to note that, while floating wind farms are relatively new in the offshore wind industry, the oil and gas industry has used offshore floating oil rig platforms for decades.

In view of this, it is considered there is negligible risk of collisions between marine mammals and floating wind structures. With respect to the conservation objectives of the Cardigan Bay SAC, this does not constitute a risk to the long-term viability of designated bottlenose dolphin populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with subsea collision during the O&M phase**.

Decommissioning Phase

During decommissioning, it is anticipated that there will be a similar number, or fewer, vessels on site than during construction, so this will not result in a significant increase in vessel traffic in the

area. These vessels are also anticipated to be stationary or slow moving for significant periods of time, throughout operations at the Project. Therefore, again, it is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions.

As determined for the construction phase, the level of vessel activity associated with decommissioning activities will not adversely affect the conservation objectives of the Cardigan Bay SAC. The low associated risk of collision will not adversely affect viability of bottlenose dolphin populations designated at this site. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with subsea collision during the decommissioning phase**.

Entanglement

Construction Phase

There is no pathway for entanglement effects to occur during the construction phase.

Operational Phase

The mooring lines, inter-array and export cables present in the water column during the operational phase of Project Erebus may represent an entanglement risk for marine mammals. Entanglement is defined as the unintentional capture/restraint of marine animals by strong, flexible, anthropogenic materials such as stationary ropes, lines, cables and other mainly linear structures including lines associated with fishing gears (Benjamins *et al.*, 2014).

Typically, smaller cetaceans such as dolphins and porpoises are not as likely to become entangled in subsea structures, with these species being typically more vulnerable to bycatch (Benjamins *et al.*, 2014).

There is nothing in the existing literature to suggest that entanglement of marine mammals in catenary or tensioned mooring lines is likely to pose a significant risk. Garavelli (2020) suggests that the relative spatial scale of devices and their associated mooring lines, the water depth, and the size of marine mammals indicates that the likelihood of encounter is low, given the very small cross section of the water column occupied by the subsea structures (mooring lines and cables). It is important to note that, while floating wind farms are relatively new in the offshore wind industry, the oil and gas industry has used offshore floating oil rig platforms for decades. The impact of entanglement with floating oil rigs is considered to be negligible (Morandi *et al.*, 2018) and, thus, a similar level of risk can be expected from floating wind structures.

The Applicant will consider the option for monitoring and reporting on this impact pathway as part of the MMMP. Should any monitoring suggest that the likelihood of this impact occurring is higher than expected, then contingency measures will be put in place. The exact measures within the contingency plan have yet to be determined, and consultation and agreement with stakeholders will be sought. Measures could, for example, involve more regular monitoring of lines and cables, in order to remove any snagged derelict gear/marine litter as quickly as possible, to minimise the chance of indirect entanglement.

Therefore, in light of the existing literature suggesting that entanglement will not pose a significant risk to marine mammals, and mitigation in the form of monitoring and reporting as part of the MMMP, it is concluded that the potential for entanglement will not prevent the conservation objectives for this site from being obtained. The low associated risk of adverse effects will not lead to a reduction in the long-term viability of bottlenose dolphin populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. It is therefore concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with entanglement**.

Decommissioning Phase

There is no pathway for entanglement effects to occur during the decommissioning phase.

Barrier Effects

Construction Phase

Underwater noise during construction could have the potential to create a barrier effect to bottlenose dolphin, preventing movement or migration between important foraging and/or breeding areas resulting from avoidance of the project area.

The worst-case scenario, in relation to barrier effects as a result of underwater noise, is based on the maximum spatial extent of proposed Project infrastructure. This allows assessment of the maximum potential disturbance, possible at any one time. This has been assessed earlier in this section, for the maximum area of potential disturbance for underwater water noise from any construction activities, maintenance and repowering activities and vessels, based on the worst-case scenarios and maximum potential ranges for:

- UXO detonation;
- Vessel movements – large and medium vessels;
- Seabed preparation - 2 types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles (Table 8.10).

As a worst-case scenario, up to 335 individuals could be affected (3.06% of the MU reference population) (Table 8.10) during the construction phase.

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential barrier effects would be of sufficient magnitude as to lead to a reduction in the long-term viability of bottlenose dolphin populations designated at this site, or to constitute disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour. The spatial extent of any barrier will be very small and the percentage of the MU reference population that may be at affected is low. There is also no evidence to suggest that this pressure would adversely impact

any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with barrier effects during construction**.

Operational Phase

The presence of the floating WTGs and substructures during the operational phase of the windfarm has the potential to result in a physical barrier effect for bottlenose dolphin.

A number of recent studies have reported the presence of marine mammals within wind farm footprints. For example, at the Horns Rev and Nysted offshore wind farms in Denmark, long-term monitoring showed that both harbour porpoise and harbour seals were sighted regularly within the operational OWFs, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.*, 2008). Similarly, a monitoring programme at the Egmond aan Zee OWF in the Netherlands reported that significantly more porpoise activity was recorded within the OWF, compared with the reference area during the operational phase *(Scheidat et al.* 2011), indicating the presence of the windfarm was not adversely affecting harbour porpoise presence. Other studies at Dutch and Danish OWFs (Lindeboom *et al.* 2011) also suggest that harbour porpoise may be attracted to increased foraging opportunities within operating offshore wind farms. Here, harbour porpoise is used as a proxy for bottlenose dolphin, due to similar behavioural changes observed in response to anthropogenic developments.

There is no information available on the potential for floating WTG sub-structures to result in barrier effects for marine mammals. However, given the relative spatial scale of devices, the low number of devices at the array area, the water depth, and the size of marine mammals, it is expected that marine mammals would be unlikely to perceive the substructures at the Project array area as a barrier to movement.

The estimated maximum area taken up by the array area, is up to 43.5 km^2.Therefore, the number of bottlenose dolphin that could be at risk of potential barrier effects based on the maximum area of 43.5 km^2, is 2 individuals (0.018% of the MU reference population).

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the predicted barrier effects would be of sufficient magnitude as to lead to a reduction in the viability of bottlenose dolphin populations designated at this site, or to cause disturbance that would suppress reproductive success, physiological health, or long-term behaviour. The spatial extent of any barrier will be very small and the percentage of the MU reference population that may be affected is low. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with barrier effects during the O&M phase**.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse**

effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with barrier effects during the decommissioning phase.

Potential Effects to Prey Resources

Construction Phase

Given that bottlenose dolphin are dependent on fish prey, there is the potential for indirect effects on bottlenose dolphin as a result of impacts upon fish species, or the habitats that support them.

During construction activities, there is the potential for disturbance to both Atlantic herring and sandeels, both of which have had potential spawning grounds identified within the Study Area and are considered a key prey species for bottlenose dolphin (Pesante *et al.*, 2008; Evans and Hintner, 2013; Nuuttila *et al.*, 2017). The spawning grounds of both of these species are highly sensitive to disturbance, however Chapter 10: Fish and Shellfish concluded that there was no significant predicted impact from construction activities, since the footprint of construction is unlikely to result in a significant change to overall stock abundance of these species. Furthermore, while there may be certain species that comprise the main part of their diet, bottlenose dolphin are considered to be generalist feeders and are thus not reliant on a single prey species.

During O&M activities, there is the potential for loss of existing habitat which currently provides foraging/spawning/nursery habitat for fish species. However, Chapter 10: Fish and Shellfish concluded that there are no significant impacts to fish species predicted during O&M. Similarly, no significant impacts to fish species were predicted during the decommissioning phase.

As outlined in Chapter 10: Fish and Shellfish, the worst-case scenario for temporary habitat loss during construction could be up to 1.35 km^2. As a worst-case scenario, up to 0.25 individuals could be temporarily affected (0.002% of the MU reference population) (Table 8.25).

As outlined in Chapter 10: Fish and Shellfish, the worst-case scenario for long-term habitat loss as a result of project infrastructure could be up to 0.16 km^2. As a worst-case scenario, <1 individual could be affected (0.009% of the MU reference population) (Table 8.25).

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential effects on prey availability will be of sufficient magnitude as to affect bottlenose dolphin natural range. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with construction phase effects on prey resources**.

Table 8.25: Summary of the maximum areas of displacement of bottlenose dolphin due to effects on prey resources resulting from temporary and long-term habitat loss

Effect	Temporary habitat loss during construction	Long-term habitat loss
Maximum area of displacement for bottlenose dolphin	4.04 km^2.	1.68 km^2.
Maximum number of individuals and % of MU	<1 individual. <0.009% of the MU reference population.	<1 individual. <0.009% of the MU reference population.
Area of Cardigan Bay/Bae Ceredigion SAC	0.42% of 958.6 km^2 SAC Area.	0.18% of 958.6km^2 SAC Area.

Operational Phase

During O&M activities, there is the potential for loss of existing habitat which currently provides foraging/spawning/nursery habitat for fish species. However, Chapter 10: Fish and Shellfish Ecology concluded that there are no significant impacts to fish species predicted during O&M. Similarly, no significant impacts to fish species were predicted during the decommissioning phase.

With respect to the conservation objectives of the Cardigan Bay SAC, any potential effects on prey availability during the operational phase will be of lower magnitude than during construction. As such, the potential indirect effects on bottlenose dolphin through reduction in resource availability will be negligible. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with O&M phase effects on prey resources**.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with decommissioning phase effects on prey resources**.

Accidental Pollution

The presence of numerous works vessels in and around the Project (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A Marine Pollution Contingency Plan (MPCP) will be produced and agreed with stakeholders, post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity, in combination with its physical environment. The strong hydrodynamic regime at the offshore site means that, should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential impact on the benthic environment. In consideration of the standard mitigation and adoption of best practice, it is expected if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to designated bottlenose dolphin populations.

During all phases of the construction, O&M, and decommissioning there is a risk of accidental pollution events. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the viability of bottlenose dolphin as a component of the site or the condition of supporting habitats and processes, and the availability of prey. It is also considered that any pollution event that did occur would be rapidly contained, avoiding physical, biological, and chemical structure and functions necessary for long-term habitat quality, or would lead to degradation in the abundance or condition of typical species. As such, it is concluded there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with accidental pollution**.

8.5.2.5. Assessment of Adverse Effects In-combination

The screening of potential in-combination pressures for marine mammals identified a number of plans and projects within the relevant bottlenose dolphin MU that were considered to have the potential to have 'in-combination' pressures for bottlenose dolphin with Project Erebus (Table 8.27).

The plans and projects selected as relevant to the in-combination assessment of impacts to marine mammals are based on an initial screening exercise undertaken on a long-list (Volume 3, Technical Appendix 30.1: Cumulative Long List). A consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales has been given, to select projects for a topic-specific short-list. For the potential pressures for marine mammals, planned projects were screened into the assessment based on the extent of the relevant marine mammal reference population area (MU).

Table 8.12 details the pressures considered for the Project alone (Section 8.5.2.4) and identifies which are considered to have the potential to adversely affect the integrity of SACs in relation to the conservation objectives for bottlenose dolphin.

Based on the information presented in Table 8.12, the in-combination assessment will consider the following pressure pathways for construction phase activities.

- Disturbance from underwater noise;
- Collision risk;
- Effects to prey resources
- Accidental pollution.

Accordingly, the long-list of projects was screened to remove the following:

- All projects that are located outside of the relevant species MU;
- All projects that are already operational/active as they are considered to be existing impacts included within the baseline (this includes all shipping ports, shipping routes and oil and gas pipelines);
- All projects where there is no expected temporal overlap with construction of the Project;
- All projects where the timing of construction activities is unknown.

The offshore plans or projects considered included:

- Offshore windfarms;
- Marine renewables (wave and tidal);
- Port and harbour developments;
- Marine aggregate extraction and dredging;
- Licensed disposal sites;
- Oil and gas exploration and extraction;
- Subsea cables and pipelines.

The assessment is based on the in-combination pressures of projects using the tiered approach as described in Table 8.26**.** The tiered approach is based on guidance from JNCC and NE (2013) and PINS (2019) Advice Note 17. The tiers reflect the likely degree of certainty and level of information associated with each development.

Table 8.27 outlines the projects and plans considered in the in-combination assessment. This includes all projects that are located within the Celtic and Greater North Seas MU for bottlenose dolphin and are scheduled to conduct offshore construction activities before or at the same time as the Project.

Table 8.26: Tiers for projects considered in the in-combination assessment

Tier	Consenting/Construction Phase
Tier 1	Operational projects that were not operational when baseline data were collected (e.g. environmental characterisation surveys); Operational projects that could have any ongoing or residual impact.
Tier 2	Projects under construction.
Tier 3	Projects that have been consented, but construction has not yet commenced.
Tier 4	Projects that have an application submitted to the appropriate regulatory body that have not yet been consented; Projects that have been consented, construction has not yet commenced and there is the potential for changes in what was consented and timelines.
Tier 5	Projects that the regulatory body are expecting an application to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects).
Tier 6	Projects that have been identified in relevant strategic plans or programmes.

Table 8.27: Projects screened into the in-combination assessment of disturbance from construction activities for bottlenose dolphin

Project	Offshore Construction Starts	Full Commissioning	2021				2022				2023				2024				2025				2026			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus	Q2 2026	Q4 2026																								
Dieppe - Le Tréport	01-Jan-24	01-Jan-25																								
Fécamp	05-Jul-21	31-Dec-23																								
Calvados	01-Jan-22	31-Oct-24																								
TwinHub	02-Jul-10	01-Jan-26																								
Greenlink Interconnector	2024	2024																								
META – East Pickard Bay (Bombora)	Q2 2022	Q3 2023																								
Rampion 2	01-Jan 26	01-Jan 29																								

Table 8.28: In-combination assessment of disturbance from construction activities for bottlenose dolphin

Project	2021				2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus																						310	310	310
Dieppe - Le Tréport													38	38	38	38								
Fécamp			21	21	21	21	21	21	21	21	21	21												
Calvados					114	114	114	114	114	114	114	114	114	114	114	114								
TwinHub	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8				
Greenlink Interconnector													4	4	4	4								
Rampion 2																					110	110	110	110
META – East Pickard Bay (Bombora)						5	5	5	5	5	5													
Total Number Impacted	8	8	29	143	148	148	148	148	148	148	148	148	143	164	164	164	8	8	8	8	110	420	420	420
% of MU Ref. Pop.	0.1	0.1	0.3	0.3	1.3	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.5	1.5	1.5	1.5	0.1	0.1	0.1	0.1	1.0	3.9	3.9	3.9

Note: in order to calculate the number of bottlenose dolphins disturbed by each project, a uniform density was assumed within the MU (204,566 km² MU, containing 10,947 bottlenose dolphins = uniform density of 0.0535 dolphins/km²).

Underwater Noise and Disturbance

The assessment of underwater noise and disturbance in-combination pressures assumes the following:

- The Project – disturbance impact based on maximum numbers presented in this impact assessment (worst-case from pile driving);
- Other windfarms: Pinpile - Assume construction related impacts are limited to a 15 km radius around the array area based on JNCC (2020);
- Other windfarms: Monopile - Assume construction related impacts are limited to a 26 km radius around the array area based on JNCC (2020)[24];
- Other windfarms: Floating - assume no pile driving. Assume construction related impacts are limited to a 5 km radius;
- Other windfarms: Gravity base - assume no pile driving. Assume construction related impacts are limited to a 5 km radius;
- Wave/tidal projects - assume no pile driving. Assume construction related impacts are limited to a 5 km radius.

The in-combination assessment assumes offshore construction timeline for the Project to be:

- Offshore pre-construction surveys: 01 April 2026 to 02 May 2026;
- Floater and mooring installation: 01 June 2026 to 30 October 2026;
- Cable installation: Bulk of offshore cable installation activity anticipated May – Sept 2026.

The potential disturbance from construction activities takes a very precautionary approach as the assessment assumes all pre/under construction projects construction window will overlap with the Project, which realistically is not the case, see anticipated construction dates (Table 8.27).

The potential disturbance from operational and maintenance activities at other projects has also been based on the worst-case scenario of the entire project array and export cable footprint. This is a very precautionary approach, as it is highly unlikely that operational windfarms and maintenance activities, such as vessel traffic, would result in disturbance across the entire offshore development area. Any disturbance is likely to be limited to the area where the activity is taking place.

All of the offshore projects screened into the assessment for bottlenose dolphins (located within the Offshore Channel and SW England MU and constructing before or concurrently with the Project) are planned to conduct offshore construction work prior to the Project offshore construction window and, thus, the predicted impacts do not overlap (Table 8.27). However, since they are planning offshore construction activities after the Project site-specific baseline surveys were completed, they

[24] Although it is acknowledged that NRW does not agree with the use of the 26 km threshold, this has been used in EIA of the majority of other UK offshore renewable developments. As such, this represents the best information available for the in-combination assessment.

are considered in this impact assessment. This means that the impact across these projects between 2021-2025 would occur irrespective of, and independent of, the Project.

Of the 7 other offshore projects screened into the cumulative impact assessment for bottlenose dolphins, it is the Project that has the highest level of predicted disturbance impact (Table 8.28). This is due to the fact that pile driving may occur and, thus, had to be included in the assessment as the worst case. Additionally, the assessment for the Project used the highly precautionary approach of applying the harbour porpoise dose-response curve, which is expected to largely over-estimate the response expected in bottlenose dolphins. Based on this assessment, in-combination disturbance effects could affect up to 420 animals, equating to 3.9% of the MU reference population. No other projects screened into in-combination assessment are located within the Cardigan Bay SAC. As such, it is not considered appropriate to express disturbance in terms of the SAC area.

With respect to the conservation objectives of the Cardigan Bay SAC, there is no indication that the potential levels of disturbance associated with Project underwater noise would lead to sufficient disturbance to bottlenose dolphin populations as to suppress reproductive success, physiological health, or long-term behaviour. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with disturbance from underwater noise**.

Collision Risk

Construction Phase

As outlined in Section 8.5.2.4 the increased presence of vessels during the construction phase of offshore wind farms, tidal and wave projects can increase the potential collision risk with bottlenose dolphin.

The assessment assumes that during the construction of offshore windfarms and other plans within the region, that vessel movements to and from any port will be restricted to existing vessel routes and, therefore, the increased risk for any vessel interaction is considered only within the Project site. Bottlenose dolphins in the area would be accustomed to the presence of vessels and therefore be expected to be able to detect and avoid construction vessels.

With respect to the conservation objectives of the Cardigan Bay SAC, considering the low percentage of the MU reference population potentially at increased risk of collision (Table 8.29) and in view of the mitigation measures outlined above, there is no indication that any increase in collision risk would impact the long-term viability of designated bottlenose dolphin populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the bottlenose dolphin feature. It can therefore be concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with subsea collision**.

Operational and Decommissioning Phase

As stated in Section 8.5.2.4 any increase in vessel movements during the operation and maintenance phase is determined to be lower than that of the construction phase, and relatively small in relation to vessel movements in the area. Therefore, there is unlikely to be a significant increase in collision risk during the operation and maintenance of offshore windfarms and, as a result, this has not been included in the in-combination assessment. The same conclusion has also been determined for the decommissioning phase. As such, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with subsea collision**.

Table 8.29: In-combination assessment for potential increased collision risk with vessels for bottlenose dolphin in the Cardigan Bay SAC

Project	2021				2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus																						<1	<1	<1
Dieppe – Le Tréport													1	1	1	1								
Fécamp			<1	<1	<1	<1	<1	<1	<1	<1	<1	<1												
Calvados					<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1								
TwinHub	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1				
Greenlink Interconnector													<1	<1	<1	<1								
Rampion 2																					2	2	2	2
META – East Pickard Bay (Bombora)						<1	<1	<1	<1	<1	<1													
Total Number Impacted	<1	<1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	<1	<1	<1	<1	2	2	2	2
% of MU Ref. Pop.	0.0004	0.0004	0.005	0.005	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.009	0.01	0.01	0.01	0.01	0.0004	0.0004	0.0004	0.0004	0.01	0.01	0.01	0.01

Note: in order to calculate the number of bottlenose dolphins disturbed by each project, a uniform density was assumed within the MU (204,566 km² MU, containing 10,947 bottlenose dolphins = uniform density of 0.0535 dolphins/km²).

Effects on prey resources

Construction Phase

The in-combination assessment on potential changes to prey availability has assumed that any potential effects on bottlenose dolphin prey species from underwater noise, including piling, would be of similar magnitude to those for bottlenose dolphin. Therefore, there would be no additional effects other than those already assessed for bottlenose dolphin. For example, the area in which prey are disturbed as a result of underwater noise will be the same, or smaller, than the area of disturbance for bottlenose dolphin, therefore any changes to prey availability would not affect bottlenose dolphin as they would already be disturbed/displaced from that area. Furthermore, effects on prey species are likely to be temporary and highly localised, and anticipated to recover quickly following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the very large potential foraging habitat in the surrounding area.

Consequently, there is no indication that the potential effects on prey availability will be of sufficient magnitude as to affect the natural range of bottlenose dolphin populations. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the bottlenose dolphin feature. In view of these factors, it is concluded that there is **no potential for an in-combinaiton adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with construction phase effects on prey resources**.

Operational and Decommissioning Phase

It is determined that the in-combination impact of any of the above during the operational and decommissioning phase of the project would be no worse than the in-combination impacts assessed above for the construction period of the Project. During times where there is limited or no construction in the region, impacts will be intermittent, temporary and highly localised to the source project. Consequently, it is determined that that there will be **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with operational and decommissioning phase effects on prey resources**.

8.5.2.6. Summary

There is no potential for any adverse effects on the integrity of the Cardigan Bay/Ceredigion Bae SAC from the Project alone in relation to the conservation objectives for bottlenose dolphin.

Based on the information currently available, there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the bottlenose dolphin feature of the Cardigan Bay SAC from any pressures associated with any effect associated with the Project (alone or in-combination)**.

8.5.3. Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau Special Area of Conservation

The Pen Llŷn a'r Sarnau/Lleyn Peninsula and the Sarnau SAC (hereto referred as the Pen Llŷn a'r Sarnau SAC) covers a wide area on the west coast of Wales. The 1,460.1 km^2 site, designated as a SAC in 2004, encompasses marine and coastal habitats and a variety of environmental conditions.

8.5.3.1. Conservation Objectives

NRW (2018f) outlines the conservation objectives for the SAC. For the Annex II species features, including grey seal, bottlenose dolphin, and otter. These are as follows.

"***5.2.6 Populations***

The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements include:

- *population size*
- *structure, production*
- *condition of the species within the site.*

*As part of this objective it should be noted that for **bottlenose dolphin** and **grey seal**;*

- *Contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression*

*For **grey seal** populations should not be reduced as a consequence of human activity.*

5.2.7 Range

The species population within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future.

*As part of this objective it should be noted that for **bottlenose dolphin** and **grey seal**:*

- *Their range within the SAC and adjacent inter-connected areas is not constrained or hindered*
- *There are appropriate and sufficient food resources within the SAC and beyond*
- *The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing*

5.2.8 Supporting habitats and species

The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include:

- *distribution*
- *extent*
- *structure*
- *function and quality of habitat*

- *prey availability and quality.*

As part of this objective it should be noted that;

- *The abundance of prey species subject to existing commercial fisheries needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term.*
- *The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term.*
- *Contamination of potential prey species should be below concentrations potentially harmful to their physiological health.*
- *Disturbance by human activity is below levels that suppress reproductive success, physiological health or long-term behaviour.*

*For **otter** there are sufficient resources within the SAC and beyond of high quality freshwater for drinking and bathing.*

5.2.8 Restoration and recovery

*As part of this objective it should be noted that for the **bottlenose dolphin** and **otter**, populations should be increasing.*"

8.5.3.2. Advice on Operations

NRW (2018f) identifies operations or activities where there is the potential for an adverse effect on a feature or component of a feature exists. The advice states that the potential for, and magnitude of, any pressure will be dependent on many variables, such as the location, extent, scale, timing and duration of operations or activities, as well as proximity to features that are sensitive to one or more factors induced or altered by the operation (NRW, 2018f). A summary of operations and activities included in the advice and relevant to bottlenose dolphin feature of the Lleyn Peninsula and the Sarnau SAC is listed in Table 8.30.

Table 8.30: Operations which may cause deterioration or disturbance to the features (Source: NRW, 2018f)

Activity	Relevant Factors	Most likely relevant components and effects	Advice as to likely required action
Shipping: vessel traffic (commercial) - widespread and common.	Geophysical regime: • Vessel wash (substrate erosion, local modification of wave exposure regime). Fundamental environmental parameters: • Turbidity. Physical disturbance: • Collision; • Noise; • Visual.	**Structure and function:** local effects to sediment habitat structure; noise/visual disturbance effecting mobile species particularly mammals; potential for collision with marine mammals; local modification of physical processes with elevated levels of suspended sediments effecting benthic flora, and smothering sessile benthic fauna; modification to biological processes including food availability, and changes to biological interactions due to modification of habitat and physical factors. **Conservation status of typical species and species features**: particularly affecting the diversity, health and extent of wave sheltered communities and the distribution of communities along physical gradients. Also an alteration/reduction in quality of communities/populations containing species sensitive to changes in turbidity, light, oxygen and smothering (particularly shallow subtidal algal and eelgrass communities, species-rich sediment infaunal communities, and sessile faunal turf communities). **Operation specific information required:** location, frequency and duration of operation; scale of effect of wash and water movement from vessel movement dependent on vessel size, activity, speed and proximity to sensitive (sheltered, intertidal and/or shallow subtidal) habitats/communities and species (seals); relevant location-specific biotic and abiotic information.	Continue to monitor shipping movement within port limits. Determine effects of vessel movement on sediment transport, mobilisation and turbidity. Review, revise or establish management practices and spatial, temporal and technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters to minimise risk to features FCS.
Alternative energy production: wind - none at present.	Geophysical regime: • Modification of wave and tidal regimes;	**Extent and distribution:** potential habitat loss within footprint of generating structures. Structure and function: potentially highly variable dependent on nature, construction and scale of structures. Modification of	Treat as plan or project as appropriate.

Activity	Relevant Factors	Most likely relevant components and effects	Advice as to likely required action
	• Modification to substrate. Environmental quality: • Possible toxic and non-toxic contaminants. Physical disturbance: • General physical effects; • Possible collision.	sedimentology and sediment processes, hydrodynamic regime. **Conservation status of typical species and species features:** modification of species variety, and distribution; modification of species ranges (disturbance; artificial reef effects). **Operation specific information required:** type, construction and size; location and extent; timing and duration of installation; permanence; cabling requirements; maintenance requirements and frequency; relevant location-specific biotic and abiotic information.	
Power/communication cables - Present	Geophysical regime: • Addition of artificial substrate; • Local modification of water movement. Physical disturbance: • Displacement; • Visual; • Noise. Potential electromagnetic effects of electrical cables.	**Structure and function:** dependent on depth of cable burial in seabed –modification of sediment transport processes and local hydrodynamic regime. Scour effect on benthic habitats from cables due to wave action. **Conservation status of typical species and species features:** dependent on depth of cable burial in seabed – localised modification of species composition, variety. Modification of behaviour caused by electro-magnetic effects. **Operation specific information required:** location, extent, scale, frequency, timing and duration; maintenance requirements and frequency; relevant location-specific biotic and abiotic information.	Treat as plan or project as appropriate, taking into account long term management requirements and likely effects.

8.5.3.3. Bottlenose Dolphin *Tursiops truncatus*

Feature Summary

Bottlenose dolphin do not form a discrete site based population within Pen Llŷn a'r Sarnau SAC but are considered part of a wider population that ranges across southwest UK and Irish waters, and encompasses the Cardigan Bay SAC (NRW, 2018f). Dolphins associated with the SAC interact with dolphins in Cardigan Bay SAC and, probably, with animals in waters of southwest UK and Ireland.

Observations of bottlenose dolphins in the SAC have been centred around locations such as Tremadog Bay, at the entrances to estuaries, and also close to some of the Sarnau reefs (NRW, 2018f). This is suggestive that the congruence of the freshwater tributaries and the presence of offshore reefs contribute to the overall site integrity for the species. Calving is known to have taken place within Cardigan Bay and the presence of newborn and very young calves has been documented from April to September, particularly in shallow and sheltered areas (NRW, 2018f).

Population dynamics of dolphins in the Pen Llŷn a'r Sarnau SAC are similar to those of the Cardigan Bay SAC, as both sites are located within Cardigan Bay. Population estimates for the bottlenose dolphin of the Cardigan Bay SAC, from 2001-07 (obtained considering the proportion of marked dolphins in each group and the mark-recapture method), provide an estimate of 210 individuals for the population using Cardigan Bay SAC in 2007, whilst a higher estimate of 379 individuals was calculated for the whole period 2001-07 (NRW, 2018f).

Feature Condition

NRW (2018f) carried out a feature condition assessment for the Pen Llŷn a'r Sarnau SAC, determining that, based on reporting and expert judgement, the population and range of bottlenose dolphin were in favourable condition, although the condition of supporting habitats was unknown.

The bottlenose dolphin population of the Pen Llŷn a'r Sarnau SAC is considered to be part of a larger coastal population closely associated with the Cardigan Bay SAC, which has been monitored for a longer period than the Pen Llŷn a'r Sarnau SAC. Therefore, NRW (2018f) used the results from the Cardigan Bay SAC as a proxy for the condition assessment for the Pen Llŷn a'r Sarnau SAC.

8.5.3.4. Assessment of Adverse Effects Alone

The assessment of potential effects assessed and the conservation objectives for the Lleyn Peninsula and Sarnau SAC are the same for the potential effects assessed for the on the Cardigan Bay SAC. It is therefore considered appropriate for the potential effects of the project alone to be summarised and assessed in relation to the conservation objectives for the Cardigan Bay SAC in Section 8.5.2**.** Therefore, it is determined that there is **no potential for any adverse effects on the integrity of the Lleyn Peninsula and Sarnau SAC from the Project alone in relation to the conservation objectives for bottlenose dolphin**.

8.5.3.5. Assessment of Adverse Effects In-combination

As outlined in Section 8.5.3.3 bottlenose dolphin do not form a discrete site-based population within Lleyn Peninsula and Sarnau SAC but are considered part of a wider population that ranges across southwest UK and Irish waters, and encompasses the Cardigan Bay SAC (NRW, 2018f). Dolphins

associated with the SAC interact with dolphins in Cardigan Bay SAC and probably with animals in waters of southwest UK and Ireland.

Given this linkage between the two populations, it is likely that effects on the Lleyn Peninsula and Sarnau SAC dolphin populations would be similar in nature to those at the Cardigan Bay SAC. In addition, given the greater degree of geographic separation, it should be considered that the magnitude of any adverse effect would be no greater for the Lleyn Peninsula and Sarnau SAC than the Cardigan Bay SAC. Section 8.5.2.5 concluded that there is **no potential for any adverse effects on the integrity of the Lleyn Peninsula and Sarnau SAC from the Project in-combination in relation to the conservation objectives for bottlenose dolphin**.

8.5.3.6. Summary

There is **no potential for any adverse effects on the integrity of the Lleyn Peninsula and Sarnau SAC from the Project alone or in-combination in relation to the conservation objectives for bottlenose dolphin**.

8.6. Pinnipeds

8.6.1. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation

The Pembrokeshire Marine/Sir Benfro Forol SAC (hereto referred as the Pembrokeshire Marine SAC) was designated in December 2004 by the National Assembly for Wales. The 1,380.4 km^2 site is located in southwest Pembrokeshire, spanning from Abereiddy on the north Pembrokeshire coast to Manorbier on the southern coast, including the coasts of several islands offshore west of Pembrokeshire. The site is designated for protection of 8 Annex I marine habitats, and 7 Annex II species.

8.6.1.1. Conservation Objectives

There are several conservation objectives for the species features of the Pembrokeshire Marine SAC, including (NRW, 2018a):

- "*The population is maintaining itself on a long-term basis as a viable component of its natural habitat*;
- *The species population range within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future*;
- *The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance, and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include:*
    - *Distribution;*
    - *Extent;*
    - *Structure;*
    - *Function and quality of habitat;*
    - *Prey availability and quality.*
- *As part of this objective it should be noted that;*

- *The abundance of prey species subject to existing commercial fishing needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term.*
- *The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term.*
- *Contamination of potential prey species should be below concentrations potentially harmful to their physiological health.*
- *Disturbance by human activity is below levels that suppress reproductive success, physiological health, or long-term behaviour*".

8.6.1.2. Advice on Operations

NRW (2018a) identifies operations or activities where there is the potential for an adverse effect on a feature or component of a feature exists. The advice states that the potential for, and magnitude of, any pressure will be dependent on many variables, such as the location, extent, scale, timing and duration of operations or activities, as well as proximity to features that are sensitive to one or more factors induced or altered by the operation (NRW, 2018a). A summary of operations and activities included in the advice and relevant to grey seal feature of the Pembrokeshire Marine SAC is listed in Table 8.31.

Table 8.31: Operations which may cause deterioration or disturbance to the features (Source: NRW, 2018a)

Activity	Relevant Factors	Most likely relevant components and effects	Advice as to likely required action
Shipping: vessel traffic (commercial) - widespread and common.	Geophysical regime: • Vessel wash (substrate erosion, local modification of wave exposure regime). Fundamental environmental parameters: • Turbidity. Physical disturbance: • Collision; • Noise; • Visual.	**Structure and function:** local effects to sediment habitat structure; noise/visual disturbance affecting mobile species particularly mammals; potential for collision with marine mammals; local modification of physical processes with elevated levels of suspended sediments effecting benthic flora, and smothering sessile benthic fauna; modification to biological processes including food availability, and changes to biological interactions due to modification of habitat and physical factors. **Conservation status of typical species and species features**: particularly affecting the diversity, health and extent of wave sheltered communities and the distribution of communities along physical gradients. Also an alteration/reduction in quality of communities/populations containing species sensitive to changes in turbidity, light, oxygen and smothering (particularly shallow subtidal algal and eelgrass communities, species-rich sediment infaunal communities, and sessile faunal turf communities). **Operation specific information required:** location, frequency and duration of operation; scale of effect of wash and water movement from vessel movement dependent on vessel size, activity, speed and proximity to sensitive (sheltered, intertidal and/or shallow subtidal) habitats/communities and species (seals); relevant location-specific biotic and abiotic information.	Continue to monitor shipping movement within port limits. Determine effects of vessel movement on sediment transport, mobilisation and turbidity. Review, revise or establish management practices and spatial, temporal and technical operational limits suitable to secure features at FCS; monitor compliance and enforce. Secure appropriate management of vessels transiting coastal waters to minimise risk to features FCS.
Alternative energy production.	Geophysical regime: • Modification of wave and tidal regimes; • Modification to	**Extent and distribution**: potential habitat loss within footprint of generating structures. Structure and function: potentially highly variable dependent on nature, construction and scale of structures. Modification of sedimentology and sediment processes, hydrodynamic regime. **Conservation status of typical species and species features:**	Treat as plan or project as appropriate.

Activity	Relevant Factors	Most likely relevant components and effects	Advice as to likely required action
	substrate. Environmental quality: • Possible toxic and non-toxic contaminants. Physical disturbance: • General physical effects; • Possible collision.	modification of species variety, and distribution; modification of species ranges (disturbance; artificial reef effects). **Operation specific information required:** type, construction and size; location and extent; timing and duration of installation; permanence; cabling requirements; maintenance requirements and frequency; relevant location-specific biotic and abiotic information	
Power/communication cables - present.	Geophysical regime: • Addition of artificial substrate; • Local modification of water movement. Physical disturbance: • Displacement; • Visual; • Noise. Potential electromagnetic effects of electrical cables.	**Structure and function:** dependent on depth of cable burial in seabed –modification of sediment transport processes and local hydrodynamic regime. Scour effect on benthic habitats from cables due to wave action. **Conservation status of typical species and species features:** dependent on depth of cable burial in seabed – localised modification of species composition, variety. Modification of behaviour caused by electro-magnetic effects. **Operation specific information required:** location, extent, scale, frequency, timing and duration; maintenance requirements and frequency; relevant location-specific biotic and abiotic information.	Treat as plan or project as appropriate, taking into account long term management requirements and likely effects.

8.6.1.3. Grey Seal *Halichoerus grypus*

Grey seal *Halichoerus grypus* (S1364) is the only Annex II marine mammal feature of the site that is assessed in this section. Otter *Lutra lutra* (S1355) is considered in the assessment of onshore Annex II mammals (Section 0).

A description of the qualifying feature is provided in the following subsections.

Feature Summary

Grey seal within the site to do not form a discrete population. Although they are present along the Pembrokeshire coast, they are considered to be part of the wider OSPAR region III MU (NRW 2020). Using the grey seal mean habitat preference map (Carter *et al.*, 2020), there are estimated to be 50,900 grey seals at-sea within the OSPAR Region III MU at any one time. It is estimated that grey seals spend 77% of their time at sea on average, therefore, accounting for the 23% of grey seals on land, the population estimate of grey seals within the OSPAR Region III MU is approximately 66,100 grey seal.

Tracking and photographic data show that grey seal have an extensive range. Individuals associated with the SAC are widely distributed and travel far beyond the boundaries of the Pembrokeshire Marine SAC. The site is important for pupping, with suitable sites (physically accessible and undisturbed rocky coast beaches, coves, and caves) present in several locations along the Pembrokeshire coastline. A high proportion of the southwest Wales seal population uses sea caves for pupping, described as an unusual variation in breeding behaviour of the species (NRW, 2018a). There are also several moulting and haul-out sites within the SAC, only a small number of which are regularly used by large numbers of seals. Winter haul-out sites are limited to the offshore islands and undisturbed/inaccessible rocky shores and beaches.

Grey seals are generalist feeders, preying on a variety of fish species, including sandeels, gadoids, and flatfish, with whiting *Merlangius merlangus* and sole *Solea solea* dominating the diet of Pembrokeshire grey seal (NRW, 2018a). Adults and weened pups feed throughout the site, however the exact habitat requirements of the species are not fully understood. Some individuals are known to make long foraging trips to deeper waters further offshore of the Pembrokeshire coastline.

Condition Assessment and Conservation Objectives

Although the extent and distribution, structure, and function of supporting habitats, and prey availability and quality are all unknown, the grey seal population size and structure, and the species range within the SAC are both considered to be in favourable condition (NRW, 2018b). Therefore, the overall feature condition is **favourable** with medium overall confidence (high at monitored grey seal pupping sites within the SAC).

Feature-specific conservation objectives include (NRW, 2018a):

- With reference to populations:
    - Grey seal range within the SAC and adjacent inter-connected areas is not constrained or hindered;
    - There are appropriate and sufficient food resources within the SAC and beyond;

- With refrence to range:
    - The sites and amount of supporting habitat used by grey seal are accessible and their extent and quality is stable or increasing;
    - Contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression;
    - Grey seal populations should not be reduced as a consequence of human activity.

8.6.1.4. Assessment of Adverse Effects Alone

The potential pressures during construction operation and maintenance, and decommissioning for the Project are:

- Underwater noise (from UXO detonation, piling, drilling, construction activities or vessel movement) resulting in auditory injury;
- Underwater noise (from UXO detonation, piling, drilling, construction activities or vessel movement) resulting in disturbance;
- Disturbance to haul-out sites;
- Collision risk (with construction, O&M or decommissioning vessels);
- Entanglement with mooring lines or ghost fishing gear;
- Barrier effects;
- Accidental pollution.

Potential for Auditory Injury resulting from Underwater Noise

Construction Phase

UXO Clearance

The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. However, in line with the recommendations outlined within the recent position statement on UXO clearance, this impact assessment includes an assessment for high-order detonations, though this is considered unlikely to occur in practice.

Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an EDR of 5 km (based on a worst-case scenario 2 kg detonation) is applied when considering the potential for disturbance from an individual UXO clearance, with 1 detonation anticipated during the construction period. Recent UXO clearance licence applications have assumed an effective deterrence range of 5 km around the source location to determine the impact area from low-order UXO clearance (e.g. GoBe, 2021). In the absence of agreed metrics and given a lack of empirical data on the likelihood of response to low-order detonations, this 5 km radius (area of 78.5 km^2) has been applied for all species. Since the array area boundary is located within the Pembrokeshire Marine SAC there is the potential for grey seal features of the Pembrokeshire Marine SAC to be present within the Project area of effect.

However, the PTS-onset impact ranges for low-order UXO detonations are negligible (Table 8.32). The number of grey seal expected to experience PTS-onset is <1 for all charge sizes, (Table 8.32).

The number of grey seal that could potentially be affected, based on the maximum potential PTS impact ranges of UXO clearance, are summarised in Table 8.32. The assessment has been based on the worst-case scenarios for the unweighted SPL peak predicted PTS impact ranges (Table 8.32), in line with a precautionary approach.

As a realistic worst-case scenario, based on a 2 kg NEQ UXO detonation, the maximum area for potential risk of auditory injury in grey seal, without any mitigation, is 1.08 km^2, which could affect up to 1 individual (0.002% for the relevant MU reference population). This area represents up to 0.08% of the Pembrokeshire Marine SAC.

Table 8.32: PTS-onset impact ranges and number of animals predicted to experience PTS-onset for low order UXO detonation

Threshold	Species	Metric	0.1 kg NEQ	0.25 kg NEQ	0.5 kg NEQ	2 kg NEQ
Unweighted SPL_{peak}						
218 dB PCW	Grey seal	Range km	0.14	0.19	0.24	0.39
		#	<1	<1	<1	1
Weighted SEL_{ss}						
185 dB PCW	Grey seal	Range km	0.03	0.04	0.06	0.11
		#	<1	<1	<1	<1

In line with the recommendations outlined within the recent position statement on UXO clearance (Defra *et al.* 2021), the impact assessment includes an assessment for high-order detonations (below), though this is considered unlikely to occur in practice.

The site specific UXO Threat and Risk Assessment Report carried out for Erebus (6-Alpha Associates, 2020) concluded that the maximum realistic worst case charge weight that can be expected to be presented in the Erebus study area is 331 kg (ferrous mass).

For a UXO charge weight of 525 kg NEQ, the predicted PTS-onset impact range is 2.5 km for seals, which equates to disturbance to 1 individual (Table 8.33), which is 0.002% of the MU. Given that the maximum expected UXO charge weight expected in the study area is only 331 kg, then the PTS-onset impact range for seal would be between 1.9 km (for a 240 kg charge) and 2.5 km (for a 525 kg charge).

As stated in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report, there are considerable assumptions behind this calculation: "*assumes no degradation of the UXO and no smoothing of the pulse over that distance, which is very precautionary… it is likely that the*

long-range smoothing of the pulse peak would reduce its potential harm and the maximum 'impulsive' range for all species is very precautionary".

Subacoustech therefore advises that "*it is likely that the long-range smoothing of the pulse peak would reduce its potential harm and the maximum 'impulsive' range for all species is very precautionary and unlikely in practice*". Given this, the impact range of up to 2.5 km for seals is considered to be highly precautionary.

As an absolute worst-case scenario, based on a 525 kg NEQ UXO detonation, the maximum area for potential risk of auditory injury in harbour porpoise outlined by the Volume 2, Appendix 12.2: Underwater Noise and Vibration Technical Report, without any mitigation, is 19.63 km^2 (corresponding with 1.42% of the Pembrokeshire Marine SAC area), which could affect up to 1 individual (0.002% of the MU reference population). It should be noted that this is to be considered an absolute worst case scenario and is not expected to occur in practice.

Table 8.33: PTS-onset impact ranges and number of animals predicted to experience PTS-onset for high order UXO detonation

Threshold	Species	Metric	25 kg NEQ	55 kg NEQ	120 kg NEQ	240 kg NEQ	525 kg NEQ
Unweighted SPL_{peak}							
218 dB PCW	Grey seal	Range km	0.9	1.1	1.5	1.9	2.5
		#	<1	<1	<1	<1	1
Weighted SEL_{ss}							
185 dB PCW	Grey seal	Range km	0.38	0.56	0.83	1.1	1.6
		#	<1	<1	<1	<1	<1

With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project UXO clearance would lead to a reduction in the long-term viability of grey seal populations designated at this site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with auditory injury from UXO clearance**.

Pile Driving

Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report presents predictive underwater noise model estimates for noise levels likely to arise during Project

construction activities. These outputs have been used to determine the potential effects on grey seal.

Underwater noise modelling results indicated that the largest instantaneous PTS-onset impact range (unweighted SPL_{peak}) for impact piling was estimated at 50 m for grey seal at both the WTG locations selected for model analysis (Table 8.34). In modelled scenarios, <1 animal is expected to be within its respective PTS-onset impact range (0.002% of MU reference populations). The estimated maximum number of grey seal that could potentially be at risk of PTS from cumulative SEL is also <1 seal.

PTS-onset impact range predictions assume that all animals within the PTS-onset range are impacted, which will overestimate the true number of impacted animals. Only 18-19% of the animals within this range are predicted to experience PTS, within the area in which the PTS-onset threshold is exceeded, meaning that the numbers provided are likely to be an overestimation (see Chapter 12: Marine Mammals). In addition, the sound is modelled as being fully impulsive, irrespective of distance from the pile, which is highly precautionary and results in predictions that are unlikely to be realistic. The Project will also be adhering to a piling mitigation plan, to be agreed with stakeholders post-consent, which will further reduce the risk of PTS occurring to negligible levels.

Table 8.34: PTS-onset impact ranges for grey seal from impact piling – worst-case (800 kJ)

Threshold	Species	Parameter	WTG01 (NW)	WTG10 (E)
Instantaneous PTS: Unweighted SPL_{peak}				
218 dB (PCW)	Grey seal	Area	< 0.01 km^2	< 0.01 km^2
		Max Range	< 50 m	< 50 m
		# Grey seal	<1	<1
Cumulative PTS: Weighted SEL_{cum}				
185 dB (PCW)	Grey seal	Area	< 0.1 km^2	< 0.1 km^2
		Max Range	< 100 m	< 100 m
		# Grey seal	<1	<1

With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project piling activities would lead to a reduction in the long-term viability of grey seal populations designated at this site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with auditory injury from pile driving**.

Other Construction Activities

A simple assessment of the noise impacts from non-piling noise is presented in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration. The expected or potential noise sources at the offshore site, considered in this assessment as other construction activities, are:

- Vessel movements – large and medium vessels;
- Seabed preparation - two types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles.

The ES concluded that the impact of non-piling construction noise, under the maximum design scenario, is not considered to have a significant effect on any marine mammal species considered in this assessment.

Using the non-impulsive weighted SEL_{cum}, PTS impact ranges were <10 m for Phocid Carnivores in Water (PCW). These are the worst-case scenario PTS impact ranges, as these values are based on a scenario where animals remain within these very small areas of effect for 24 hours. In reality, this is considered to be extremely unlikely, and it is far more likely that any marine mammal within the injury zone would move away from the source of disturbance. This resulted in PTS impact ranges of <10 m for PCW for all non-piling construction activity; a grey seal would have to be within 10 m of the continuous noise source at the start of the activity to acquire the necessary exposure to induce PTS (Table 8.35). Furthermore, these noise sources will have a highly localised spatial extent, short duration and will be intermittent.

As a worst-case scenario, based on rock placement and the presence of 2 large vessels, the maximum area for potential risk of auditory injury in grey seal, without any mitigation, is 7.9 km^2, which could affect up to 0.32 individuals (0.002% of the relevant MU reference population). This area represents up to 0.57% of the Pembrokeshire Marine SAC.

There is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project construction activities would negatively impact conservation objectives for the Pembrokeshire Marine SAC site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. As such, it is considered highly unlikely that this would lead to a reduction in the long-term viability of grey seal populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there will be **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with auditory injury from other construction activities**.

Table 8.35: Summary of the source level (SEL_{cum} dB re 1 µPa @ 1 m RMS) and PTS-onset impact ranges (m) for the different construction noise sources using the non-impulsive criteria from Southall *et al.* (2019) for grey seal assuming a stationary receptor (S)

Noise source	Source Level	PTS S (m)
Vessel movement (large)	168	<10
Vessel movement (medium)	161	<10
Backhoe dredging	165	<10
Suction dredging	186	<10
Cable laying	171	<10
Trenching	172	<10
Rock placement	172	<10
Drag embedment anchors	171	<10
Suction pile installation	192	<60
Drilling	170.1	<10

Potential for Disturbance Resulting from Underwater Noise

Construction Phase

UXO Clearance

As outlined above, the Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario throughout the ES and has formed the basis of the impact assessment undertaken in Chapter 10: Fish and Shellfish Ecology and Chapter 12: Marine Mammals. Deflagration employs a low-order explosive to burn the explosive material within the main charge without detonating it. Whilst deflagration charges typically have a TNT equivalent charge weight of <250 g, a realistic worst-case scenario is represented within this assessment as having a charge weight of 2 kg. For the basis of this assessment an EDR of 5 km (based on a worst-case scenario 2 kg detonation) is applied, when considering the potential for disturbance from an individual UXO clearance, with 1 detonation anticipated during the construction period. Since the array area boundary is located within the Pembrokeshire Marine SAC, any UXO detonation would not overlap spatially with the SAC, with the potential for disturbance to grey seal features.

An EDR of 5 km (78.5 km^2) would contribute to a total of 5.6% of the total Pembrokeshire Marine SAC (1,380.4 km^2). Assuming an EDR of 5 km the assessment indicates that 3 grey seal, equating to 0.005% of the relevant MU reference population could be temporarily disturbed during any UXO clearance in the offshore development area, based on the worst-case scenario (Table 8.36).

With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project UXO clearance activities would lead to a level of disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour of grey seal populations designated at this site. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with disturbance from UXO clearance**.

Table 8.36: Estimated area of Pembrokeshire Marine SAC that grey seal could potentially be disturbed from during UXO clearance

Species	Density (#km^2)	Area (km^2) % Area of SAC	#Disturbed	MU	% MU Disturbed
Grey seal	0.041	78.5 5.6%	3	OSPAR Region III: 66,100	0.005%

Pile Driving

The ES assessed the disturbance impact for piling using the dose-response approach and predicted that, as the worst-case scenario (800 kJ at WTG10 (E)), a mean of 18 (95% CI: 1-37) grey seals may experience disturbance from impact piling, equating to 0.3% of the MU reference population (Table 8.38). Using the maximum most likely scenario (600 kJ at WTG10 (E)), this is reduced to 12 (95% CI: 1-24) animals at 0.2% of the MU reference population.

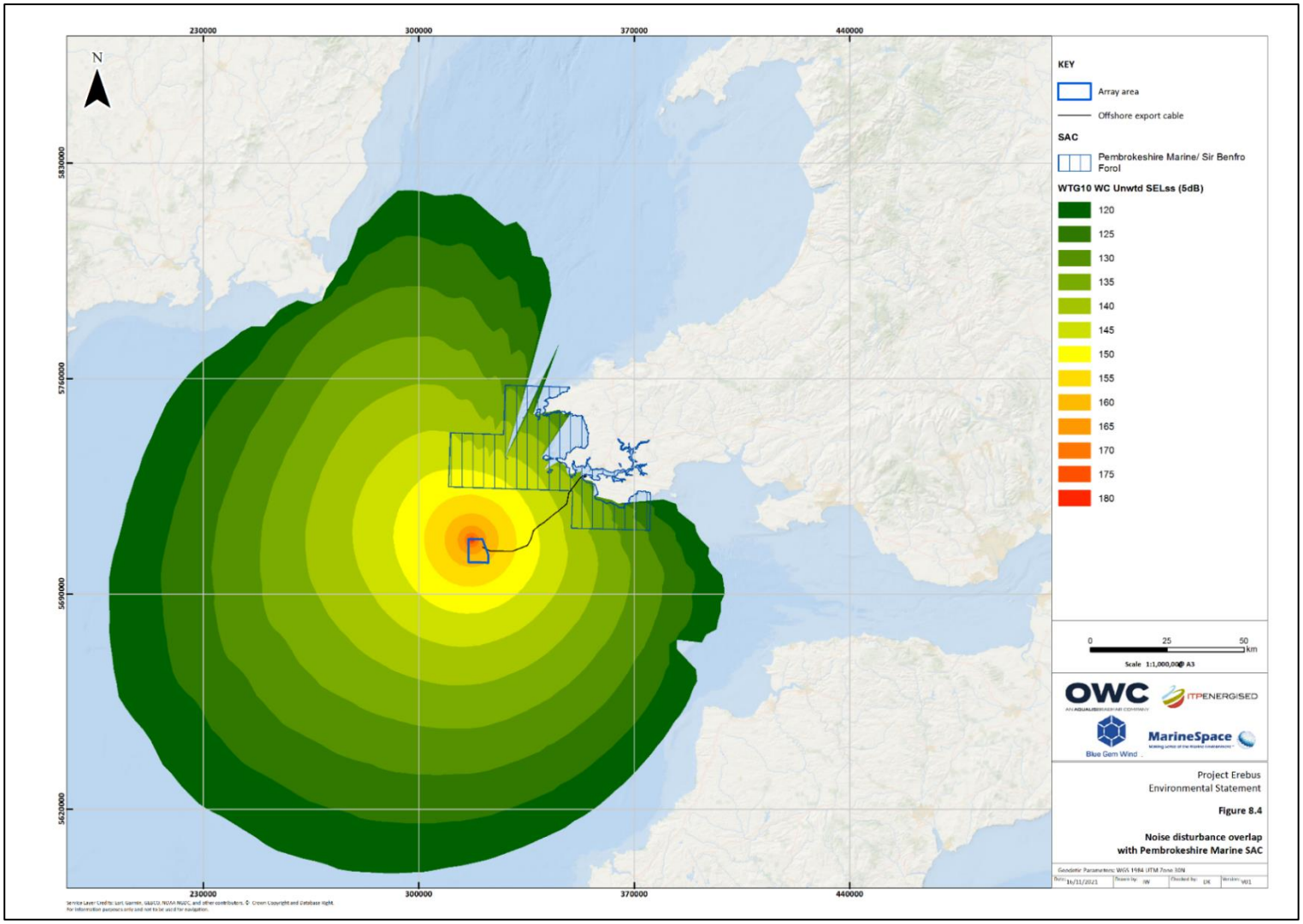
In order to assess the extent of the disturbance effect on the SAC, the 5 dB SEL_{ss} noise contours were used, alongside the dose-response curve to estimate the area of the SAC that would be impacted. The total area of Pembrokeshire Marine SAC impacted, according to dose response calculations is 137.79 km², which corresponds with 9.98% of the total SAC extent (Table 8.37; Figure 8.3).

Table 8.37: Interaction between 5 dB SELss noise contours and Pembrokeshire Marine SAC; dose-response curve values provided to allow determination of area of the SAC impacted

Impact contour SELss	Area overlap with SAC (km²)	Dose Response	Area of SAC impacted (km²)
180+	0	1	0
175<180	0	0.648	0
170<175	0	0.7626	0
165<170	0	0.5438	0
160<165	0	0.4852	0
155<160	0	0.4872	0
150<155	94.16	0.4731	44.55
145<150	256.37	0.3637	93.24
<145	304.89	0	0
Total	**665.42**		**137.79**

Figure 8.3: Overlap between 5 dB SELss noise contours and the Pembrokeshire Marine SAC

Spatial area of overlap detailed in Table 8.36



With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that subsea acoustic emissions associated with Project pile driving activities would lead to a significant level of disturbance to grey seal populations designated at this site. It is expected that any disturbance would not be sufficient to suppress reproductive success, physiological health or long-term behaviour of grey seal populations. In addition, the spatial area at risk is low and the percentage of the MU reference population that may be at temporarily affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with disturbance from pile driving**.

Table 8.38: Disturbance impact for impact piling using the dose-response approach

Species	Worst-case (800 kJ)		Most likely (600 kJ)	
	WTG01 (NW)	WTG10 (E)	WTG01 (NW)	WTG10 (E)
Grey seal	15 (1-31)	18 (1-37)	10 (1-21)	12 (1-24)
MU: 66,100	0.023% (0.002-0.047)	0.027% (0.002-0.056)	0.015% (0.002-0.032)	0.018% (0.002-0.036)

Other Construction Activities

A simple assessment of the noise impacts from non-piling noise is presented in Volume 3, Technical Appendix 12.2 Underwater Noise and Vibration. The expected or potential noise sources from the Project considered in this assessment as other construction activities are:

- Vessel movements – large and medium vessels;
- Seabed preparation - 2 types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles.

The ES concluded that the predicted level of disturbance from other construction activity (dredging, cable laying, rock placement, drag embedment anchors, suction pile anchors, drilling and sheet piling) was negligible to minor (adverse) significance, which is not significant in terms of the EIA regulations.

Table 8.39 shows that suction dredging, cable laying, trenching and drilling activities will elicit the highest levels of disturbance for grey seal. However, disturbance from these activities will only affect 3 individuals, which relates to 0.005% of the relevant MU reference population. These activities will not occur concurrently, it is expected that only 1 activity will be occurring at any given time,

therefore this assessment is highly precautionary. Based on only 1 activity occurring, the total area of disturbance in relation to other activities will compromise 5.6% of the Pembrokeshire Marine SAC.

There is no indication that the potential for auditory injury caused by subsea acoustic emissions associated with Project construction activities would negatively impact conservation objectives for the Pembrokeshire Marine SAC site. The spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. As such, it is considered highly unlikely that this would lead to a level of disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour of grey seal populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with disturbance from other construction activities**.

Table 8.39: Disturbance to grey seal associated with the other construction activities at the Project

Potential Effect	Suction Dredging	Cable Laying	Trenching	Rock Placement	Drag embedment anchors	Suction pile installations	Drilling
Maximum area of disturbance for grey seal	5 km 78.5 km²	5 km 78.5 km²	5 km 78.5 km²	100 m 0.03 km²	200 m (based on vessel disturbance) 0.13 km²	500 m 0.79 km²	5 km 78.5 km²
Maximum number of grey seal and % of MU and SACs	3 individuals 0.005% of the MU reference population 5.6% of SAC	3 individuals 0.005% of the MU reference population 5.6% of SAC	3 individuals 0.005% of the MU reference population 5.6% of SAC	<1 individual <0.002% of the MU reference population 0.001% of the SAC	<1 individual <0.002% of the MU reference population 3.6% of the SAC	<1 individual <0.002% of the MU reference population 0.08% of the SAC	3 individuals 0.005% of the MU reference population 5.6% of SAC

Operational Phase

Vessel Traffic

It is anticipated there will be 2 crew transfer vessels on site per day (1 per 12 hour period) conducting round trips throughout the operational lifetime, so this will not result in a significant increase in vessel traffic in the area.

Grey seal have been shown to respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m (Thomsen *et al.,* 2006), due to their wide range of hearing from 50 Hz-86 kHz (Southall *et al.,* 2019). However, they are frequently observed in areas of high vessel traffic, particularly within 50 km of the coast close to seal haul-outs (Jones *et al.,* 2017b). The co-occurrence of grey seal and vessel traffic has also not been linked to any adverse impact on population size.

It is also likely that grey seal will become habituated to increased boat traffic, particularly larger commercial vessels which have predictable patterns of movement and do not actively disrupt feeding behaviour as a recreational or tourist vessel may (Sini *et al*., 2005).

Using the worst-case scenario, of the disturbance of all grey seal over the entire area of the wind farm and offshore cable corridor, 43.5 km^2 potential disturbance effects could impact 2 individuals, equating to 0.003% of the respective MU reference population and disturbance impacts from vessels would occur in 3.15% of the SAC.

With respect to the conservation objectives of the Pembrokeshire Marine SAC, disturbance associated with operational vessel traffic will be low and will present no risk of suppressing reproductive success, physiological health or long-term behaviour. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with disturbance from vessel traffic**.

Disturbance to Haul-out Sites

The presence of vessels close to the coast and additional noise from onshore/landfall construction of the export cable route has the potential to lead to the disturbance of coastal and onshore habitats used by seals as haul-out sites.

One of the main seal breeding sites is located in north Pembrokeshire, approximately 48 km from the Project array area and 12 km from the landfall site (West Angle Bay) (SCOS, 2020).

The ES concluded that the location of the landfall site (West Angle Bay) is too far from the nearest key grey seal haul-out/breeding site to cause any disturbance to the seal haul-outs.

A study of grey seal mothers found that they responded to vessel disturbance by moving into the water, more due to boat speed than as a result of the distance, although movement into the water was generally observed to occur at distances of between 20 m and 70 m, with no detectable disturbance at 150 m (Strong and Morris, 2010; Wilson, 2014). In other studies, grey seal have also been reported to move into the water when vessels are at a distance of approximately 200-300 m (Wilson, 2014).

Disturbance on grey seal breeding beaches also has the potential to interrupt mother-pup bonding and there is the potential for separation and energetic loss, although this disturbance is thought to be of a lesser extent for grey seal than harbour seal (Wilson, 2014). However, a degree of habituation has also been observed in grey seal in response to frequent non-harassing vessels (Strong and Morris, 2010). For example, on breeding beaches on Ramsey Island, frequent tour boat vessel traffic occurs, yet no reduction in reproductive rate has been recorded (Strong and Morris, 2010); indicating that seals may become habituated to the regular Project vessel traffic during the construction phase.

There is the potential for vessels moving between port and the array area during all project phases to cause disturbance to grey seal haul-outs, however, it is not expected that any vessels would pass close enough to the haul-out or be travelling at sufficient speed to result in any disturbance. The ES therefore concluded that the impact, should it occur, is predicted to be of local spatial extent, short-term duration, intermittent and is reversible, with no potential for survival and reproductive rates to be impacted to the extent that the population trajectory would be altered.

It can therefore be determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with disturbance to seal haul out sites**.

Collision Risk

Construction Phase

As outlined in previous sections, during the construction of the Project there will be an increase in vessel traffic, within the site and the wider region. This increased vessel presence and movements associated with the construction of the Project could have the potential to increase the collision risk with grey seal using the site. Collision with a boat or ship may result in physical trauma injuries such as blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision of marine mammals (in this case grey seal) with vessels would be directly influenced by the type of vessel and the speed at which it is travelling (Laist *et al.,* 2001). It is also indirectly influenced by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

It is anticipated that there will be a maximum of 4 vessels required for semi-submersible floating platform installation on site at any one time on 60 days; and that vessel movements for cable installation will occur on 228 days of the 8 month construction period. In addition, vessels will follow established shipping routes where possible when transiting between the offshore site and other ports to minimise vessel traffic.

The ES concludes grey seal are considered relatively small and highly mobile, and given observed behavioural responses to noise, are expected to detect vessels in close proximity and largely avoid collision. 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).

Furthermore, the UK Cetacean Strandings Investigation Programme (CSIP) documents the annual number of reported strandings and the cause of death for those individuals examined at post-mortem. The CSIP data show that very few strandings have been attributed to vessel

collisions[25], therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post-mortem examinations.

The Project has committed to the implementation of a Vessel Management Plan (VMP) which adopts best practice vessel handling protocols in order to reduce the risk of collision to negligible levels (e.g. following the Codes of Conduct provided by the WiSe Scheme, the Scottish Marine Wildlife Watching Code, or the Guide to best practice for watching marine wildlife). In addition, vessels will follow established shipping routes where possible, when transiting between the Project and other ports to minimise vessel traffic.

Consequently, it is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions. In addition, the embedded mitigation of a vessel management plan will ensure that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals.

With respect to the conservation objectives of the Pembrokeshire Marine SAC, considering the very low percentage of the MU reference population potentially at increased risk of collision, and in view of the mitigation measures outlined above there is no indication that any increase in collision risk would impact the viability of designated grey seal populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with subsea collision during the construction phase**.

Operational Phase

Chapter 12: Marine Mammals concluded that it is not expected that the level of vessel activity during operations would cause an increase in the risk of mortality from collisions. The adoption of a vessel management plan during operations will minimise the potential for any adverse effect.

In response to the Project HRA Screening Report (NRW, 2021c), NRW advised that assessment of collision risk should include consideration of potential for collision with Project infrastructure. There is no information available on the potential for marine mammals to collide with floating WTG sub-structures. However, given the relative spatial scale of devices, the low number of devices at the array area, the water depth, and the size of marine mammals, it is expected that the risk of collisions would be negligible. In addition, turbine sub-structures remain relatively stationary, and it is therefore expected that these could easily be avoided by marine mammals present in the area.

Garavelli (2020) suggests that the relative spatial scale of devices and their associated mooring lines, the water depth and the size of marine mammals indicates that the likelihood of encounter is low,

[25] (CSIP, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018)

given the very small cross section of the water column occupied by the subsea mooring lines and cables. It is important to note that, while floating wind farms are relatively new in the offshore wind industry, the oil and gas industry has used offshore floating oil rig platforms for decades.

In view of this, it is considered there is negligible risk of collisions between marine mammals and floating wind structures. With respect to the conservation objectives of the Pembrokeshire Marine SAC, this does not constitute a risk to the long-term viability of designated grey seal populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with subsea collision during the O&M phase**.

Decommissioning Phase

During decommissioning, it is anticipated that there will be a similar number, or fewer, vessels on site than during construction, so this will not result in a significant increase in vessel traffic in the area. These vessels are also anticipated to be stationary or slow moving for significant periods of time throughout operations at the Project Erebus. Therefore, again, it is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions

As determined for the construction phase, the level of vessel activity associated with decommissioning activities will not adversely affect the conservation objectives of the Pembrokeshire Marine SAC. The low associated risk of collision will not adversely affect viability of grey seal populations designated at this site. It can therefore be concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with subsea collision during the decommissioning phase**.

Entanglement

Construction Phase

There is no pathway for entanglement effects to occur during the construction phase.

Operational Phase

The mooring lines, inter-array and export cables present in the water column during the operation phase of the Project may represent an entanglement risk for marine mammals. Entanglement is defined as the unintentional capture/restraint of marine animals by strong, flexible, anthropogenic materials such as stationary ropes, lines, cables and other mainly linear structures including lines associated with fishing gears (Benjamins *et al.,* 2014).

The mooring lines, inter-array and export cables present in the water column during the operational phase of the Project may represent an entanglement risk for marine mammals. Entanglement is defined as the unintentional capture/restraint of marine animals by strong, flexible, anthropogenic materials such as stationary ropes, lines, cables and other mainly linear structures including lines associated with fishing gears (Benjamins *et al.,* 2014).

There is nothing in the existing literature to suggest that entanglement of marine mammals in catenary or tensioned mooring lines is likely to pose a significant risk, however Garavelli (2020) suggests that the relative spatial scale of devices and their associated mooring lines, the water depth, and the size of marine mammals indicates that the likelihood of encounter is low because the subsea structures (mooring lines and cables) occupy a very small cross section of the water column. It is important to note that, while floating wind farms are relatively new in the offshore wind industry, the oil and gas industry have used offshore floating oil rig platforms for decades. The impact of entanglement with floating oil rigs is considered to be negligible (Morandi *et al.,* 2018) and thus a similar level of risk can be expected from floating wind structures.

The Applicant will consider the option for monitoring and reporting on this impact pathway as part of the MMMP. Should any monitoring suggest that the likelihood of this impact occurring is higher than expected, then contingency measures will be put in place. The exact measures within the contingency plan have yet to be determined, and consultation and agreement with stakeholders will be sought. Measures could, for example, involve more regular monitoring of lines and cables, in order to remove any snagged derelict gear/marine litter as quickly as possible, to minimise the chance of indirect entanglement.

Therefore, in light of the existing literature suggesting that entanglement will not pose a significant risk to marine mammals, and mitigation in the form of monitoring and reporting as part of the MMMP, it is concluded that the potential for entanglement will not prevent the conservation objectives for this site from being obtained. The low associated risk of adverse effects will not lead to a reduction in the long-term viability of grey seal populations designated at this site. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. It is therefore concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with entanglement**.

Decommissioning Phase

There is no pathway for entanglement effects to occur during the decommissioning phase.

Barrier Effects

Construction Phase

Underwater noise during construction could have the potential to create a barrier effect to grey seal, preventing movement or migration between important foraging and/or breeding areas as a result of avoidance of the Project area.

The worst-case scenario in relation to barrier effects as a result of underwater noise, is based on the maximum spatial scenarios. This assumes the maximum potential disturbance there could be at any one time. This has been assessed earlier in this section, for the maximum area of potential disturbance for underwater water noise from any construction activities, maintenance and repowering activities and vessels, based on the worst-case scenarios and maximum potential ranges for:

- UXO detonation;
- Vessel movements – large and medium vessels;
- Seabed preparation - 2 types of dredging, backhoe and suction;
- Cable installation – noise from cable laying vessel and trenching machinery;
- Cable protection – noise from rock placement;
- Installation of drag embedment anchors;
- Suction pile installation;
- Drilling to install foundation piles (Table 8.10).

As a worst-case scenario, as a result of the maximum area of potential disturbance and any barrier effects from underwater noise during construction, up to 13 individuals could be affected at any one time (0.02% of the relevant MU reference populations).

With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that the potential barrier effects would be of sufficient magnitude as to lead to a reduction in the long-term viability of grey seal populations designated at this site, or to constitute disturbance sufficient to suppress reproductive success, physiological health or long-term behaviour. The spatial extent of any barrier will be very small and the percentage of the MU reference population that may be at affected is low. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with barrier effects during construction**.

Operational Phase

The presence of the floating WTGs and substructures during the operational phase of the windfarm has the potential to result in barrier effects for marine mammals. Barrier effects during the operational phase may be relevant to the following conservation objectives:

- Grey seal range within the SAC and adjacent inter-connected areas is not constrained or hindered;
- The sites and amount of supporting habitat used by grey seal are accessible and their extent and quality is stable or increasing.

Recent tagging work by Russell *et al.* (2014) found that some tagged grey seals demonstrated grid-like movement patterns as the animals moved between individual WTGs, strongly suggestive of these structures being used for foraging. A number of recent studies have reported the presence of marine mammals within wind farm footprints. For example, at the Horns Rev and Nysted offshore wind farms in Denmark, long-term monitoring showed that both harbour porpoise and harbour seals were sighted regularly within the operational OWFs, and within two years of operation, the populations had returned to levels that were comparable with the wider area (Diederichs *et al.* 2008). There is no information available on the potential for floating WTG sub-structures to result in barrier effects for marine mammals. However, given the relative spatial scale of devices, the low number of devices at the array area, the water depth, and the size of marine mammals, it is expected that marine mammals would be unlikely to perceive the substructures at the array area as a barrier to movement.

The estimated maximum area taken up by the project is 43.5 km^2.Therefore, the number of grey seal that could be at risk of potential barrier effects based on the maximum area of 43.5 km^2 is 2 individuals (0.003% of the MU reference population). At any one time the maximum area of potential disturbance as a result of potential physical barrier effects could be up to 4.54% of the Pembrokeshire Marine SAC.

With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that the predicted barrier effects would be of sufficient magnitude as to lead to a reduction in the viability of grey seal populations designated at this site, or to cause disturbance that would suppress reproductive success, physiological health or long-term behaviour. The spatial extent of any barrier will be very small and the percentage of the MU reference population that may be at affected is low. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with barrier effects during the O&M phase**.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with barrier effects during the decommissioning phase**.

Potential Effects to Prey Resources

Construction Phase

Given that grey seal are dependent on fish prey, there is the potential for indirect effects, as a result of impacts upon fish species or the habitats that support them.Chapter 12: Marine Mammals states that grey seal are generalist feeders, with key prey species including Atlantic cod, righteye flounders, large-tooth flounders, (Stringell *et al.*, 2015; Nelms *et al.*, 2019) and whiting, poor-cod, Dover sole and Atlantic herring (Evans and Hinter, 2013).

During construction activities, there is the potential for disturbance to both Atlantic herring and sandeels, both of which have had potential spawning grounds identified within the Study Area and are considered a key prey species for grey seal (Santos *et al.*, 2004; Hernadez-Milian, 2011; Berrow and Rogan, 1995). The spawning grounds of both of these species are highly sensitive to disturbance, however Chapter 10: Fish and Shellfish concluded that there was no significant predicted impact from construction activities since the footprint of construction is unlikely to result in a significant change to overall stock abundance of these species. Furthermore, while there may be certain species that comprise the main part of their diet, grey seal are considered to be generalist feeders and are thus not reliant on a single prey species.

As outlined in Chapter 10: Fish and Shellfish, the worst-case scenario for temporary habitat loss during construction could be up to 1.35 km^2. As a worst-case scenario, up to <1 individual could be temporarily affected (0.002% of the MU reference population) (Table 8.40). At any one time the

maximum area of potential displacement of grey seal, as a result for changes in prey availability and temporary habitat loss, could be up to 0.29% of the Pembrokeshire Marine SAC area.

As outlined in Chapter 10: Fish and Shellfish, the worst-case scenario for long-term habitat loss as a result of project infrastructure could be up to 0.16 km^2. As a worst-case scenario, up to <1 individual could be affected (0.002% of the MU reference population) (Table 8.40). At any one time the maximum area of potential displacement of grey seal due to long-term habitat loss driven reduction in prey availability, could be 0.12% of the Pembrokeshire Marine SAC area.

As noted above, while there are certain species that comprise the main part of the grey seal diet, the grey seal is considered to be a generalist feeder and is thus not reliant on a single prey species. Therefore, works of all phases of the Project will not affect the conservation objective: "*there are appropriate and sufficient food resources within the SAC and beyond*". There is no indication that the potential effects on prey availability will be of sufficient magnitude as to affect grey seal natural range, distribution or abundance. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available.

It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with construction phase effects on prey resources**.

Table 8.40: Summary of the maximum areas of displacement of grey seal due to effects on prey resources resulting from temporary and long-term habitat loss

Effect	Temporary habitat loss during construction	Long-term habitat loss
Maximum area of displacement for grey seal	4.04 km^2	1.68 km^2
Maximum number of individuals and % of MU	<1 individuals <0.002% of the MU reference population	<1 individuals <0.002% of the MU reference population
Area of Pembrokeshire Marine/Sir Benfro Forol SAC	0.29% of 1,380.4 km^2 SAC Area	0.12% of 1,380.4 km^2 SAC Area

Operational Phase

During O&M activities, there is the potential for loss of existing habitat which currently provides foraging/spawning/nursery habitat for fish species. However, Chapter 10: Fish and Shellfish Ecology concluded that there are no significant impacts to fish species predicted during O&M. Similarly, no significant impacts to fish species were predicted during the decommissioning phase.

With respect to the conservation objectives of the Pembrokeshire Marine SAC, any potential effects on prey availability during the operational phase will be of lower magnitude than during

construction. As such, the potential indirect pressures on grey seal through reduction in resource availability will be negligible. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with O&M phase effects on prey resources**.

Decommissioning Phase

Pressures during decommissioning are assumed to be similar and of lower magnitude than those associated with construction phase. As such it is concluded that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with decommissioning phase effects on prey resources**.

Accidental Pollution

The presence of numerous works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A Marine Pollution Contingency Plan (MPCP) will be produced and agreed with stakeholders, post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity, in combination with its physical environment. The strong hydrodynamic regime across the Study Area, means that should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential impact on the benthic environment. In consideration of the standard mitigation and adoption of best practice, it is expected if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to designated grey seal populations.

During all phases of the construction, O&M, and decommissioning there is a risk of accidental pollution events. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the viability of grey seal as a component of the site or the condition

of supporting habitats and processes, and the availability of prey. It is also considered that any pollution event that did occur would be rapidly contained, avoiding physical, biological, and chemical structure and functions necessary for long-term habitat quality, or would lead to degradation in the abundance or condition of typical species. As such, it is concluded there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with accidental pollution**.

8.6.1.5. Assessment of Adverse Effects In-combination

The screening of potential in-combination pressures for marine mammals identified a number of plans and projects within the relevant grey seal MUs that were considered to have the potential to have 'in-combination' pressures for grey seal with Project Erebus (Table 8.42).

The plans and projects selected as relevant to the in-combination assessment of impacts to marine mammals are based on an initial screening exercise undertaken on a long list (Chapter 30: Cumulative Effects Assessment). A consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales has been given to select projects for a topic-specific short-list. For the potential pressures for marine mammals, planned projects were screened into the assessment based on the extent of the relevant marine mammal reference population area (MU).

Table 8.12 details the pressures considered for the Project alone (Section 8.6.1.4) and identifies which are considered to have the potential to adversely affect the integrity of SACs in relation to the conservation objectives for grey seal. In addition, it is determined that there is the no potential for in-combination disturbance to haul-outs with other projects, based on the location and distances of the projects.

Based on the information presented in Table 8.12 and the information above, the in-combination assessment will consider the following pressures for construction phase activities.

- Disturbance from underwater noise;
- Collision risk;
- Effects to prey resources;
- Accidental pollution.

Accordingly, the long-list of projects was screened to remove the following:

- All projects that are located outside of the relevant species MU;
- All projects that are already operational/active as they are considered to be existing impacts included within the baseline (this includes all shipping ports, shipping routes and oil and gas pipelines);
- All projects where there is no expected temporal overlap with construction of the Project;
- All projects where the timing of construction activities is unknown.

The offshore plans or projects considered included:

- Offshore windfarms;
- Marine renewables (wave and tidal);
- Port and harbour developments;
- Marine aggregate extraction and dredging;

- Licensed disposal sites;
- Oil and gas exploration and extraction;
- Subsea cables and pipelines.

The assessment is based on the in-combination pressures of projects using the tiered approach as described in Table 8.41**.** The tiered approach is based on guidance from the PINS (2019) Advice Note 17. The tiers reflect the likely degree of certainty and level of information associated with each development.

Table 8.41: Tiers for projects considered in the in-combination assessment

Tier	Consenting/Construction Phase
Tier 1	Operational projects that were not operational when baseline data were collected (e.g. environmental characterisation surveys); Operational projects that could have any ongoing or residual impact.
Tier 2	Projects under construction.
Tier 3	Projects that have been consented, but construction has not yet commenced.
Tier 4	Projects that have an application submitted to the appropriate regulatory body that have not yet been consented; Projects that have been consented, construction has not yet commenced and there is the potential for changes in what was consented and timelines.
Tier 5	Projects that the regulatory body are expecting an application to be submitted for determination (e.g. projects listed under the Planning Inspectorate programme of projects).
Tier 6	Projects that have been identified in relevant strategic plans or programmes.

Table 8.42outlines the projects and plans considered in the in-combination assessment. This includes all projects that are located within the OSPAR Region III seal management unit and are scheduled to conduct offshore construction activities before or at the same time as the Project.

Table 8.42: Projects screened into the in-combination assessment for grey seal feature of the Pembrokeshire Marine SAC

Project	Offshore Construction Starts	Full Commissioning	2021				2022				2023				2024				2025				2026			
			Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus	Q2 2026	Q4 2026																								
Holyhead Deep (Minesto)	2022	2022																								
Greenlink Interconnector	2024	2024																								
META – East Pickard Bay (Bombora)	Q2 2022	Q3 2023																								
Atlantic Marine Energy Test Site	2021	2021																								
Codling (Relevant Project)	01-Sep-24	01-Jan-27																								
Shearwater One	01-Jan-26	01-Jan-29																								
TwinHub	02-Jul-10	01-Jan-26																								
Dublin Array (Relevant Project)	01-Jul-25	01-Jan-27																								
Fair Head	2022	2025																								
Oriel (Relevant Project)	01-Jan-23	01-Jan-25																								

Table 8.43: In-combination assessment of disturbance to grey seal feature of the Pembrokeshire Marine SAC

Project	2021				2022				2023				2024				2025				2026			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Erebus																						18	18	18
Holyhead Deep (Minesto)					1	1	1	1																
Greenlink Interconnector													1	1	1	1								
META – East Pickard Bay (Bombora)						1	1	1	1	1	1													
Atlantic Marine Energy Test Site	1	1	1	1																				
Codling (Relevant Project)															37	37	37	37	37	37	37	37	37	37
Shearwater One																				1	1	1	1	1
TwinHub	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Dublin Array (Relevant Project)																			37	37	37	37	37	37
Fair Head					1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				
Oriel (Relevant Project)									1	1	1	1	1	1	1	1								
Total Number Impacted	3	3	3	3	4	5	5	5	5	5	5	4	5	5	42	42	39	39	76	77	74	92	92	92
% of MU Ref. Pop.	0.004	0.004	0.004	0.004	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

Note: in order to calculate the number of grey seal disturbed by each project, a uniform density was assumed within the MU (383,569 km² MU, containing 66,100 grey seal à uniform density of 0.0172 seal/km²).

Underwater Noise and Disturbance

The assessment of underwater noise and disturbance in-combination pressures assumes the following:

- The Project – disturbance impact based on maximum numbers presented in this impact assessment (worst-case from pile driving);
- Other windfarms: Pinpile - Assume construction related impacts are limited to a 15 km radius around the array area based on JNCC (2020);
- Other windfarms: Monopile - Assume construction related impacts are limited to a 26 km radius around the array area based on JNCC (2020)[26];
- Other windfarms: Floating - assume no pile driving. Assume construction related impacts are limited to a 5 km radius;
- Other windfarms: Gravity base - assume no pile driving. Assume construction related impacts are limited to a 5 km radius;
- Wave/tidal projects - assume no pile driving. Assume construction related impacts are limited to a 5 km radius.

The in-combination assessment assumes offshore construction timeline for the Project to be:

- Offshore pre-construction surveys: 01 April 2026 to 02 May 2026;
- Floater and mooring Installation: 01 June 2026 to 30 October 2026;
- Cable installation: Bulk of offshore cable installation activity anticipated May – Sept 2026.

Out of all of the offshore projects screened into the assessment for grey seal (located within the Wales MU and constructing before or concurrently with the Project), Codling, Shearwater One and Dublin Array are planned to conduct offshore construction work during the Project offshore construction window and, thus, the predicted impacts overlap (see Table 8.42). Although the remaining projects screened into the assessment for grey seal are planning offshore construction prior to the Project offshore construction window, the construction activities will occur after completion of the Project site-specific baseline surveys, and are therefore considered in this impact assessment. This means that the impact across these projects between 2021-2025 would occur irrespective of, and independent of, the Project.

The Codling offshore project screened into the in-combination assessment for grey seal (Table 8.42) involves activities typically associated with high levels of disturbance, such as pile driving construction work. Accordingly, levels of disturbance are high. Activities associated with acoustic disturbance (i.e. construction phase) for Codling, Shearwater One and Dublin array screened into in-combination assessment will be ongoing during Project construction activities. As such, levels of

[26] Although it is acknowledged that NRW does not agree with the use of the 26 km threshold, this has been used in EIA of the majority of other UK offshore renewable developments. As such, this represents the best information available for the in-combination assessment.

in-combination disturbance will exceed those for Project activities alone. It is determined that up to 92 grey seal could potentially be disturbed as a result of in-combination effects relating to noise and disturbance (this would equate to 0.1% of the MU reference population; Table 8.43). No other projects screened into in-combination assessment are located within the Pembrokeshire Marine SAC. As such, it is not considered appropriate to express disturbance in terms of the SAC area.

With respect to the conservation objectives of the Pembrokeshire Marine SAC, there is no indication that the potential levels of disturbance associated with underwater noise created by the Proposed Development or other projects considered would lead to sufficient disturbance to grey seal populations as to suppress reproductive success, physiological health or long-term behaviour. In addition, the spatial area at risk is very low and the percentage of the MU reference population that may be at affected is small. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with disturbance from underwater noise**.

Collision Risk

Construction Phase

As outlined in Section 8.6.1.4 the increased presence of vessels present during the construction phase of offshore wind farms, tidal and wave projects can pose the potential for increased collision risk with grey seal.

The assessment assumes that during the construction of offshore windfarms and other plans within the region that vessel movements to and from any port will be restricted to existing vessel routes and therefore the increased risk for any vessel interaction is considered only within the project site. Grey seal in the area would be accustomed to the presence of vessels and therefore be expected to be able to detect and avoid construction vessels.

With respect to the conservation objectives of the Pembrokeshire Marine SAC, considering the low percentage of the MU reference population potentially at increased risk of collision and in view of the mitigation measures outlined above there is no indication that any increase in collision risk would impact the long-term viability of designated grey seal populations. There is also no evidence to suggest that this pressure would adversely impact any other factor required to maintain the favourable conservation status of the grey seal feature. It can therefore be concluded that there is **no potential for an in-commination adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with subsea collision**.

Operational and Decommissioning Phase

As stated in Section 8.6.1.4 any increase in vessel movements during the operation and maintenance are determined to be lower than that of the construction phase and relatively small in relation to vessel movements in the area. Therefore, there is unlikely to be a significant increase in collision risk during the operation and maintenance of offshore windfarms and as a result this has not been

included in the in-combination assessment. The same conclusion has also been determined for the decommissioning phase. It can therefore be concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with subsea collision**.

Effects on Prey Resources

Construction Phase

The in-combination assessment on potential changes to prey availability has assumed that any potential pressures on grey seal prey species from underwater noise, including piling, would be of similar magnitude to those for grey seal. Therefore, there would be no additional effects other than those already assessed for grey seal. For example, the area in which prey are disturbed as a result of underwater noise will be the same or smaller than the area of disturbance for grey seal, therefore any changes to prey availability would not affect grey seal as they would already be disturbed/displaced from the given area. Furthermore, effects on prey species are likely to be intermittent, temporary and highly localised, and anticipated to recover quickly following cessation of the disturbance activity. Any permanent loss or changes of prey habitat will typically represent a small percentage of the potential foraging habitat in the surrounding area.

Consequently, there is no indication that the potential effects on prey availability will be of sufficient magnitude as to affect the natural range, abundance or distribution of grey seal populations. Any reductions would be highly localised and temporary and there is extensive alternative similar habitat available. It is therefore concluded that this would not adversely impact any factor required to maintain the favourable conservation status of the grey seal feature. In view of these factors, it is concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with construction phase effects on prey resources**.

Operational and Decommissioning Phase

It is determined that the in-combination impact of any of the above during the operational and decommissioning phase of the project would be no worse than the in-combination impacts assessed above for the construction period of the proposed Project Erebus. During times where there is limited or no construction in the region, impacts will be intermittent, temporary and highly localised to the source project. In view of these factors, it is concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the grey seal feature of the Pembrokeshire Marine SAC from any pressures associated with operation and decommissioning phase effects on prey resources.**

8.6.1.6. Summary

There is **no potential for any adverse effects on the integrity of the Pembrokeshire Marine SAC from the Project alone or in-combination in relation to the conservation objectives for grey seal**.

9. Special Protection Areas with Marine Components Assessment

9.1. Introduction

This section covers the assessment of adverse effects on classified populations of SPAs with marine components. The section provides information to determine whether there is an adverse effect on the integrity of the conservation objectives of the SPAs screened into assessment resulting from the potential effects of the proposed Erebus project. The chapter is structured as follows:

- A summary of HRA screening results and potential pressure pathways;
- A summary of the proposed Erebus project design envelope, outlining the worst-case scenario used to inform the assessment;
- For each SPA screened into the assessment:
  - A description of each SPA, its conservation objectives, and baseline information gathered to aid the assessment;
- For each feature of each SPA screened into the assessment:
  - A summary of the ecology of the species;
  - An assessment of the pressures during construction, operation and decommissioning of the proposed Erebus project alone;
  - An assessment of adverse effects when considering the proposed Erebus project in-combination with other developments.

9.1.1. Summary of Screening

Screening was conducted in order to identify potential exposure pathways for SPAs with marine components (refer to Volume 3, Technical Appendix 8.2: HRA Screening Report). All classified bird populations of SPAs or Ramsar sites were screened for exposure pathways. Receptor populations were initially identified using the following criteria:

- Breeding populations where the SPA/Ramsar site is located within the species-specific foraging range of the proposed works (+1 Standard Deviation (SD) where applicable; foraging range as determined by Woodward *et al.*, 2019);
- Potential for interaction between migrating individuals from classified populations of SPAs determined by migratory routes as reported in SOSS-05 (Wright *et al.*, 2012);
- SPAs that are situated entirely offshore and SPAs for wintering features if located within 10 km of the Project array area or Export Cable Corridor (ECC) footprint.

9.1.1.1. Breeding Populations

The breeding bird populations that meet these criteria and were considered further in Stage 1 screening:

- Northern gannet *Morus bassanus*;
- Northern fulmar *Fulmarus glacialis**;
- Manx shearwater *Puffinus puffinus*;

- European storm-petrel *Hydrobates pelagicus*;
- Great skua *Stercorarius skua**;
- Lesser black-backed gull *Larus fuscus*;
- Black-legged kittiwake *Rissa tridactyla*;
- Common guillemot *Uria aalge*;
- Razorbill *Alca torda*;
- Atlantic puffin *Fratercula arctica*.

*Species subsequently screened out of HRA – see below.

Connectivity with the Project array area and ECC site footprint for classified SPA breeding populations was ascertained based on foraging ranges provided in Woodward *et al.* (2019). This process identified 152 SPA sites. Based on outcomes of site-specific apportioning analysis it was established that for all species considered within assessment, the proportional weight for the closest SPA site is >0.8 and the proportional weight for the second closest SPA site is <0.04. As such, it is considered that the risk of adverse effects from Project activities on classified bird populations other than the closest SPA will be negligible.

During consultation with NRW and JNCC it was ascertained that certain species could be screened out of Stage 2 assessment (e.g. northern fulmar and great skua). For the remaining species, all sites for which connectivity with the Proposed Development has been identified based on foraging ranges provided by Woodward *et al.* (2019) are screened into assessment. However, an iterative approach has been adopted, where assessment is carried out for the site with the greatest proportional weight as determined by apportioning calculations i.e. the site from which the greatest proportion of birds of each classified population are attributed. If Adverse Effect on Site Integrity (AEOSI) is determined, then assessment will be carried out for the site with the next greatest proportional weight. If no AEOSI is determined, additional sites will not be considered further.

Table 9.1 provides a summary of the outcomes from Stage 1 screening for potential for Likely Significant Effect (LSE) on offshore classified seabird breeding populations.

Table 9.1: Screening outcome for classified SPA breeding populations with foraging ranges that overlap with the Project array area or export cable corridor

Receptor	Phase	Pressure	Screening Outcome
Atlantic puffin	Construction	Disturbance	LSE
	Construction	Underwater Noise	LSE
	O&M	Displacement	LSE
	O&M	Collision risk	No LSE; low risk of collision due to high probability of displacement and low flight height.
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very

Receptor	Phase	Pressure	Screening Outcome
			small relative to the overall habitat available to bird species.
	All phases	Accidental pollution	LSE
European storm petrel	Construction	Disturbance	No LSE due to low risk of disturbance
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	LSE
	O&M	Collision risk	No LSE due to very low flight height
	All phases	Accidental pollution	LSE
Lesser Black-backed gull	Construction	Disturbance	No LSE due to low risk of disturbance
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	No LSE due to low risk of displacement
	O&M	Collision risk	LSE
	All phases	Accidental pollution	LSE
Manx shearwater	Construction	Disturbance	No LSE due to low risk of disturbance
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	LSE

Receptor	Phase	Pressure	Screening Outcome
	O&M	Collision risk	No LSE due to low flight height
	All phases	Accidental pollution	LSE
Black-legged kittiwake	Construction	Disturbance	No LSE due to low risk of disturbance
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	LSE
	O&M	Collision risk	LSE
	All phases	Accidental pollution	LSE
Common guillemot	Construction	Disturbance	LSE
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	LSE
	O&M	Collision risk	No LSE due to low risk of collision
	All phases	Accidental pollution	LSE
Razorbill	Construction	Disturbance	LSE
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	LSE
	O&M	Collision risk	No LSE; low risk of collision due to high probability of displacement and

Receptor	Phase	Pressure	Screening Outcome
			low flight height
	All phases	Accidental pollution	LSE
Great skua	Construction	Disturbance	No LSE determined due to low numbers recorded in DAS data and low risk of collision and/or disturbance/displacement.
	Construction	Underwater Noise	
	O&M	Barrier Effects	
	O&M	Habitat loss	
	O&M	Displacement	
	O&M	Collision risk	
	All phases	Accidental pollution	
Northern gannet	Construction	Disturbance	No LSE due to low risk of disturbance
	Construction	Underwater Noise	LSE
	O&M	Barrier Effects	LSE
	O&M	Habitat loss	No LSE; the direct footprint of Project infrastructure/activities will be very small relative to the overall habitat available to bird species.
	O&M	Displacement	LSE
	O&M	Collision risk	LSE
	All phases	Accidental pollution	LSE
Northern fulmar	Construction	Disturbance	No LSE determined due to low numbers recorded in DAS data and low risk of collision and/or disturbance/displacement.
	Construction	Underwater Noise	
	O&M	Barrier Effects	
	O&M	Habitat loss	
	O&M	Displacement	
	O&M	Collision risk	
	All phases	Accidental pollution	

Although not identified, based on the assessment criteria detailed above, and not recorded in 24 months' Digital Aerial Survey (DAS) data, Balearic shearwater *Puffinus mauretanicus* have also been taken forward for Stage 2 assessment. This species has recently been recorded in waters approximately 25 km south of the Project (Philips *et al.*, 2021) and as such it is possible that its range may extend further northwards and overlap with the site of the Proposed Development. Given its status as Europe's only globally critically endangered seabird this species will be included in assessment and addressed qualitatively. Similarly, European storm-petrel were not recorded in 24 months' of DAS but have been identified as important receptors by NRW and JNCC, and as such will also be assessed qualitatively.

9.1.1.2. Migratory Populations

The migratory populations considered in the screening include:

- Red-throated diver *Gavia stellata*.
- Northern gannet;
- Manx shearwater;
- Northern fulmar;
- European storm-petrel;
- Great cormorant *Phalacrocorax carbo*;
- European shag *Phalacrocorax aristotelis*;
- Great skua;
- Black-headed gull *Chroicocephalus ridibundus*;
- Common gull *Larus canus*;
- Herring gull *Larus argentatus*;
- Great black-backed gull *Larus marinus*;
- Lesser Black-backed gull;
- Black-legged kittiwake;
- Roseate tern *Sterna dougallii*;
- Common tern *Sterna hirundo*;
- Arctic tern *Sterna paradisaea*;
- Sandwich tern *Sterna sandvicensis*;
- Common guillemot;
- Razorbill;
- Atlantic puffin.

The Screening Strategic Ornithological Support Services Migration Assessment Tool (SOSSMAT) approach was used to calculate the proportion of international and national bird populations that are expected to interact with the Project array area. All results were below the 1% threshold for UK population and therefore **no LSE** was concluded for the proposed Project alone on all migratory bird species considered.

Although the effects of the Project in-combination with other developments would be greater, and therefore may exceed the 1% threshold for in-combination assessment, it should be noted that this approach is highly precautionary. The SOSSMAT approach calculates the proportion of bird populations that may interact with the Project site. The Statutory Nature Conservation Body (SNCB) review of how avoidance rates should be applied in determination of collision risk from offshore

wind developments recommends a minimum 98% avoidance rate to be applied (SNCB, 2014). Similarly, displacement and disturbance rates are variable between species. However, mortality rates within displaced birds are not expected to exceed 1% (value informed by the rates used for Hornsea Project Three offshore wind farm, for Moray West offshore wind farm in Scotland, and from the modelling work undertaken by the Centre for Hydrology and Ecology (CEH) for the Forth and Tay offshore wind farms in Scotland). As such, taking account of likely avoidance and mortality rates, the number of individual birds affected by the Project and other developments in-combination is also likely to be considerably below the 1% threshold and therefore **no LSE** was concluded for the proposed Project in-combination on all migratory bird species considered.

9.1.2. Summary of Potential Pressure Pathways

Several potential pressure pathways were identified for the remaining features in the screening process. No LSE was determined for habitat loss and therefore this pressure has been screened out of Stage 2 assessment. Given that Section 9.1.1.2 concluded that no migratory seabird populations will be taken forward to Stage 2 assessment, no LSE is also determined for barrier effects. No LSE could not be concluded for the remaining pressures, and thus these are taken forward for Stage 2 assessment:

- Disturbance;
- Displacement;
- Underwater noise;
- Barrier effects;
- Collision risk;
- Accidental pollution.

9.2. Project Design Envelope Parameters Relevant to Offshore Ornithological Features

Table 9.2 provides parameters for use as the realistic worst-case scenario within assessment. It should be noted that these parameters are not limited to those for which there is spatial overlap between the direct or indirect area of effect and an SPA site. Due to the highly mobile nature of seabirds, it is necessary to consider pressure pathways outside SPA boundaries in order to consider potential for adverse effects on classified bird populations during transit to, or from, an SPA. As such, the parameters provided in Table 9.2 describe the full range of marine activities associated with the Project. The activities, and associated pressures are not limited to specific spatial extents of any particular SPA boundary.

Table 9.2: Project realistic worst case scenario parameters for use in assessment of potential for adverse effects on classified SPA seabird populations

Potential Pathway Change / Impact	Realistic Worst Case Scenario	Justification
Construction		
Disturbance and displacement from increased vessel activity (array and ECC)	Up to 6 x vessels active offshore at any one moment during construction phase	Vessels required for mooring lay-down, floating platform hook-up, cable installation, landfall works
Disturbance and displacement from underwater noise via construction activities (including piling and UXO)	**Piling** • 35 piled anchors; • Diameter: 2.5 m; • Length: 55 m; • Penetration depth: 52 m; • Hammer energy: 800 kJ; • Piling duration: 114 min per pile (incl. soft-start and ramp-up); • Total piling time for 35 anchors: 66.5 hours; • Maximum 2 piles installed per day; • Total 18 days piling. **UXO** The Project is seeking consent for 1 UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario. • Low order detonation: 2 kg net explosive quantity (NEQ); • High order detonation: 525 kg device, included as precautionary assessment, based on recent advice (Defra *et al.*, 2021).	**Piling** Maximum number of piles and hammer energy used to install piles represents the PTS and disturbance maximum design scenario. **UXO** Maximum number of detonations via deflagration (low-order) within the PDE. High order detonation of up to 525 kg device also modelled and assessed, although judged to be an unrealistic worst case scenario

Potential Pathway Change / Impact Operation and Maintenance	Realistic Worst Case Scenario	Justification
Collision risk	A series of scenarios were developed to inform the collision risk modelling. The scenarios present a hybrid of engineering parameters from the PDE according to the current design status of the Project. The scenarios do not reflect the parameters of a single WTG, but a combination of minimum and maximum values that are attributed to a range of potential WTG manufactures. The scenarios are as follows: Maximum number of turbines at minimum height (10 WTGs, 196 m minimum height, 109 m hub height, 174 m rotor diameter, 22 m air gap, 9.5 MW rated power)	The worst case is defined on a species-by-species basis depending on the proportion of seabirds flying at collision risk height.
	Minimum number of turbines at maximum height (6 WTGs, 270 m maximum height, 150 m hub height, 242 m rotor diameter, 22 m air gap, 16-18 MW rated power) Realistic worst case (7 WTGs, 244 m total height, 133 m hub height, 222 m rotor diameter, 22 m air gap, 14 MW rated power)	
Displacement/Barrier Effect	10 x WTGs with a maximum spacing of 3,500 m between each turbine	Largest area of seabed activity that may lead to displacement effects on seabirds.
Disturbance and displacement from vessel activity (O&M and cable repairs)	Vessel quantities per year: 2 x 12 hr day (CTV) (transit 1.5-2 hrs)	The maximum numbers of vessels and associated vessel movements represents the maximum potential for collision risk and disturbance.

Potential Pathway Change / Impact	Realistic Worst Case Scenario	Justification
Decommissioning		
Indirect impacts as a result of displacement of prey due to construction activities	As per construction phase	As per construction phase
Disturbance and displacement from increased vessel activity (array and ECC)	As per construction phase	As per construction phase
Disturbance and displacement from underwater noise via construction activities (including piling and UXO)	As per construction phase	As per construction phase

9.3. Approach to Assessment

This assessment is provided to determine Project activities which can be expected to result in an adverse effect on the integrity of the conservation objectives related to classified SPA seabird populations screened into Stage 2 assessment.

The subsequent sections are structured as follows:

- A summary of baseline surveys completed to date, and the key findings relevant to classified SPA populations;
- Details of approach that is be adopted for apportioning, displacement analysis, collision risk modelling and population viability analysis. Where appropriate, details are provided on spatial scale and relevant species-specific parameters;
- A description is provided for each SPA considered in Stage 2 assessment, including details of the classified seabird features which are screened into assessment, the relevant conservation objectives and current conservation status;
- A description of the potential pressures associated with the Proposed Development and how these may interact with the classified populations and conservation objectives for these SPA sites alone;
- An assessment of in-combination pressures when considering the Proposed Development together with other developments;
- Proposed mitigation measures to avoid adverse effects on the SPA features over and above embedded mitigation;
- A summary of potential for adverse effects on the integrity of the relevant SPAs.

9.4. Digital Aerial Surveys and Modelling

9.4.1. Digital Aerial Survey Data Collection

24 months' of Digital Aerial Surveys (DAS) were commissioned by the Applicant following consultation with NRW (October 2019). It was agreed surveys would be undertaken of the array area and a 4 km buffer, see Volume 2, Figure 11.1: 1km Transects within the Survey Area and 4km Buffer. The results of these surveys are presented in Volume 3, Technical Appendix 11.6: Year 2 Bird Survey Report and relevant information summarised for assessment in Volume 3, Technical Appendix 11.1: Baseline Data.

DAS focus on the seabird (and other marine fauna) interests that may be present in the array area and 4 km buffer and aim to provide a representative sample of seasons over a 24 month pre-construction period to characterise the site.

Monthly surveys were flown from October 2019-September 2021, with a survey design that placed 15 transects, spaced 1 km apart across the Project array area and a 4 km buffer, comprising a total area of 200.11 km^2, see Volume 3, Technical Appendix 11.6: Year 2 Bird Survey Report. The transects had a north/south orientation principally so that they were perpendicular to the water depth gradient and potential oceanic fronts, thus helping to reduce variation in bird and mammal abundance between transects.

The DAS were undertaken using a specialist survey aircraft equipped with four Gen II cameras with sensors set to a resolution of 2 cm ground sample distance when flown at ~550 m above relative sea level. Each camera sampled a strip of about 125 m width, separated from the next camera by approximately 25 m, which provides a combined sampled width of 500 m within a 575 m overall strip. Two cameras were analysed giving ~25% sample coverage of the site.

Data analysis followed a two-stage process in which video footage was reviewed (with a 20% random sample used for audit) then the detected objects were identified to species or species group level (again with 20% selected at random for audit). The audit of both stages requires 90% agreement to be achieved.

Density and abundance estimates were calculated using strip transect analysis and a statistical technique called Kernel Density Estimation (KDE) was used to create density surface maps. A full summary of the survey methodology and survey results is available in Volume 3, Technical Appendix 11.6: Year 2 Bird Survey Report.

9.4.2. Additional Data

Following a meeting held on the 28 January 2021 with NRW, JNCC, Royal Society for the Protection of Birds (RSPB), Wildlife Trust of South and West Wales (WTSWW) and representatives from Oxford University, Heriot-Watt University, Sheffield University, University of Gloucestershire, and the British Trust for Ornithology (BTO), it became evident that data, in addition to that from the DAS, were available to inform the impact assessment. Further discussions were held with those researchers responsible for each data set, and the following data analysis was commissioned by the Applicant:

- Langley L, and Votier S, July 2021. Grassholm Gannet Project – Analysis of tracking data to inform Erebus EIA (Heriot-Watt University). The report provides analysis of northern gannet tracking data including: analysis of connectivity between the Project array area (and 4 km

buffer) and Grassholm SPA using existing GPS tracking data; an estimate of flux through the Project array area (including details of age of bird and season); behavioural usage of the Project array area, for example travelling/searching/feeding/resting; analysis of diurnal activity patterns of gannets within the Project array area including nocturnal and crepuscular activity; and average flight speed through the Project array area;

- Davies K, Padget O, and Guilford T, July 2021. An analysis of Oxnav Manx shearwater tracking data in relation to the Erebus project (University of Oxford). The report provides analysis of Manx shearwater tracking data including: analysis of connectivity between the Project array area (and 4 km buffer) and Skomer, Skokholm and Seas off Pembrokeshire/ Sgomer, Sgogwm a Moroedd Penfro SPA, and other important SPA breeding colonies using existing GPS tracking data; analysis of diurnal activity patterns of Manx shearwaters, including nocturnal and crepuscular, activity within the Project array area using GPS tracking data; provide an expert opinion on flight heights using currently unpublished on-board video-tracking data; and provide an assessment as to the important of the Project for Balearic shearwaters and connectivity with Spanish SPAs;
- Birkhead T, September 2021. Skomer Common Guillemot long-term population study: analysis of survival data to inform Erebus EIA (University of Sheffield). The report provides analysis of common guillemot survival data based on the long-term population study on Skomer, running since 2007, comprising guillemot annual survival estimates of adults, immatures and juveniles.

The Applicant recognised the importance of reviewing/acquiring as much data as possible. However, most data were privately held (i.e. not in the public domain) and so any analysis commissioned was funded by the Applicant, in addition to the 24 months' DAS. Therefore, proposals were prioritised based on the species and number of birds recorded during the DAS; to ensure they added value to the data gathered during the 24 months' of DAS and subsequent impact assessment. Discussions were held with the following organisations, but no specific work was commissioned:

- Niall Burton and Chris Thaxter, BTO. Discussions were held with the BTO regarding analysis of lesser black-backed gull tracking data. Lesser black-backed gull were not considered as high a priority as northern gannet, Manx shearwater and common guillemot; having been recorded in far fewer numbers in the DAS. Accordingly, it was considered the data gathered during the 24 months DAS were sufficient to inform the EIA and HRA;
- Matt Wood, seabird populations, University of Gloucestershire. Matt Wood co-ordinates the monitoring of survival (and in some cases productivity) for 6 species of seabirds on Skomer, other than common guillemot (see above). These data could be helpful to inform population viability analysis (PVA) if required, but predicted impacts are so low that judgements on significance for most species can be made without the use of PVA.

The reports commissioned by the Applicant provide information that can be used to confirm connectivity between SPAs and the array area as required for HRA. The northern gannet and Manx shearwater data have been used to confirm the apportioning calculations, Volume 3, Technical Appendix 11.2: Apportioning, and used in assessments provided in this chapter. The common guillemot data have been utilised in the population viability analysis for this species presented in Volume 3, Technical Appendix 11.5: Population Viability Analysis.

The academic reports prepared by Heriot-Watt University, The University of Sheffield and The University of Oxford are confidential but may be shared with the regulators (NRW, JNCC, PEDW, The Welsh Ministers) on a confidential basis in order to corroborate the modelling and analysis performed as part of the environmental impact assessment. Release of the academic reports to other statutory consultees may be possible subject to prior written confirmation from the Applicant, Blue Gem Wind, and execution of a non-disclosure agreement with the relevant university (if appropriate).

9.4.3. Apportioning and Seasonal Biologically Defined Minimum Population Scales

Potential for connectivity between the Project and classified seabird populations during the breeding season was determined based on the species-specific foraging ranges as reported by Woodward *et al.* (2019). The mean-maximum range (i.e. the mean average of the maximum foraging trips recorded) plus one standard deviation was applied during Stage 1 screening to establish whether there is likely to be connectivity (and hence risk of an impact) between the Project and an SPA breeding colony. For those receptor species screened into assessment, apportioning was carried out following the guidance provided by NatureScot (2018). This process allows prediction of the proportion of individuals for each receptor species present at the Project site that originate from specific key SPA breeding populations.

The apportioning calculation is a weighting based on population size, distance between the Project and the breeding colonies within foraging range, and area of sea included in the foraging range (as per methodology provided by NatureScot, 2018). See Volume 3, Technical Appendix 11.2: Apportioning for full details of the methodology applied and input data used in apportioning. Apportioning outcomes for SPA breeding populations are provided in Table 9.3.

Apportioning in the non-breeding season uses data from Furness (2015) on Biologically Defined Minimum Population Scales (BDMPS) to calculate the number of birds from each SPA as a proportion of the total BDMPS population. Where evidence allows, this enables non-breeding season impacts to be linked to specific SPA breeding colonies and allows both breeding and non-breeding season impacts to be considered together against the reference population of concern. Full details of the methodology applied, and input parameters used in apportioning for the non-breeding season is provided in Volume 3, Technical Appendix 11.3: Collision Risk Modelling. Apportioning outcomes for non-breeding populations considered in Stage 2 assessment are provided in Table 9.4.

Table 9.3: Apportionment of adult seabirds to SPA and non-SPA breeding colonies within foraging range which include this species as a feature

SPA Site (and Component SSSI Sites) Northern Gannet	Count of Adults	Distance to Erebus (km)	I/proportion foraging range as sea	Resulting Weight	Proportional Weight
Grassholm	61,376	20	1.607	64.045	0.995
Saltee Islands	3,790	92	1.507	0.175	0.003
Skelligs	57,598	357	1.161	0.136	0.002

SPA Site (and Component SSSI Sites)	Count of Adults	Distance to Erebus (km)	I/proportion foraging range as sea	Resulting Weight	Proportional Weight
Manx shearwater					
Skomer, Skokholm and the Seas off Pembrokeshire	302,000	24	1.073	108.812	0.995
Aberdaron Coast and Bardsey Island	32,366	148	1.072	0.306	0.003
Rum	240,000	602	1.072	0.137	0.001
Blasket Islands	39,068	362	1.068	0.062	0.001
Black-legged kittiwake					
Skomer, Skokholm and the Seas off Pembrokeshire	2,472	24	1.774	4.275	0.817
Saltee Islands	2,076	92	1.733	0.239	0.046
Howth Head Coast	6,162	209	2.172	0.172	0.033
Lambay Island	6,640	226	2.206	0.161	0.031
Ireland's Eye	3,220	218	2.165	0.082	0.016
Wicklow Head	1,546	167	2.172	0.068	0.013
Old Head of Kinsale	1,422	206	1.325	0.025	0.005
Rockabill	532	231	2.207	0.012	0.002
Helvick Head to Ballyquin	130	152	1.520	0.005	0.001
Isles of Scilly	150	170	1.193	0.003	0.001
Common Guillemot					
Skomer, Skokholm and the Seas off Pembrokeshire	29,744	24	1.452	5.537	0.754
Saltee Islands	25,851	92	1.600	0.361	0.049
Wicklow Head	955	167	1.904	0.005	0.001
Helvick Head to Ballyquin	1,170	152	1.899	0.007	0.001

SPA Site (and Component SSSI Sites)	Count of Adults	Distance to Erebus (km)	I/proportion foraging range as sea	Resulting Weight	Proportional Weight
Razorbill					
Skomer, Skokholm and the Seas off Pembrokeshire	10,694	24	1.519	6.085	0.892
Saltee Islands	6,519	92	1.612	0.268	0.039
Atlantic Puffin					
Skomer, Skokholm and the Seas off Pembrokeshire	38,342	24	1.744	32.404	0.997
Saltee Islands	390	92	1.784	0.023	0.001
Ynysoedd Y Gwylanod, Gwylan Islands	1238	160	2.520	0.034	0.001
Lesser black-backed gull					
Skomer, Skokholm and the Seas off Pembrokeshire	12,836	24	1.728	17.891	0.978
Isles of Scilly	4,944	170	1.084	0.086	0.005
Saltee Islands	502	92	1.773	0.049	0.003
Lambay Island	690	226	2.359	0.015	0.001

Table 9.4: Apportionment of seabirds in the non-breeding season to SPA colonies assessed

Species	SPA	Autumn Migration	Non-breeding	Spring Migration
Northern Gannet	Grassholm	0.237	n/a	0.196
Manx shearwater	Skomer, Skokholm and the Seas off Pembrokeshire	0.703	n/a	0.703
Black-legged kittiwake	Skomer, Skokholm and the Seas off Pembrokeshire	0.002	n/a	0.003
Common guillemot	Skomer, Skokholm and the Seas off Pembrokeshire	n/a	0.043	n/a

Species	SPA	Autumn Migration	Non-breeding	Spring Migration
Razorbill	Skomer, Skokholm and the Seas off Pembrokeshire	0.033	0.013	0.033
Atlantic puffin	Skomer, Skokholm and the Seas off Pembrokeshire	n/a	0.032	n/a
Lesser Black-Backed Gull	Skomer, Skokholm and the Seas off Pembrokeshire	0.115	0.110	0.115

9.4.4. Displacement Analysis

The installation of offshore wind turbines may lead to the direct disturbance and displacement of birds that are naturally present in the area of the Proposed Development. This disturbance may occur as a result of construction, decommissioning and operation and maintenance activities, or simply from the presence of turbine structures following installation. Disturbance may result in effective habitat loss; a reduction in the area available to seabirds for foraging or loafing.

Displacement is considered by Furness *et al.* (2013) and Bradbury *et al.* (2014) to be "*a reduced number of birds occurring within or immediately adjacent to an offshore wind farm*". This happens when birds avoid the area of operational turbines and different species are more or less likely to display this behaviour. The reaction to offshore works activity of the presence of anthropogenic structures differs across seabird species. Both Furness *et al.* (2013) and Bradbury *et al.* (2014) give a displacement ranking for a range of species based on susceptibility to disturbance and habitat specialisation. This gives an indication of species more likely to be displaced and the potential consequences of that displacement.

9.4.4.1. Spatial Scale

For displacement assessment, the defined impact zone is the footprint of the offshore array plus a 2 km buffer. Assessment is based on this as a 'worst case'. For certain species, such as divers and seaducks, a 4 km buffer is currently recommended. However, these species were not recorded at the Project (see Volume 3, Technical Appendix 11.1: Baseline).

9.4.4.2. Defined Seasons

As set out in the SNCB guidance (SNCB, 2017), displacement matrices are required for each species for the breeding and non-breeding seasons. As noted in Chapter 11: Offshore Ornithology, these seasons are taken from Furness (2015) report on biologically defined minimum population scales (BDMPS) and are presented in Table 9.5.

Table 9.5: Defined seasons for use in assessment of species-specific displacement effects

Species	Migration-free breeding season	BDMPS		
		Autumn migration	Non-breeding	Spring migration
Guillemot	Mar-Jun	n/a	Aug-Feb	n/a
Razorbill	Apr-Jun	Aug-Oct	Nov-Dec	Jan-Mar
Puffin	May-Jun	n/a	Aug-Mar	n/a
Kittiwake	May-Jul	Aug-Dec	n/a	Jan-Apr
Gannet	Apr-Aug	Sep-Nov	n/a	Dec-Mar
Manx shearwater	Jun-Jul	Aug-Oct	n/a	Mar-May

9.4.4.3. Mean seasonal peak population estimates

The SNCB guidance (SNCB 2017) defines displacement as affecting both birds on the water and in flight, therefore the mean seasonal peaks were calculated from monthly population estimates for all birds present within the impact zone which comprises the footprint of the offshore array plus a 2 km buffer. For the 3 auk species (common guillemot, razorbill and Atlantic puffin), the estimates were adjusted for availability bias to account for birds likely to be diving at the time of survey (see Volume 3, Technical Appendix 11.1: Baseline).

The mean seasonal peak population estimates are based on the 24 months' DAS data for each of the defined seasons in Table 9.5. Volume 3, Technical Appendix 11.1: Baseline sets out the monthly population estimates for each species in the impact zone from which can be derived the peak estimates for each season in each year.

9.4.4.4. Displacement rates

SNCB guidance

The 'disturbance susceptibility' scores outlined in SNCB guidance (SNCB 2017) and based on Furness *et al.* (2013) and Bradbury *et al.* (2014), can be used as a proxy for displacement rates where specific empirical evidence is lacking. For example, the SNCBs advise that species with a 'disturbance susceptibility' score of 1 are unlikely to be displaced (or at least be displaced at very low levels) and so this score would translate to a displacement level of 10% or less. Species with a 'disturbance susceptibility' score of 3, where species have a moderate to high sensitivity to disturbance, would translate to a likely displacement level of between 30-70%. The SNCB guidance is used to inform the

displacement rates for each species presented in Table 9.6 and are presented as 'worst case' to inform assessment.

Following recently published joint SNCB interim guidance (SNCB, 2017), displacement impacts for each relevant species are presented using a wide range of potential displacement and mortality rates. These have been presented as separate matrix tables, one for each of the seasons being assessed (e.g. 'breeding', 'post-breeding', 'non-breeding', and 'pre-breeding'). The matrices and assessments presented in this RIAA take into consideration three species-specific factors:

- Intensity of displacement within a given area (i.e. what proportion of the population is displaced);
- spatial extent – to what distance from turbines any individuals within the population will be displaced;
- seasonality – what magnitude of impact there will be within a population (taken as percentage mortality), based on the species' particular sensitivity during a particular stage in the life cycle.

It is recognised that for many species, limited information is available to predict the magnitude of displacement or, should it occur, its resultant effects on populations. For most species there has been little evidence of total or near-total displacement from constructed offshore wind farms (e.g. Krijgsveld *et al.*, 2011). For some species, such as auks, the reported levels of displacement have been variable.

9.4.4.5. Mortality Rates

The fitness consequences of displacement on seabirds are two-fold; birds may expend more energy deviating from their usual flight or foraging areas, whilst a loss of perceived and physical habitat may reduce available food resources, in turn increasing risk of potential mortality (Fox *et al.*, 2006; Fox and Krag Peterson, 2019). This level of mortality will differ depending on factors such as the size of the wind farm, the amount of habitat lost, the distance deviated by birds in flight, the availability of suitable replacement habitat and the level of increased competition. The level of mortalities will also differ between season and species, based on their morphology, foraging range, foraging rates and seasonal energetic needs such as when provisioning for chicks (Masden *et al.*, 2010).

Evidence from bird species in non-marine habitats indicate that species with limited flexibility in habitat use will be expected to experience greater fitness consequences from displacement than those species that are more generalised (Colles *et al.*, 2009; Duraes *et al.*, 2013). It is assumed that this also applies within marine environments. Accordingly, scores have been assigned for species-specific 'habitat specialisation' (Table 9.6) to provide an indication of the relative scale of mortality arising from displacement for each species. Species considered less flexible in their habitat use, are likely to be more vulnerable to displacement from favoured habitats. A high score for specialisation would therefore be expected to indicate a higher level of potential mortality.

Table 9.6: Displacement ranking for ranking for species recorded at the Project site considered to be at risk of displacement

Species	Latin name	Disturbance susceptibility	Habitat specialisation
Common guillemot	*Uria aalge*	3	3
Razorbill	*Alca torda*	3	3
Atlantic puffin	*Fratercula arctica*	2	3
Black-legged kittiwake	*Rissa tridactyla*	2	2
Northern gannet	*Morus bassanus*	2	1
Manx shearwater	*Puffinus puffinus*	1	1

Species-specific Factors

Auks have a relatively high cost of flight due to the faster flapping required due to their large body mass and small wing area. Auks undertake few short provisioning trips during the breeding season and so would experience high additional costs if having to travel large distances to avoid obstacles such as wind farms (Masden *et al.*, 2010).

Despite their shorter more frequent provisioning trips, the energy efficient wing loading in black-legged kittiwake mean their energetic costs would be comparatively lower than auks for additional distances flown. When accounting for average species-specific foraging ecology, Masden *et al.* (2010) found terns to have the greatest additional energy costs, followed by black-legged kittiwake, Atlantic puffin, common guillemot, and northern gannet. Whilst razorbill was not assessed they are likely to have a similar energetic demand as common guillemot.

In contrast, northern gannet undertake few, but long, foraging trips using efficient gliding flight and so their energy expenditure for additional distance would be comparatively low. Northern gannet are also likely to be less vulnerable to mortality by displacement due to their large foraging ranges (Woodward *et al.*, 2019). However, this risk of mortality may increase in the breeding season, as birds are more constrained to their nest sites. Northern gannet at Bass Rock were recorded making consistently shorter foraging trips during the chick rearing period (Lane *et al.*, 2020). However, this was somewhat negated by increased rates of birds, in particular females, entering nearby wind farms to forage during this time.

Manx shearwater are considered to be at a very low risk of displacement, although it should be noted that there is a high level of uncertainty associated with this assertion (Wade *et al.*, 2016). Their wide-ranging pelagic nature and high flexibility of habitat use means it is unlikely that high levels of mortality will result from displacement impacts.

The levels of mortality proposed for assessment of Project displacement represent the 'worst-case' and is informed by the rates used for Hornsea Project Three offshore wind farm, for Moray West offshore wind farm in Scotland and from the modelling work undertaken by CEH for the Forth and Tay offshore wind farms in Scotland. Within assessment the predicted changes to mortality rates are contextualised against species-specific levels of background mortality (inverse of adult survival rates as reported by Horswill and Robinson (2015)).

9.4.4.6. Summary

Table 9.7 provides an overview of the proposed displacement and mortality rates to be used in Project displacement analysis based on the information provided above.

Table 9.7: Parameters for Displacement Analysis within Project Footprint Plus 2 km Buffer

Species	Season	Months	Displacement Rate (%)	Mortality Rate (%)
Common Guillemot	Migration-free Breeding Season	March-June	70	5
	Non-breeding	August-February		1
Razorbill	Migration-free Breeding Season	April-June	70	5
	Autumn Migration	August-October		1
	Non-breeding	November-December		
	Spring Migration	January-March		
Atlantic Puffin	Migration-free Breeding Season	May-June	70	5
	Non-breeding	August-March		1
Black-legged Kittiwake	Migration-free Breeding Season	May-July	30	
	Autumn Migration	August-December		
	Spring Migration	January-April		
Northern Gannet	Migration-free Breeding Season	April-August	70	2
	Autumn Migration	September-November		1
	Spring Migration	December-March		

Species	Season	Months	Displacement Rate (%)	Mortality Rate (%)
Manx Shearwater	Migration-free Breeding Season	June-July	10	1
	Autumn Migration	August-October		
	Spring Migration	December-March		

Full details of the displacement analysis methodology and input data used is provided in Volume 3, Technical Appendix 11.4: Displacement Analysis.

9.4.5. Collision Risk Modelling

Collision risk modelling provides a consistent and quantitative method for estimating the risk that a bird entering the 'risk window', the sweep of the turbine blades, could be struck. These outcomes are combined with agreed avoidance rates to account for the likelihood that birds will take action to avoid being struck, whether this is avoiding the wind farm completely (macro-avoidance) or altering their flight path in proximity to the turbine blades (meso- and micro-avoidance).

Collision risk is calculated through application of the stochastic Collision Risk Model (sCRM) (McGregor *et al.*, 2018). This model builds upon the Band model (Band, 2012), previously developed for offshore wind farms, through the incorporation of measures of uncertainty and variability within the input parameters.

The sCRM takes account of expected proportion of time the wind turbines will be operational, accounting for downtime due to wind speed (either too low or too high for effective turbine operation) or during maintenance activities (either scheduled or unscheduled). Additional species-specific parameters such as body length, wingspan and flight speed that have been used, in combination with monthly densities, as derived from site-specific DAS data.

Model option 1 uses site-specific data on the proportion of birds flying at collision risk height, as calculated from DAS data. In contrast, model option 2 uses the generic flight height data collated in Johnston *et al.* (2014) from a range of wind farm sites around the UK. Avoidance rates used within the sCRM are in accordance with the rates presented in SNCB (2014).

Full details of the collision risk modelling methodology and input data used is provided in Volume 3, Technical Appendix 11.3: Collision Risk Modelling.

9.4.6. Population Viability Analysis

In instances where displacement or collision risk analysis identifies high numbers of mortalities for a specific receptor species, the implications of these mortality on the classified SPA populations are explored using a Population Viability Analysis (PVA). PVA models are used to forecast future population levels under different scenarios, comparing baseline 'no impact' conditions with 'impact' scenarios based on actual or predicted effects from a proposed development (such as an offshore wind farm) that may affect bird numbers via changes to the survival or productivity of individual birds. Population metrics that are derived from comparisons of 'baseline' and 'impacted' predictions

generated by PVAs can then be used to assess the significance of the anticipated additional mortality associated with planned developments.

In this case, PVA is applied to assess estimated demographic rates for a population (i.e. survival and productivity information) in a mathematical model and thereby forecast future population sizes, either under currently prevailing circumstances or as would be expected following the construction of the Proposed Development.

Full details of the PVA modelling methodology and input data used is provided in Volume 3, Technical Appendix 11.5: Population Viability Analysis.

9.5. Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro Special Protection Area

The Skomer, Skokholm and the seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro SPA (hereto referred as the Skomer, Skokholm and the Seas off Pembrokeshire SPA) is a 1,668 km^2 site located in Welsh inshore and offshore waters off the coast of Pembrokeshire. The site was originally classified in 1982, encompassing a much smaller area of 4.3 km^2, and was named Skokholm and Skomer SPA. In 2014, the site SPA was re-classified, extending the boundary by a 4 km radius to include 143.5 km^2 of at-sea areas and foraging habitat for several seabird species (JNCC, 2019c). Following further consultation, the SPA was re-classified again in 2017 to include an additional 1,524 km^2 of marine area, including locations identified as hot spots for Manx shearwater and Atlantic puffin. As the new site boundaries encroach into waters beyond the 12 nm line, it is the joint responsibility of NRW and JNCC to provide advice in relation to the SPA.

As the SPA has recently been re-classified, the conservation objectives are currently in draft form (JNCC, 2019c). Therefore, until JNCC and NRW issue revised conservation advice for the extended/re-classified SPA, the conservation objectives for the original Skomer and Skokholm SPA (CCW, 2008b) remain applicable. NRW and JNCC (2015) have produced draft conservation objectives for each feature of the SPA. JNCC (2019c) note that "*the overarching conservation objective for the protected features of this site is ensure that their condition is maintained or enhanced*".

The SPA is in place to protect classified populations of the breeding Annex I seabird, European storm-petrel, as well as several migratory seabird features (refer to Section 9.9.1) and a breeding seabird assemblage (SBA) consisting of almost 400,000 individuals (NRW, 2015a; JNCC, 2019c).

The following features of the SPA are screened in to Stage 2 assessment:

- Breeding population of European storm-petrel *Hydrobates pelagicus*;
- Breeding population of lesser black-backed gull *Larus fuscus*;
- Breeding population of Manx shearwater *Puffinus puffinus*;
- Breeding population of Atlantic puffin *Fratercula arctica*;
- Breeding seabird assemblage.

A description of each qualifying features is provided in the following subsections.

9.5.1. European Storm-Petrel *Hydrobates pelagicus*

Feature Summary

Being an Article 4.1 species listed in Annex I of the Birds Directive, European storm-petrel is a qualifying breeding feature of the SPA (NRW, 2015a). European storm-petrel in the UK belong to the *pelagicus* subspecies, with an estimated population of 25,650 breeding pairs, as estimated by Mitchell *et al.* (2004). The estimate for the population at the Skomer, Skokholm and the Seas off Pembrokeshire SPA is 2,540 nests in 2001 (Mitchell *et al.*, 2004). The SPA supports approximately 9.5% of the Great Britain population of European storm-petrel.

Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the SPA was classified and therefore feature condition is **unknown**.

The original, and still applicable, conservation objectives specific to European storm petrel are outlined by CCW (2008b):

"*The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:*

- *The population of storm petrel will be at least 3500 pairs within the SPA,*
- *Sufficient suitable nesting sites will be present to support at least the current populations*
- *The factors affecting the feature are under control*

NB. Breeding success is not examined in this species due to its sensitivity to disturbance".

The draft conservation objectives for the reclassified SPA (NRW and JNCC, 2015) expand upon the above to include:

- "*The breeding population of storm petrel should be stable or increasing. The aim, across the 2 islands* [Skomer and Skokholm] *is for at least 3500 pairs, with this number to be stable or increasing*";
- "*The distribution of this species within the site should not be constrained by anthropogenic factors, including disturbance by the public and activities leading to possible loss of suitable nesting sites*";
- "*The foraging habitat of this species should be stable or increasing in terms of its area, and its quality should remain unaffected by anthropogenic factors. There should be no contraction of the distribution of nesting sites as a result of anthropogenic factors*";
- "*Breeding success of this species should remain unaffected by negative human influence. Factors affecting the species within the site should be under control*".

9.5.2. Lesser Black-Backed Gull *Larus fuscus*

The lesser black-backed gull is listed on Annex II of the Birds Directive and is a qualifying breeding feature of the SPA (NRW, 2015a). The UK has an estimate population of 47,994 breeding pairs of lesser black-backed gull, as estimated by Mitchell *et al*. (2004). Stroud *et al*. (2001) estimated almost

20,300 pairs at the Skomer, Skokholm and the Seas off Pembrokeshire SPA, supporting approximately 16.4% of the biogeographical population of lesser black-backed gull at that time.

Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the SPA was classified and therefore feature condition is **unknown**.

The original, and still applicable, conservation objectives specific to lesser black-backed gull are outlined by CCW (2008b):

"*The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:*

- *During the breeding season the population of lesser black-backed gull will be at least 20,300 pairs within the SPA*
- *Breeding success will be at least 0.4 chicks/pair*
- *Sufficient suitable nesting sites will be present to support at least the current populations*
- *The factors affecting the feature are under control"*

The draft conservation objectives for the reclassified SPA (NRW and JNCC, 2015) expand upon the above to include:

- "*The breeding population size of lesser black-backed gull should be stable or increasing, aiming for at least 20,300, with a breeding productivity rate and an adult survival rate that allows this number to be maintained/increased. Colonies of this species must not be lost as a result of anthropogenic influence*";
- "*The distribution of this species within the site should not be constrained by anthropogenic factors. Reductions in the range of this species can only be acceptable if there is significant risk of detriment, to the FCS of priority features of this SPA*";
- "*The breeding and foraging habitat of this species should be stable or increasing in terms of its area, and its quality should remain unaffected by anthropogenic factors*";
- "*There should be no mammalian land predators present in the SPA, and control measures should be in place to ensure that accidental introduction does not take place. Access beyond designated footpaths, should be under appropriate control. Factors affecting the specie within the site should be under control"*

9.5.3. Manx Shearwater *Puffinus puffinus*

Being an Article 4.1 species listed in Annex I of the Birds Directive, Manx shearwater is a qualifying breeding feature of the SPA (NRW, 2015a). The UK has an estimate population of 295,045 breeding pairs of Manx shearwater, as estimated by Mitchell *et al*. (2004). Stroud *et al*. (2001) estimated 150,968 pairs at the Skomer, Skokholm and the Seas off Pembrokeshire SPA, supporting approximately 56.9% of the global population of Manx shearwater.

Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the SPA was classified and therefore feature condition is **unknown**.

The original, and still applicable, conservation objectives specific to Manx shearwater are outlined by CCW (2008b):

"*The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:*

- *During the breeding season the population of Manx shearwater will be at least 150,000 pairs within the SPA (this represents around half of the current breeding population).*
- *Breeding success will be at least 0.5 chicks per egg laid*
- *The factors affecting the feature are under control*

The draft conservation objectives for the reclassified SPA (NRW and JNCC, 2015) expand upon the above to include:

- "*The breeding population of Manx shearwater should be stable or increasing with no measured decrease in numbers (based on a population count of 150,968), based on annual study plots*";
- "*The distribution of this species within the site should not be constrained by anthropogenic factors, including disturbance of nesting sites by the public and activities leading to possible loss of suitable nesting sites.*";
- "*The breeding and foraging habitat of this species should be stable or increasing in terms of its area, and its quality should remain unaffected by anthropogenic factors*";
- "*Rafting birds should remain unaffected by boat use and other anthropogenic factors; appropriate codes of conduct must be followed by all visitors and craft surrounding the islands. Factors affecting the species within the site should be under control"*

9.5.4. Atlantic Puffin *Fratercula arctica*

The Atlantic puffin is a migratory species of conservation priority under Birds Directive and is a qualifying breeding feature of the SPA (NRW and JNCC, 2015). The UK has an estimate population of 579,104 breeding pairs of Atlantic puffin, as estimated by Mitchell *et al*. (2004). Stroud *et al*. (2001) estimated 9,500 pairs at the Skomer, Skokholm and the Seas off Pembrokeshire SPA, supporting approximately 1.1% of the global population of the Atlantic Puffin.

Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the SPA was classified and therefore feature condition is **unknown**.

The original, and still applicable, conservation objectives specific to Atlantic puffin are outlined by CCW (2008b):

"*The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:*

- *During the breeding season the population of puffins will be at least 9,500 pairs within the SPA*
- *Breeding success will be 0.7 chicks/pair*
- *Sufficient suitable nesting sites will be present to support at least the current populations*
- *The factors affecting the feature are under control"*

The draft conservation objectives for the reclassified SPA (NRW and JNCC, 2015) expand upon the above to include:

- "*The breeding population of Atlantic puffin should be stable or increasing with an aim of 9500 individuals being achieved.*";
- "*The distribution of this species within the site should not be constrained by anthropogenic factors. There should be no contraction of the distribution of nesting sites as a result of anthropogenic factors*";
- "*The breeding and foraging habitat of this species should be stable or increasing in terms of its area, and its quality should remain unaffected by anthropogenic factors.*";
- "*There should be no mammalian land predators present in the SPA, and control measures should be in place to ensure that accidental introduction does not take place. Access beyond designated footpaths, should be under appropriate control. Rafting birds should remain unaffected by boat use and other anthropogenic factors; appropriate codes of conduct must be followed by all visitors and craft surrounding the islands. Factors affecting the species within the site should be under control"*

9.5.5. Breeding Seabird Assemblage

Feature Summary

When first classified, the SPA supported a total of 67,278 individual seabirds as part of a breeding assemblage of 7 seabird species (CCW, 2008b). Since initial classification of the SPA, the original figure of 67,278 individuals (Stroud *et al.*, 2001) has been found to be erroneous, a higher figure of 394,260 breeding individuals has been confirmed as correct by JNCC in August 2013 (NRW, 2015a). The threshold for SPA qualification is 20,000, highlighting the importance of Skomer and Skokholm for breeding seabirds. Species included in the assemblage are:

- European storm-petrel *Hydrobates pelagicus*;
- Manx shearwater *Puffinus puffinus*;
- Lesser black-backed gull *Larus fuscus*;
- Black-legged kittiwake *Rissa tridactyla*;
- Common guillemot *Uria aalge*;
- Razorbill *Alca torda*;
- Atlantic puffin *Fratercula arctica*.

Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the SPA was classified and therefore feature condition is **unknown**.

The original, and still applicable, conservation objectives specific to European storm petrel are outlined by CCW (2008b):

"*The vision for this feature is for it to be in a favourable conservation status, where all of the following conditions are satisfied:*

- *Each of the component species of the seabird assemblage will be in favourable condition for the assemblage as a whole to achieve Favourable Condition*
- *During the breeding season the SPA will regularly support at least 67,000 individual seabirds for the following species, most of which also qualify independently as SPA features:*
    - *Razorbill* Alca torda
    - *Guillemot* Uria aalge
    - *Kittiwake* Rissa tridactyla
    - *Puffin* Fratercula arctica
    - *Lesser black-backed gull* Larus fuscus
    - *Manx shearwater* Puffinus puffinus
    - *Storm petrel* Hydrobates pelagicus".

The draft conservation objectives for the reclassified SPA (NRW and JNCC, 2015) expand upon the above to include:

- "*The breeding populations should be stable or increasing based on a total population of 394,260*";
- "*The distribution of these species within the site should not be constrained by anthropogenic factors, including disturbance by the public and activities leading to possible loss of suitable nesting sites*";
- "*The breeding and foraging habitat of these species should be stable or increasing in terms of their area, and its quality should remain unaffected by anthropogenic factors. There should be no contraction of the distribution of nesting sites as a result of anthropogenic factors*";
- "*There should be no mammalian land predators present in the SPA, and control measures should be in place to ensure that accidental introduction does not take place. Access beyond designated footpaths, should be under appropriate control. Rafting birds should remain unaffected by boat use and other anthropogenic factors; appropriate codes of conduct must be followed by all visitors and craft surrounding the islands. Factors affecting these species within the site should be under control*".

9.5.6. Assessment of Adverse Effects Alone

9.5.6.1. Construction/Decommissioning

Common Guillemot; Razorbill; Atlantic Puffin

Disturbance

Disturbance effects may result from vessel presence associated with construction/decommissioning activities such as cable lay and trenching. However, given the transient nature of this pressure and the small spatial extent relative to displacement due to presence of turbine structures during the operational phase, effects of disturbance will be no greater than that determined for displacement

during the operational phase. Accordingly, it is determined there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of common guillemot, razorbill and Atlantic puffin features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressures associated with temporary disturbance**.

All Receptors

Accidental Pollution

The presence of numerous works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. A Marine Pollution Contingency Plan (MPCP) will be produced and agreed with stakeholders post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a seabird species to accidental release of pollutants will be dependent upon its sensitivity to the type of pollution in combination with its physical environment. For example, direct contamination from surface oil pollution can cause mortality owing to loss of insulation from bird plumage, or by poisoning when ingested. Similarly, fresh oil spills occurring directly into sheltered waters supporting foraging habitats are likely to have a greater degree of adverse than if spilled subtidally, where oil sinks and becomes emulsified and adsorbed onto particles. The strong hydrodynamic regime across the Study Area, means that should an accidental release occur, the substance should rapidly disperse, and thus minimise the pressure on seabird foraging grounds. In consideration of the standard mitigation and adoption of best practice it is expected if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to designated bird populations.

During construction and decommissioning Project phases there is a risk of accidental pollution events. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect the long-term viability of seabird populations, or the abundance, condition or diversity of supportive habitats. It is also considered that any pollution event that did occur would be rapidly contained, avoiding contamination of potential prey species and ensuring that if this did occur it would not exceed concentrations potentially harmful to the condition of classified SPA seabird populations or to indirectly affect breeding success. There is also no evidence to suggest that accidental pollution events will reduce access to nesting sites. Therefore, it is assessed that **no**

potential for an adverse effect on integrity, having regard to the conservation objectives of all classified populations of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with accidental pollution.

Underwater Noise (UXO Clearance)

The Project is seeking consent for one UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario (with regards to UXO clearance) and has formed the basis of the impact assessment undertaken. However, in line with the recommendations outlined within the recent position statement on UXO clearance, this assessment includes an assessment for high-order detonations, though this is considered unrealistic to occur in practice.

Deflagration (low-order) is the Project's preferred method for UXO clearance and, based on current industry knowledge and precedent set by other offshore projects (e.g., Greenlink Interconnector, Sofia Offshore Wind Farm (GoBe, 2021) and Seagreen Offshore Wind Farm), is considered the realistic worst case scenario. High order UXO detonation, as an absolute worst case, has been modelled and reported in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report. However, this has been considered for completeness and is not deemed realistic as the Project intends to employ deflagration (low-order) as the clearance method.

This approach is informed by the UXO Threat and Risk Assessment (6-Alpha Associates, 2020) completed to inform project specific geotechnical surveys, which provides an assessment of potential threat sources and the likelihood of contamination across the Project array area and offshore export cable corridor. The Project is also cognisant of the recently consented Marine Licence for the Greenlink Interconnector and the UXO approach adopted for the cable route in Welsh waters, i.e., the same as proposed for the Project.

Furthermore, a pre-installation (post-consent) geophysical survey will also be carried out and include a magnetometer survey, designed to identify any potential UXO targets in the vicinity of the planned cable route. If a UXO target is identified the intention would be to route around the UXO and avoid interacting with it. The offshore export cable corridor has sufficient width, built in, to allow this to occur. However, if it is not possible to route around the UXO a more detailed assessment of the specific target would be undertaken (potentially via ROV) to determine UXO risk and only if no alternative existed, would the Project undertake UXO clearance via deflagration (low-order). This is considered the realistic worst case.

A full assessment on the effects of underwater noise within the marine environment is presented in Technical Appendix 12.2: Underwater Noise and Vibration. Within Crowell *et al.* (2015) the hearing sensitivity of a number of diving bird species including red throated diver, northern gannet and a number of duck species all showed greatest hearing sensitivity at 1,000-3,000 Hz using auditory brainstem response techniques. A similar study undertaken by Hansen *et al.* (2016) showed similar findings within great cormorant in response to underwater noise.

Although these studies indicate that diving birds are receptive to underwater noise, assessments on the risk of injury to these species has not been conducted, and no thresholds for temporary threshold shift (TTS) or mortality as a result of exposure have been quantified. Diving birds may however be alerted to potential underwater noise through exposure to airborne noise, which is likely to act as a deterrent.

This will allow a rapid fleeing response to take place, following which the foraging behaviour of the diving bird receptors will be able to take place outside of the area of underwater noise influence until construction activities cease. Additionally, noise-making construction activities will be both short-term and restricted to a small portion of available foraging birds. Therefore, the magnitude of this impact is assessed as being negligible.

Diving birds can spend considerable amounts of time underwater. Studies indicated that common guillemot, razorbill and Atlantic puffin spend between 25% and 14% of their time at sea underwater (Thaxter *et al.*, 2010; Spencer, 2012). Calculations for these values are presented in Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report.

Should exposure to underwater noise occur this will be limited to the time in which the individual is underwater, typically less than a minute. It is expected that dives would be aborted in the presence in noise levels high enough to have the potential for injury, allowing for the impact to be limited via exposure minimisation. Although these species can spend large periods of time underwater during foraging activities, the potential for fleeing behaviour will result in a low sensitivity to this impact. However due to current limitations in available research on the sensitivities of diving birds to underwater noise, the sensitivity of this impact has conservatively been assessed as medium.

Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of all classified populations of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with underwater noise (UXO clearance).**

9.5.6.2. Operation and Maintenance

All Receptors

Barrier Effects

Following construction, the Project has the potential to act as a barrier to seabirds' movement. Regular seabird flight routes associated with migration and foraging behaviour may change as a result. A number of seabird species are known to exhibit avoidance behaviour following the introduction of offshore infrastructure. This assessment is limited to the Project infrastructure only, with the impact of vessels being assessed separately above.

Modelling of the additional energy requirements of bird species resulting from barrier effects have been conducted within Masden *et al.* (2010) where a number of factors including foraging range, number of trips, flight speed was considered for each bird species modelled. This study indicates that heavier seabird species including shag and great cormorant, followed by auks including common guillemot and Atlantic puffin, will have the most significant increase in energy expenditure per foraging trip should they be required to circumnavigate a barrier in order to access foraging grounds. However, as auks tend to undertake a larger number of smaller foraging trips, this group was determined to expend the most energy overall as a result of barrier effects.

The array area is limited to 7 km at its widest point, with a maximum of 10 WTG being considered. This limited array size, combined with significant empty sea space within the region means that diversion in response to barrier effects for any seabirds travelling offshore from the Skomer, Skokholm and the Seas of Pembrokeshire SPA will be limited to approximately 1.7 km. As the array

area is located approximately 35 km offshore, this results in a worst-case scenario being a 5% increase in distance between nesting and foraging grounds. The energy consumption required for this additional flight distance is small when compared to the impact of wind conditions, which can increase energy consumption during foraging flights for some seabirds by up to 100% in poor conditions (Furness and Bryant, 1996).

For migratory species the barrier effects of the Project will only impact individuals once per migration. The impact of barrier effects is therefore more limited when compared to the impact of barrier effects on foraging behaviour. The impact of single instance avoidances is assessed within Speakman *et al.* (2009), with worst-case assessments determining that migratory birds will consume an additional 2% of available fat reserves. Due to the small size of the windfarm, and the low energy costs associated with potential avoidance behaviour when compared to natural variation in weather conditions, the magnitude of this potential effect is therefore considered to be low.

Not all species are sensitive to the barrier effects of OFWs. The avoidance and attraction of a number of seabird species is considered within Dierschke *et al.* (2016). Of the seabirds observed as a part of the project specific DAS (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report), some species, such as northern gannet and northern fulmar showed consistent and strong avoidance behaviour in associated with OWFs. However, species including Manx shearwater, razorbill and common guillemot showed a reduced level of avoidance, whilst gull species showed a level of attraction to these structures. Although this avoidance behaviour is primarily considered to constitute a displacement effect, such avoidance of a specific area may lead to increased distances travelled when travelling to or from foraging areas, i.e. barrier effects. Species known to be less sensitive to displacement from OWFs, would therefore be expected to be less susceptible to barrier effects.

Due to the relatively low increase in energy expenditure in sensitive species, relative to natural variation, it is considered that this pressure will not result in measurable population level changes. The size of the population is expected to remain stable, and the distribution of the population maintained the classified populations of the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long-term. There is no evidence to suggest that barrier effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of all classified populations of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with barrier effects**.

Accidental Pollution

Planned and unplanned operation and maintenance activities (mooring, sub-structure inspection, cable repairs etc) throughout the O&M phase of the Project may be required, that may increase the risk of spillage or chemical contamination. Accidental spillage of lubricants, oils or chemicals may occur directly from the WTG themselves or from vessels present on site during maintenance activities. This introduced potential for direct adverse effects on marine ornithological receptors or indirect effects through damage to supportive habitats.

It is expected that vessel presence for O&M activities will not exceed 2 x 12h periods per semi-submersible platform per year and thus vessels on site will be less frequent than required during the

shorter construction period. As detailed in Section 9.5.6.1, best practice will be employed at all times to reduce the risk of a pollution event and a MPCP will be produced and agreed with stakeholders post-consent.

As determined in Section 9.5.6.1, in consideration of the strong hydrodynamic regime of the area and adoption of best practice to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect available food resources or habitats available to support the classified bird populations. It is also considered that any pollution event that did occur would be rapidly contained, avoiding contamination of potential prey species and ensuring that if this did occur it would not exceed concentrations potentially harmful to the condition of classified SPA seabird populations or to adversely affect breeding success. There is also no evidence to suggest that accidental pollution events will reduce access to nesting sites. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of all classified populations of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with accidental pollution**.

Manx Shearwater

Displacement

There is an absence of empirical evidence of displacement effects from offshore wind farms on Manx shearwater. The majority of evidence available for other receptors species originates from studies in the North Sea, where Manx shearwater is uncommon. As such, these studies do not include findings for Manx shearwater. Due to this lack of species-specific information, Manx shearwater susceptibility to displacement is informed by the species sensitivity scores as reported by Furness *et al.* (2013) and Bradbury *et al.* (2014). Risk calculations presented in Furness *et al*. (2013) indicate that Manx shearwater have low sensitivity to displacement and disturbance by offshore wind developments. The paper states any species with a Species Concern Index value below 8 seem very unlikely to be affected by displacement; Manx shearwater is assessed as having a Species Concern Index value of 2 and are therefore considered unlikely to be affected by displacement.

Similarly, Bradbury *et al.* (2014) scored Manx shearwater 1, the lowest classification in terms of population vulnerability to displacement. In view of the very low risk of the likely disturbance/displacement effects on Manx shearwater, a displacement rate of 10% has been applied from the Project array area and 2 km buffer; during the breeding and non-breeding seasons.

There is a scarcity of evidence to determine likely levels of mortality for displaced Manx shearwater. The present assessment is carried out based on species-specific mortality rates for displaced birds of 1% in the breeding season and non-breeding season. These rates are considered appropriate given their wide-ranging pelagic nature and high flexibility of habitat use attributed to this species.

Breeding Season

Project-specific survey outputs concluded that the mean-peak number of Manx shearwater present in the Project array area, inclusive of a 2 km buffer is 1,540. Based on apportioning outputs (as described in Volume 3, Technical Appendix 11.2: Apportioning) it can be projected that 1,533 of these birds are from the Skomer, Skokholm and the Seas off Pembrokeshire SPA breeding

population. Displacement analysis predicts mortality of 2 Manx shearwater birds, based on 10% displacement, and 1% mortality within displaced birds (Table 9.8). Of these mortalities, 2 individuals are apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

The breeding population of Manx shearwater within the Skomer, Skokholm and the Seas off Pembrokeshire SPA is reported to be 302,000 individuals and therefore a loss of 2 birds after apportioning to the SPA due to displacement related mortality would represent <0.01% of the SPA population, which constitutes <0.01% increase above background mortality (13%; Horswill and Robinson, 2015).

Table 9.8: Predicted mortality levels for Manx shearwater (no apportioning) due to displacement from the Project array area during the breeding season

Jun-Jul Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	2	4	5	7	8	16	24	31	47	77	124	154
20	4	7	10	13	16	31	47	62	93	154	247	308
30	5	10	14	19	24	47	70	93	139	232	370	463
40	7	13	19	25	31	62	93	124	185	308	493	616
50	8	16	24	31	39	77	116	154	231	385	616	770
60	10	19	28	37	47	93	139	185	278	463	740	925
70	11	22	33	44	54	108	162	216	324	539	863	1078
80	13	25	37	50	62	124	185	247	370	616	986	1232
90	14	28	42	56	70	139	208	278	416	693	1109	1386
100	16	31	47	62	77	154	231	308	462	770	1232	1540
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Post-breeding Migration

Apportioning outcomes for the post-breeding season allocated 557 birds from the mean-peak Manx shearwater population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 1 Manx shearwater, based on 10% displacement and 1% mortality within displaced birds (Table 9.9). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.9: Predicted mortality levels for Manx shearwater (no apportioning) due to displacement from the Project array area during the post-breeding migration

Aug-Oct Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	2	2	3	3	6	9	12	17	28	45	56
20	2	3	4	5	6	12	17	23	34	56	90	112
30	2	4	6	7	9	17	26	34	51	84	134	168
40	3	5	7	9	12	23	34	45	67	112	179	223
50	3	6	9	12	14	28	42	56	84	140	223	279
60	4	7	11	14	17	34	51	67	101	168	268	335
70	4	8	12	16	20	39	59	78	117	195	312	390
80	5	9	14	18	23	45	67	90	134	223	357	446
90	6	11	16	21	26	51	76	101	151	251	402	502
100	6	12	17	23	28	56	84	112	168	279	446	557
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Pre-breeding Migration

Table 9.10: Predicted mortality levels for Manx shearwater (no apportioning) due to displacement from the Project array area during the pre-breeding migration

Mar-May Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	1	1	1	1	1	1	1	1	2	2
20	1	1	1	1	1	1	1	1	2	2	3	4
30	1	1	1	1	1	1	1	2	2	3	5	6
40	1	1	1	1	1	1	2	2	3	4	6	8
50	1	1	1	1	1	1	2	2	3	5	8	9
60	1	1	1	1	1	2	2	3	4	6	9	11
70	1	1	1	1	1	2	2	3	4	7	11	13
80	1	1	1	1	1	2	3	3	5	8	12	15
90	1	1	1	1	1	2	3	4	5	9	13	17
100	1	1	1	1	1	2	3	4	6	9	15	18
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Apportioning outcomes for the pre-breeding season allocated 18 birds from the mean-peak Manx shearwater population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this

value estimates a mortality of 1 Manx shearwater, based on 10% displacement and 1% mortality within displaced birds (Table 9.10). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Conclusion

Due to the low proportion of Manx shearwater from the Skomer, Skokholm and the Seas off Pembrokeshire SPA predicted to be affected by displacement effects, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) and the Manx shearwater population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long-term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of Manx shearwater features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects.**

Black-legged Kittiwake

Displacement

Risk calculations presented in Furness *et al.* (2013) indicate that black-legged kittiwake have low sensitivity to displacement and disturbance by offshore wind developments. The paper states any species with a Species Concern Index value above 15 should be considered as a focal point for concern with regards to potential disturbance and disturbance; black-legged kittiwake is assessed as having a Species Concern Index value of 6 and are therefore considered unlikely to be affected by displacement.

Findings on kittiwake avoidance/attraction to wind farms post-construction is somewhat mixed. Vanerman *et al*. (2014) reported that black-legged kittiwake did not show significant avoidance to a Belgium OWF and were found to frequent the wind farm boundary, with increased foraging rates in the turbine area compared to the control area. However, Mendel *et al*. (2014) did report a significant drop in black-legged kittiwake abundance after the construction of Alpha Ventus. Krijgsveld *et al*. (2011) reported only an 18% macro-avoidance rate (avoidance of the wind farm as a whole) by flying 'gulls' at OWEZ, although did not present rates for black-legged kittiwake individually.

In view of the low risk of the likely disturbance/displacement effects on black-legged kittiwake, a displacement rate of 30% has been applied from the Project array area and 2 km buffer, during the breeding and non-breeding seasons.

Despite their shorter more frequent provisioning trips, the energy efficient wing loading in black-legged kittiwake means their energetic costs would be comparatively lower than auks for additional distances flown. When accounting for average species-specific foraging ecology, Masden *et al*. (2010) found terns to have the greatest additional energy costs, followed next by black-legged kittiwake. The present assessment is carried out based on species-specific mortality rates for displaced birds of 2% in the breeding season and 1% in the non-breeding season.

Breeding Season

Project-specific survey outputs concluded that the mean-peak number of black-legged kittiwake present in the Project array area, inclusive of a 2 km buffer is 2. Based on apportioning outputs (as described in Volume 3 Technical Appendix 11.2 Apportioning) 2 individuals are apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA breeding population. Displacement analysis predicts mortality of 1 black-legged kittiwake from this SPA breeding population, based on 30% displacement, and 2% mortality within displaced birds (Table 9.11). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

The breeding population of black-legged kittiwake within the Skomer, Skokholm and the Seas off Pembrokeshire SPA is reported to be 2,472 individuals, and therefore a loss of 1 bird after apportioning to the SPA due to displacement related mortality would represent 0.04% of the SPA population, which constitutes 0.3% increase above background mortality (14.6%; Horswill and Robinson, 2015).

Table 9.11: Predicted mortality levels for black-legged kittiwake (no apportioning) due to displacement from the Project array area during the breeding season

May-Jul	Mortality Rate											
Proportion of Birds Displaced	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	1	1	1	1	1	1	1	1	1	1
20	1	1	1	1	1	1	1	1	1	1	1	1
30	1	1	1	1	1	1	1	1	1	1	1	1
40	1	1	1	1	1	1	1	1	1	1	1	1
50	1	1	1	1	1	1	1	1	1	1	1	1
60	1	1	1	1	1	1	1	1	1	1	1	2
70	1	1	1	1	1	1	1	1	1	1	2	2
80	1	1	1	1	1	1	1	1	1	1	2	2
90	1	1	1	1	1	1	1	1	1	1	2	2
100	1	1	1	1	1	1	1	1	1	1	2	2
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Post-breeding Migration

Apportioning outcomes for the post-breeding season allocated 2,022 birds from the mean-peak black-legged kittiwake population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 7 individuals, based on 30% displacement and 1% mortality within displaced birds (Table 9.12). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.12: Predicted mortality levels for black-legged kittiwake (no apportioning) due to displacement from the Project array area during the post-breeding migration

Aug-Dec Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	3	5	7	9	11	21	31	41	61	102	162	203
20	5	9	13	17	21	41	61	81	122	203	324	405
30	7	13	19	25	31	61	91	122	182	304	486	607
40	9	17	25	33	41	81	122	162	243	405	648	809
50	11	21	31	41	51	102	152	203	304	506	809	1,011
60	13	25	37	49	61	122	182	243	364	607	971	1,214
70	15	29	43	57	71	142	213	284	425	708	1,133	1,416
80	17	33	49	65	81	162	243	324	486	809	1,295	1,618
90	19	37	55	73	91	182	273	364	546	910	1,456	1,820
100	21	41	61	81	102	203	304	405	607	1,011	1,618	2,022
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Pre-breeding Migration

Apportioning outcomes for the pre-breeding season allocated 508 birds from the mean-peak black-legged kittiwake population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 2 individuals, based on 30% displacement and 1% mortality within displaced birds (Table 9.13). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.13: Predicted mortality levels for black-legged kittiwake (no apportioning) due to displacement from the Project array area during the pre-breeding migration

Jan-Apr Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	2	2	3	3	6	8	11	16	26	41	51
20	2	3	4	5	6	11	16	21	31	51	82	102
30	2	4	5	7	8	16	23	31	46	77	122	153
40	3	5	7	9	11	21	31	41	61	102	163	204
50	3	6	8	11	13	26	39	51	77	127	204	254
60	4	7	10	13	16	31	46	61	92	153	244	305
70	4	8	11	15	18	36	54	72	107	178	285	356
80	5	9	13	17	21	41	61	82	122	204	326	407
90	5	10	14	19	23	46	69	92	138	229	366	458
100	6	11	16	21	26	51	77	102	153	254	407	508
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Collisions Risk

The predicted number of collisions was predicted using a sCRM (McGregor *et al.,* 2018). Seasonal collision mortalities were modelled for the most realistic scenario of 7 x 14 MW turbines assuming worst case site-specific flight height data.

Collision risk model analysis predicts that a total of 57 mortalities due to collision events at the Project array area across a full annual cycle (based on an avoidance rate of 98.9%) (Table 9.14). Of these birds, a maximum of 2 birds are apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. This represents 0.08% of the classified SPA population (2,472 adults), which constitutes a 0.55% increase above background mortality (14.6%; Horswill and Robinson, 2015).

Table 9.14: Black-legged kittiwake seasonal collision mortalities

Season	Number of Collisions Predicted (No Apportioning)	Proportion	Predicted Number of Collisions Apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA
Breeding	0	0.817	0
Pre-breeding	19	0.003	1
Post-breeding	38	0.002	1
Total	**57**		**2**

Combined Effects of Displacement and Collision

SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some level of degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

A total of 1 mortality is are predicted for black-legged kittiwake apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA during the breeding season, which would represent 0.04% of the SPA population. In addition, 2 mortalities are predicted for each of the pre- and post-breeding seasons, representing 0.08% of the classified SPA population (2,472 adults), which constitutes a 0.55% increase above background mortality (14.6%; Horswill and Robinson, 2015).

Conclusion

Due to the low proportion of black-legged kittiwake from the Skomer, Skokholm and the Seas off Pembrokeshire SPA predicted to be affected by collision, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) so that the black-legged kittiwake population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long-term. There is also no evidence to suggest that displacement effects will reduce access to nesting sites. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of black-legged kittiwake features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with collision events**.

Common Guillemot

Displacement

Risk calculations presented in Furness *et al*. (2013) indicate that common guillemot have sensitivity to displacement and disturbance by offshore wind developments. The paper states any species with a Species Concern Index value above 15 should be considered as a focal point for concern with regards to potential disturbance and disturbance; common guillemot is assessed as having a Species Concern Index value of 14 and are therefore, in this assessment, considered likely to be affected by displacement.

Common guillemot displayed significant avoidance of the Princess Amalia Wind Farm (PAWP) and Egmond aan Zee (OWEZ) offshore wind farms, offshore of the Netherlands, as reported by Leopold *et al*. (2013). The same was reported at Alpha Ventus in German waters (Mendel *et al*. 2014), with a significant reduction in birds up to 10 km away. Vanerman *et al*., (2014) recorded a 71% decrease in guillemot abundance after the installation of an offshore wind farm at the Belgian Bligh Bank in a region extending 0.5 km away from the wind farm compared to a control area, with further reported displacement effects up to 3 km away (Krijgsveld *et al*., 2011; Leopold *et al*., 2013). Krijgsveld *et al*. (2011) reported a 68% macro-avoidance rate by flying auks at OWEZ.

In view of the medium-high risk of the likely disturbance/displacement effects on common guillemot, a displacement rate of 70% has been applied from the Project array area and 2 km buffer; during the breeding and non-breeding seasons.

There is a scarcity of evidence to determine likely levels of mortality for displaced common guillemot. However, it should be noted that auks have a relatively high cost of flight due to their large body mass and small wing area, and thus faster flapping. Auks undertake few short provisioning trips in the breeding season and so would experience the greatest additional costs if having to travel large distances to avoid wind farms (Masden *et al*. 2010). The present assessment is carried out based on species-specific mortality rates for displaced birds of 5% in the breeding season and 1% in the non-breeding season.

Breeding Season

Project-specific survey outputs concluded that the mean-peak number of common guillemot present in the Project array area, inclusive of a 2 km buffer is 3,558. Based on apportioning outputs (as described in Volume 3 Technical Appendix 11.2 Apportioning) it can be projected that 2,683 of these birds are from the Skomer, Skokholm and the Seas off Pembrokeshire SPA breeding population. Displacement analysis predicts mortality of 125 individuals, based on 70% displacement, and 5% mortality within displaced birds (Table 9.15). Of these mortalities, 94 individuals are apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

The breeding population of common guillemot within the Skomer, Skokholm and the Seas off Pembrokeshire SPA is reported to be 29,744 individuals, and therefore a loss of 94 birds after apportioning due to displacement related mortality would represent 0.32% of the SPA population, which constitutes a 5.2% increase above background mortality (6.1%; Horswill and Robinson, 2015).

Table 9.15: Predicted mortality levels for common guillemot (no apportioning) due to displacement from the Project array area during the breeding season

Mar-Jun	Mortality Rate											
Proportion of Birds Displaced	1	2	3	4	5	10	15	20	30	50	80	100
10	4	8	11	15	18	36	54	72	107	178	285	356
20	8	15	22	29	36	72	107	143	214	356	570	712
30	11	22	33	43	54	107	161	214	321	534	854	1,068
40	15	29	43	57	72	143	214	285	427	712	1,139	1,424
50	18	36	54	72	89	178	267	356	534	890	1,424	1,779
60	22	43	65	86	107	214	321	427	641	1,068	1,708	2,135
70	25	50	75	100	125	250	374	499	748	1,246	1,993	2,491
80	29	57	86	114	143	285	427	570	854	1,424	2,278	2,847
90	33	65	97	129	161	321	481	641	961	1,602	2,562	3,203
100	36	72	107	143	178	356	534	712	1,068	1,779	2,847	3,558
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Non-breeding Season

Apportioning outcomes for the non-breeding season allocated 15,324 birds from the mean peak common guillemot population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 108 common guillemot, based on 70% displacement and 1% mortality within displaced birds (Table 9.16). Of these mortalities, 5 individuals are apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.16: Predicted mortality levels for common guillemot (no apportioning) due to displacement from the Project array area during the non-breeding season

Aug-Feb Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	16	31	46	62	77	154	230	307	460	767	1,226	1,533
20	31	62	92	123	154	307	460	613	920	1,533	2,452	3,065
30	46	92	138	184	230	460	690	920	1380	2,299	3,678	4,598
40	62	123	184	246	307	613	920	1,226	1,839	3,065	4,904	6,130
50	77	154	230	307	384	767	1,150	1,533	2,299	3,831	6,130	7,662
60	92	184	276	368	460	920	1,380	1,839	2,759	4,598	7,356	9,195
70	108	215	322	430	537	1,073	1,610	2,146	3,219	5,364	8,582	10,727
80	123	246	368	491	613	1,226	1,839	2,452	3,678	6,130	9,808	12,260
90	138	276	414	552	690	1,380	2,069	2,759	4,138	6,896	11,034	13,792
100	154	307	460	613	767	1,533	2,299	3,065	4,598	7,662	12,260	15,324
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Conclusion

SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some level of degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

These combined values are provided together with additional PVA below. The overall conclusion regarding potential for adverse effects from both displacement and collision are provided together with the outcomes of PVA (see section following Collision Rick below).

Collision Risk

The predicted number of collisions was predicted using a sCRM (McGregor *et al.,* 2018). Seasonal collision mortalities were modelled for the most realistic scenario of 7 x 14 MW turbines based on generic flight height data (Table 9.17).

Table 9.17: Common guillemot seasonal collision mortalities

Season	Number of Collisions Predicted (No Apportioning)	Proportion	Predicted Number of Collisions Apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA
Breeding	1	0.754	1
Non-breeding	2	0.043	1
Total	**3**		**2**

sCRM analysis predicts that a total of 3 mortalities due to collision events at the Project array area across a full annual cycle (based on an avoidance rate of 98%). Of these birds, a maximum of 2 birds are apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. This represents <0.01% of the classified SPA population (29,744 adults), which constitutes a 0.11% above background mortality (6.1%).

Conclusion

SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some level of degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

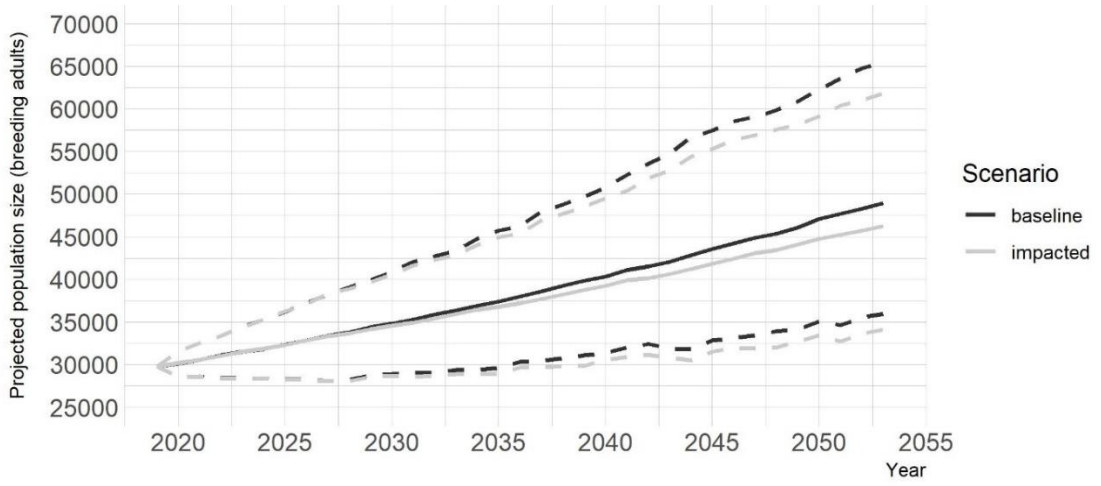
These combined values are provided together with additional PVA below. The overall conclusion regarding potential for adverse effects from both displacement and collision are provided together with the outcomes of PVA (see section Population Viability Analysis immediately below).

Population Viability Analysis

PVA was completed for common guillemot in recognition of the high number of mortalities predicted for this receptor (101 mortalities during breeding and non-breeding seasons combined due to Project displacement effects and collision events).

Figure 9.1: Median population trajectory and 95% confidence intervals for the Skomer, Skokholm and Seas off Pembrokeshire classified population of common guillemot

Values as estimated from PVA modelling outputs for both baseline and impacted populations



Modelled outputs show that both baseline and impacted populations increased steadily between the census year (2019) and the commencement of effects (2027) (Figure 9.1). After 2027, the baseline population increases slightly more rapidly than the impacted population. At the end of the 25 years of effect (2052), the difference in median population size between the two scenarios was 5.8% and the median counterfactual of population size (i.e. the predicted size of impacted population expressed as a proportion of the predicted size of the non-impacted population) was 0.946.

Modelling outcomes demonstrate that both the baseline and impacted population sizes show stable growth. The counterfactual (ratio) of population growth rate and population size, suggest that the estimates of mortality due to the operational phase of the Project (collision risk and displacement) would not have a large effect on the viability of the SPA population.

Although median growth rate is lower for the impacted scenario, which consequently reduces the median population size over the projected 25-year period, final median population size is 0.946 of the non-impacted baseline.

The fact that even in impacted conditions, the population size for common guillemot shows consistent growth gives confidence that the Project will not lead to adverse impacts on the viability of the breeding population at the Skomer, Skokholm and Seas off Pembrokeshire SPA.

In view of the outcomes of PVA, demonstrating that the classified population of common guillemot from the Skomer, Skokholm and the Seas off Pembrokeshire SPA will continue to grow despite the level of mortalities predicted to result from the presence of the Proposed Development, the common guillemot population is expected to remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement related effects or collision events will reduce access to nesting sites. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of**

common guillemot features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects or collision events.

Razorbill

Displacement

Risk calculations presented in Furness *et al*. (2013) indicates that razorbill have sensitivity to displacement and disturbance by offshore wind developments. The paper states any species with a Species Concern Index value above 15 should be considered as a focal point for concern with regards to potential disturbance and disturbance; razorbill is assessed as having a Species Concern Index value of 14 and, for the purposes of this assessment, are therefore considered likely to be affected by displacement.

Vanerman *et al*. (2014) reported a 64% decrease in razorbill abundance after the installation of an offshore wind farm at the Belgian Bligh Bank in a region extending 0.5 km away from the wind farm compared to a control area, although did not appear to show signs of displacement beyond this. Krijgsveld *et al*. (2011) reported a 68% macro-avoidance rate by flying auks at OWEZ.

In view of the medium-high risk of the likely disturbance/displacement effects on razorbill, a displacement rate of 70% has been applied from the Project array area and 2 km buffer; during the breeding and non-breeding seasons.

There is a scarcity of evidence to determine likely levels of mortality for displaced razorbill However, it should be noted that auks have a relatively high cost of flight due to their large body mass and small wing area, and thus faster flapping. Auks undertake few short provisioning trips in the breeding season and so would experience the greatest additional costs if having to travel large distances to avoid wind farms (Masden *et al.*, 2010). The present assessment is carried out based on species-specific mortality rates for displaced birds of 5% in the breeding season and non-breeding season and 1% in the non-breeding season.

Breeding Season

Project-specific survey outputs concluded that the mean-peak number of razorbill present in the Project array area, inclusive of a 2 km buffer is 84. Based on apportioning outputs (as described in Volume 3, Technical Appendix 11.2: Apportioning) it can be projected that 75 of these birds are from the Skomer, Skokholm and the Seas off Pembrokeshire SPA breeding population. Displacement analysis predicts mortality of 4 individuals, based on 70% displacement, and 5% mortality within displaced birds (Table 9.18). Of these mortalities, 3 individuals are apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

The breeding population of razorbill within the Skomer, Skokholm and the Seas off Pembrokeshire SPA is reported to be 10,694 individuals, and therefore a loss of 3 birds after apportioning to the SPA due to displacement related mortality would represent 0.03% of the SPA population, which constitutes 0.27% increase above background mortality (10.5%; Horswill and Robinson, 2015).

Table 9.18: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the breeding season

Apr-Jun Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	1	1	1	2	2	3	4	6	9	11
20	1	1	1	1	2	3	4	5	7	11	17	21
30	1	1	1	2	2	4	5	7	10	16	25	31
40	1	1	2	2	3	5	7	9	13	21	33	42
50	1	2	2	3	3	6	8	11	16	26	42	52
60	1	2	2	3	4	7	10	13	19	31	50	62
70	1	2	3	3	4	8	11	15	22	37	58	73
80	1	2	3	4	5	9	13	17	25	42	66	83
90	1	2	3	4	5	10	14	19	28	47	75	93
100	2	3	4	5	6	11	16	21	31	52	83	103
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Post-breeding Migration

Apportioning outcomes for the post-breeding season allocated 1,228 birds from the mean-peak razorbills population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 9 razorbill birds, based on 70% displacement and 1% mortality within displaced birds (Table 9.19). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.19: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the post-breeding migration.

Aug-Oct Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	2	3	4	5	7	13	19	25	37	62	99	123
20	3	5	8	10	13	25	37	50	74	123	197	246
30	4	8	12	15	19	37	56	74	111	185	295	369
40	5	10	15	20	25	50	74	99	148	246	393	492
50	7	13	19	25	31	62	93	123	185	307	492	614
60	8	15	23	30	37	74	111	148	222	369	590	737
70	9	18	26	35	43	86	129	172	258	430	688	860
80	10	20	30	40	50	99	148	197	295	492	786	983
90	12	23	34	45	56	111	166	222	332	553	885	1,106
100	13	25	37	50	62	123	185	246	369	614	983	1,228
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Non-breeding season

Apportioning outcomes for the non-breeding season allocated 566 birds from the mean peak common guillemot population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 4 common guillemot, based on 70% displacement and 1% mortality within displaced birds (Table 9.20). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.20: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the non-breeding season

Nov-Dec Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	2	2	3	3	6	9	12	17	29	46	57
20	2	3	4	5	6	12	17	23	34	57	91	114
30	2	4	6	7	9	17	26	34	51	85	136	170
40	3	5	7	10	12	23	34	46	68	114	182	227
50	3	6	9	12	15	29	43	57	85	142	227	283
60	4	7	11	14	17	34	51	68	102	170	272	340
70	4	8	12	16	20	40	60	80	119	199	317	397
80	5	10	14	19	23	46	68	91	136	227	363	453
90	6	11	16	21	26	51	77	102	153	255	408	510
100	6	12	17	23	29	57	85	114	170	283	453	566
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Pre-breeding Migration

Apportioning outcomes for the pre-breeding season allocated 460 birds from the mean-peak razorbill population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. Application of displacement analysis to this value estimates a mortality of 4 razorbill birds, based on 70% displacement and 1% mortality within displaced birds (Table 9.21). Of these mortalities, 1 is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Table 9.21: Predicted mortality levels for razorbill (no apportioning) due to displacement from the Project array area during the pre-breeding migration

Jan-Mar Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	2	2	3	5	7	10	14	23	37	46
20	1	2	3	4	5	10	14	19	28	46	74	92
30	2	3	5	6	7	14	21	28	42	70	111	139
40	2	4	6	8	10	19	28	37	56	92	148	184
50	3	5	7	10	12	23	35	46	69	115	184	230
60	3	6	9	12	14	28	42	56	83	139	221	277
70	4	7	10	13	17	33	49	65	97	162	258	323
80	4	8	12	15	19	37	56	74	111	184	295	368
90	5	9	13	17	21	42	63	83	125	207	332	414
100	5	10	14	19	23	46	69	92	138	230	368	460
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Conclusion

Due to the low proportion of razorbill from the Skomer, Skokholm and the Seas off Pembrokeshire SPA predicted to be affected by displacement effects, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) so that razorbill population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is also no evidence to suggest that displacement effects will reduce access to nesting sites. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of razorbill features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

Atlantic Puffin

Displacement

Risk calculations presented in Furness *et al*. (2013) indicates that Atlantic puffin is likely to have some sensitivity to displacement and disturbance by offshore wind developments. The paper states any species with a Species Concern Index value above 15 should be considered as a focal point for concern with regards to potential disturbance and disturbance; Atlantic puffin is assessed as having a Species Concern Index value of 10 and are therefore considered, for the purposes of this assessment, likely to be affected by displacement.

Krijgsveld *et al*. (2011) reported a 68% macro-avoidance rate by flying auks at OWEZ. In view of the medium-high risk of the likely disturbance/displacement effects on Atlantic puffin, a displacement

rate of 70% has been applied from the Project array area and 2 km buffer; during the breeding and non-breeding seasons.

There is a scarcity of evidence to determine likely levels of mortality for displaced Atlantic puffin. However, it should be noted that auks have a relatively high cost of flight due to their large body mass and small wing area, and thus faster flapping. Auks undertake few short provisioning trips in the breeding season and so would experience the greatest additional costs if having to travel large distances to avoid wind farms (Masden et al. 2010). The present assessment is carried out based on species-specific mortality rates for displaced birds of 5% in the breeding season and 1% in the non-breeding season.

Breeding Season

Project-specific survey outputs concluded that the mean-peak number of Atlantic puffin present in the Project array area, inclusive of a 2 km buffer is 449. Based on apportioning outputs (as described in Volume 3, Technical Appendix 11.2: Apportioning) it can be projected that 448 of these birds are from the Skomer, Skokholm and the Seas off Pembrokeshire SPA breeding population. Displacement analysis predicts mortality of 16 individuals, based on 70% displacement, and 5% mortality within displaced birds (Table 9.22). Of these mortalities, 16 individuals are apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

The breeding population of Atlantic puffin within the Skomer, Skokholm and the Seas off Pembrokeshire SPA is reported to be 38,342 individuals, and therefore a loss of 16 birds after apportioning to the SPA due to displacement related mortality would represent 0.04% of the SPA population, which constitutes 0.44% increase above background mortality (9.4%; Horswill and Robinson, 2015).

Table 9.22: Predicted mortality levels for Atlantic puffin (no apportioning) due to displacement from the Project array area during the breeding season

May-Jun	Mortality Rate											
Proportion of Birds Displaced	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	2	2	3	5	7	9	14	23	36	45
20	1	2	3	4	5	9	14	18	27	45	72	90
30	2	3	5	6	7	14	21	27	41	68	108	135
40	2	4	6	8	9	18	27	36	54	90	144	180
50	3	5	7	9	12	23	34	45	68	113	180	225
60	3	6	9	11	14	27	41	54	81	135	216	270
70	4	7	10	13	16	32	48	63	95	158	252	315
80	4	8	11	15	18	36	54	72	108	180	288	360
90	5	9	13	17	21	41	61	81	122	203	324	405
100	5	9	14	18	23	45	68	90	135	225	360	449
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Non-breeding season

Apportioning outcomes for the non-breeding season allocated 32 birds from the mean peak Atlantic puffin population present in the Project array area, inclusive of a 2 km buffer, to the Skomer, Skokholm and the Seas off Pembrokeshire SPA.

Table 9.23: Predicted mortality levels for Atlantic puffin (no apportioning) due to displacement from the Project array area during the non-breeding season

Aug-Mar Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	1	1	1	1	1	1	1	2	3	4
20	1	1	1	1	1	1	1	2	2	4	6	7
30	1	1	1	1	1	1	2	2	3	5	8	10
40	1	1	1	1	1	2	2	3	4	7	11	13
50	1	1	1	1	1	2	3	4	5	8	13	16
60	1	1	1	1	1	2	3	4	6	10	16	20
70	1	1	1	1	2	3	4	5	7	12	18	23
80	1	1	1	2	2	3	4	6	8	13	21	26
90	1	1	1	2	2	3	5	6	9	15	24	29
100	1	1	1	2	2	4	5	7	10	16	26	32
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Application of displacement analysis to this value estimates a mortality of 1 Atlantic puffin, based on 70% displacement and 1% mortality within displaced birds (Table 9.23). Of these mortalities, 1 individual is apportioned to the Skomer, Skokholm and Seas off Pembrokeshire SPA.

Conclusion

Due to the low proportion of Atlantic puffin from the Skomer, Skokholm and the Seas off Pembrokeshire SPA predicted to be affected by displacement effects, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) so that the Atlantic puffin population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is also no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of common Atlantic puffin features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

European Storm-Petrel

Displacement

European storm-petrel was not recorded during commissioned surveys of Project array and historical at-sea surveys of this area also found at most very low density of this species (Stone *et al.* 1995). Furthermore, Furness and Wade (2013) considered the species unlikely to be affected to either collision or displacement. However, due to the scarcity of information available on European storm-petrel response to potential displacement, and in view of consultation feedback on the HRA Screening Report, this receptor has been included in assessment to maintain a precautionary approach.

Given the lack of European storm-petrel recorded during the digital aerial surveys the likely mortalities arising from displacement would be 0 which equates to predicted displacement mortalities of <1% of regional numbers.

Due to the low proportion of European storm petrel from the Skomer, Skokholm and the Seas off Pembrokeshire SPA predicted to be affected by displacement effects, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) so that the European storm petrel population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of European storm petrel features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

Lesser Black-backed Gull

Collision Risk

The predicted number of collisions was predicted using a sCRM (McGregor *et al.,* 2018). Seasonal collision mortalities were modelled for the most realistic scenario of 7 x 14 MW turbines assuming site-specific flight height data (Table 9.24).

Table 9.24: Lesser black-backed gull seasonal collision mortalities

Season	Number of Collisions Predicted (No Apportioning)	Proportion	Predicted Number of Collisions Apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA
Breeding	6	0.978	6
Non-breeding	0	0.110	0
Pre-breeding	0	0.115	0
Post-breeding	0	0.115	0
Total	**6**		**6**

Collision risk model analysis predicts that a total of 6 mortalities due to collision events at the Project array area across a full annual cycle (based on an avoidance rate of 99.5%). Of these birds, a maximum of 6 birds are apportioned to the Skomer, Skokholm and the Seas off Pembrokeshire SPA. This represents 0.05% of the classified SPA population (12,836 adults), which constitutes a 0.41% above background mortality (11.5%).

Conclusion

Due to the low proportion of lesser black-backed gull from the Skomer, Skokholm and the Seas off Pembrokeshire SPA predicted to be affected by collision, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) so that lesser black-backed gull population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of lesser black-backed gull features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with collision events**.

9.5.7. Assessment of Adverse Effects In-combination

The screening of potential in-combination pressures for classified seabird populations identified plans and projects within the relevant species-specific foraging range that were considered to have the potential to have 'in-combination' pressures (Table 9.26).

The plans and projects selected as relevant to the in-combination assessment of pressures to classified SPA populations are based on an initial screening exercise undertaken on a long list

prepared for the ES cumulative effects assessment (see Chapter 30: Cumulative Effects Assessment and Volume 3, Technical Appendix 30.1: Cumulative Effects Assessment). Consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales has been given to select projects for a topic-specific short-list. For the potential pressures for ornithological receptors, projects were screened into the assessment based on the spatial extent of the relevant species-specific foraging range (as reported by Woodward *et al.*, 2019).

Certain pressures assessed for the Project alone have not been considered for in-combination effect where these are:

- Of a highly localised spatial extent;
- Adjudged to cause changes of such small magnitude that these will not contribute in any meaningful way at a population level to a potential in-combination effect (based on determination for Project effects alone); or
- Will not take place for a considerable period of time, and therefore there is insufficient certainty over relevant input parameters to reasonably allow assessment of likely cumulative effects.

Pressures scoped out of the in-combination assessment include:

- Pressures associated with the construction phase of the Project, including disturbance effects or accidental pollution;
- Barrier effects during the operational phase, given that other developments screened into in-combination assessment are sufficiently distant (>270 km) that there will be no measurable cumulative barrier effects. The journey distance for any individuals that travel far enough to encounter multiple projects will be so long as to ensure that the small increase in distance will be negligible in comparison;
- All pressures during the decommissioning phase of the Project, as all pressures during this stage are likely to be of similar significance to those during the construction phase and data and information available for other plans associated with this source of pressure are of no or low confidence.

Following the screening process undertaken above, and considering the outcome of the assessments made for the Project alone, and for other projects, the following pressures are scoped in for in-combination assessment:

- Displacement of Manx shearwater, black-legged kittiwake, common guillemot, razorbill and Atlantic puffin during the operation and maintenance stage of the Project, in-combination cumulatively with other planned/proposed, in-construction, and installed offshore wind projects; and
- Collision risk to black-legged kittiwake, common guillemot and lesser black-backed gull during the operation and maintenance stage of the Project, in-combination cumulatively with other planned/proposed, in-construction, and installed offshore wind projects.

Consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales has been given in order to select projects for a topic-specific short-list. It is determined that, except

where projects are in the local region, all sectors excluding marine renewables can be screened out of in-combination assessment due to absence of effect pressure pathway.

Planned and operational marine energy projects were screened into the assessment depending on presence of a potential pressure-receptor-pathway during construction, operation and maintenance, or decommissioning.

Following geospatial review of the long list and comparing the locations of projects, regional seas, the results of the apportioning analysis (Volume 3, Technical Appendix 11.2: Apportioning), and taking the SOSS 05 report (Wright *et al.*, 2012) into consideration, projects outside the following regions were screened out of in-combination assessment:

- Celtic Sea;
- Irish Sea;
- English Channel;
- North of Scotland;
- Ireland and Northern Ireland; and
- The western and northern coasts of France.

Connectivity between projects out with these regions and the seabird colonies or populations, or migratory routes, that may interact with the Project is deemed to be very low (see Volume 3, Technical Appendix 11.2: Apportioning and Wright *et al.*, 2012)). The Project specific apportioning analysis suggests that the seabird populations that may be affected are localised and predominantly (often >99%) belong to nearby colonies or SPAs. Wright *et al.* (2012) shows limited connectivity between the screened out regions, such as the North Sea, and the Project.

In addition to this, most marine bird species avoid flying over land, and as such, there is distinct geographical separation between the Project and other projects outside the aforementioned regions. Therefore, it can be determined that any effect in-combination with the Project and projects outside these regions on seabirds can be considered negligible effect and will not compromise the conservation objectives of any relevant SPA site.

Pressures associated with other projects that were included on the initial site long-list, and where located within the Celtic and Irish Seas, on the east coast of England and Scotland, and those in Ireland and Northern Ireland, as well as projects in the English Channel (UK and French), and on the north and west coast of France have been screened in for in-combination assessment, and considered within the site short-list.

The long-list of projects was screened to remove the following:

- All projects that are located outside of the Celtic and Irish Seas, in Wales, on the east coast of England and Scotland, and those in Ireland and Northern Ireland, as well as projects in the English Channel (UK and French) and on the north and west coast of France (i.e., no spatial overlap);
- All operational/active projects where there is no ongoing risk of additional adverse effect, as they are considered to be existing effects included within the baseline (this includes all shipping ports, shipping routes and oil and gas pipelines). It should be noted that OWF

projects are not included in this category as the full effects of the development are not yet displayed in available data;

- All projects where there is no expected temporal overlap with operation and maintenance of the Project;
- All projects where there is a lack of certainty over the timing of construction activities or project timeline; and
- All projects that have been cancelled or are fully decommissioned.

The offshore plans or projects considered included:

- Marine renewables (wind, wave and tidal);
- Port and harbour developments;
- Marine aggregate extraction and dredging;
- Licensed disposal sites;
- Oil and gas exploration and extraction;
- Subsea cables and pipelines.

The assessment is based on the in-combination pressures of projects using the tiered approach as described in Table 9.25.

Table 9.25: Description of tiers of other developments considered for in-combination assessment (adapted from PINS Advice Note 17) (PINS, 2019)

Tier	Description
Tier 1	Built and operational projects, where an ES, supplementary information, and potentially post-construction monitoring have been submitted. Any design variation will have been identified. These projects are considered within in-combination assessment and are not considered to be part of the baseline as effects may not yet be captured within the baseline data for the Project. High confidence.
Tier 2	Projects that are currently under construction, where an ES and any supplementary information will have been submitted. Any design variation will have been identified. High confidence.
Tier 3	Consented applications that have not yet began construction/been implemented. These projects will have submitted an ES and any supplementary information, however, it is noted that changes in design (within the scope of the PDE) may not yet been accounted for. These projects may or may not proceed. Medium confidence.
Tier 4	Projects that have submitted applications that have not yet been determined. These projects will have an ES, however, may not have supplementary information and changes in design (within the scope of the PDE) will not have been identified yet. These projects may or may not proceed. Low confidence.

Tier	Description
Tier 5	Future projects that have not yet submitted an application, however, may have submitted a scoping report. Confidence in these is considered low as this tier covers projects that have announced with no information submitted. These projects may or may not proceed, and changes in design are considered likely. Low confidence.

The tiered approach is based on guidance from PINS (2019) Advice Note 17 and reflects the likely degree of certainty and level of information associated with each development. In assessing the potential cumulative effects for the Project, it is important to recognise that certain projects, predominantly those 'proposed' or identified in development plans, may not actually be taken forward, or fully built out as described within their maximum design scenario. There is, therefore, a need to build in some consideration of certainty (or uncertainty) with respect to the pressures which might arise from such proposals.

With this in mind, all projects and plans considered alongside the Project have been allocated into 'tiers' reflecting their current stage within the planning and development process. This allows the in-combination assessment to present several future development scenarios, each with a differing potential for being ultimately built out. This approach also allows appropriate weight to be given to each scenario (tier) when considering any potential adverse effect. The proposed tier structure is intended to ensure that there is a clear understanding of the level of confidence associated with the in-combination.

The initial long list contained 1,160 marine renewable energy (predominantly OWF) plans/projects within 2,365 km of the Project. The long-list also contained 398 projects from sectors other than offshore renewables (i.e. carbon capture and storage, dredge disposal, interconnector cables, natural gas storage, aggregate extraction etc.). Following refinement by location, and removal of cancelled and fully decommissioned projects, this list was reduced to 98 projects.

Several (23) of these 98 projects are located in French waters, and following review and thorough search of available literature and reports, no suitable data or information could be found in English. Therefore, these projects have been screened out of in-combination assessment on the basis that the data confidence is either very low or not available.

The remaining 75 other projects underwent detailed and thorough. Based on data availability, the projects were ascribed a 'Data Confidence' score of Low (i.e. no usable data or assessment available), Medium (i.e., no quantitative assessment available; qualitative assessment or monitoring reports may be available) or High (i.e. quantitative assessment of collision risk or displacement mortality available for at least one species).

For projects are in early stages (i.e. ascribed Tier 5), there typically was insufficient project information in the public domain to allow the effects to be reasonably understood and a cumulative assessment undertaken. These were ascribed a Low data confidence and scoped out of in-combination assessment. Tier 1-4 projects were also reviewed, with the majority receiving a Low data confidence due to lack of data and assessment availability. A total of 11 other projects were

ascribed a Medium or High score, these projects are screened in and considered for in-combination assessment.

See Table 9.26 for the list of projects screened in for CEA, including relevant details and justification. The in-combination assessment assumes that the Project will be operational from 2027-2052.

The majority of other projects listed in Table 9.26 do not have suitable data nor a quantitative risk assessment for effects for most species screened into in-combination assessment. For assessment of displacement effects mean peak population estimates are provided for Manx shearwater and common guillemot at Burbo Bank Extension (DONG energy, 2013a) and for Manx shearwater, common guillemot and razorbill at Walney Extension (DONG energy, 2013b). It should be noted that these figures are provided for the array area and a 4 km buffer, and as such are not directly comparable with data for the Project, which is based on the array area with a 2 km buffer (in accordance with SNCB guidance (2107)). However, this increased (4 km) buffer is likely to overestimate potential impacts, and is therefore considered to be in accordance with a precautionary approach.

For all other species, and for all other projects, only qualitative assessments or indications of effects are available (Natural Power, 2002; SeaScape Energy Ltd, 2002, 2009; May, 2005; Npower, 2005; RBA, 2005; DONG energy, 2006; RSK, 2006; ESS Ltd, 2007; RPS, 2020). Although these have been considered where possible, it is not possible to confidently determine associated risk of in-combination displacement effects.

For assessment of collisions risk, where applicable, data on collision mortalities is taken from the database provided by MacArthur Green and Royal Haskoning (2019). This database provides a summary of offshore ornithological collision risk modelling data for UK offshore windfarms. The database provides comparability of collision related mortalities for those seabird species considered to be of particular risk of collision with wind turbines (northern gannet, black legged kittiwake, herring gull, lesser black-backed gull and great black-backed gull). The database also provides the most recent and available as-built turbine parameters and, as such, is considered more accurate than values in ES, which correspond with ‘as applied for’ parameters.

For all other projects, only qualitative assessments or indications of impacts are available (Natural Power, 2002; SeaScape Energy Ltd, 2002, 2009; May, 2005; Npower, 2005; DONG energy, 2006; RSK, 2006; ESS Ltd, 2007; RPS, 2020). These have been considered where possible, however, cannot provide confident contribution to the in-combination assessment for collision risk.

Due to the absence of appropriate apportioning values for the majority of projects screened into in-combination assessment it is not practically possible to draw any confident conclusions regarding the in-combination effects on the specific Skomer, Skokholm and the Seas of Pembrokeshire SPA populations. *In lieu* of this, predicted mortality levels are contextualised against regional BDMPS populations.

Table 9.26: Other projects screened in for assessment of potential in-combination effects on the Stockholm, Skomer and the Seas off Pembrokeshire SPA

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
1	**Arklow Bank – Phase 1** **(RPS, 2020)**	Fully commissioned: 01/06/2004	146	Medium	The Environmental Statement (ES), survey reports and monitoring reports are not available for Phase 1 of the Arklow Bank project; however, the Arklow Bank Phase 2 Scoping Report is available. Only qualitative information relating to Arklow Bank Phase 1 is available in the Scoping Report for Phase 2, however, this can be used to indicate impacts to local populations of several seabird species.
1	**Burbo Bank** **(SeaScape Energy Ltd, 2002, 2009)**	Fully commissioned: 18/10/2007	275	Medium	The ES and pre- and post-construction monitoring reports are available for the project. The information contained within the ES and monitoring reports does not include species-specific mortality associated with displacement or collision risk, however, impacts can be indicated from the monitoring reports. As such, only a qualitative assessment can be made.
1	**Burbo Bank Extension** **(DONG energy, 2013a)**	Fully commissioned: 01/04/2017	271	High	The ES, post construction monitoring reports, and raw ornithological monitoring data are available for the project. The ES contains results of collision risk assessment and displacement mortality for some seabird species, which have been considered in this CEA.
1	**Gwynt y Môr** **(NPower, 2005)**	Fully commissioned: 18/06/2015	257	Medium	The ES and post-construction monitoring reports are available for this project. Only qualitative assessments were made for displacement effects and collision risk, with no estimation of mortality rate available either effect. Potential impacts can be inferred from monitoring reports.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
1	**North Hoyle** **(May, 2005)**	Fully commissioned: 01/06/2004	258	Medium	The post-construction monitoring report is available, however, the ES, and therefore impact assessments, is not available. Impacts to seabirds can be inferred, although not quantified, from the monitoring report.
1	**Ormonde** **(RBA, 2005)**	Fully commissioned: 22/02/2012	323	High	The ES and construction monitoring reports, as well as seabird-specific impact assessment reports are available for this project. Collision risk model outputs are presented in the ES and its appendices, however, the assessment is made against significance thresholds (in terms of additional mortality) and predicted mortality is not explicitly stated. Displacement effects were assessed qualitatively.
1	**Rhyl Flats** **(ESS Ltd, 2007)**	Fully commissioned: 02/12/2010	248	Medium	The full ES is not available for this project, however, ornithological baseline and monitoring reports are publicly available. As no ES is available, there is no available quantitate assessment of collision risk or displacement mortality, however, impacts associated with the development may be inferred from monitoring reports.
1	**Robin Rigg** **(Natural Power, 2002)**	Fully commissioned: 15/09/2010	384	High	The ES for this project is available, as are ornithological monitoring reports. Quantitative assessments for collision risk are presented in the ES, however, the species screened in for CEA for Erebus were screened out for Robin Rigg and therefore assessed qualitatively.
1	**Walney – Phase 1 and 2** **(DONG energy, 2006)**	Fully commissioned: 14/06/2012	316	Medium	The full project ES and pre- and post-construction ornithological monitoring reports are available. The assessments for collision risk and displacement mortality are mostly qualitative and are based on mortality thresholds.

Tier	Project (Sources)	Relevant Dates	Distance (km)	Data Confidence	Justification
1	**Walney Extension** **(DONG energy, 2013b)**	Fully commissioned: 06/09/2018	314	High	The scoping report, ES, and HRA are available; however, no pre- or post-construction ornithological monitoring reports are available. The ES contains quantitative collision risk assessments for most species screened in, however, displacement effects are typically qualitative assessments.
1	**West of Duddon Sands** **RSK (2006)**	Fully commissioned: 30/10/2014	312	High	The full ES and baseline bird surveys are available; however, ornithological monitoring reports are not available. The assessments for collision risk and displacement mortality are mostly qualitative and are based on mortality thresholds.

9.5.7.1. Manx Shearwater

Displacement

Table 9.27 summarises the predicted mortality levels based on the mean peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 9.27: Predicted in-combination displacement mortality for Manx shearwater *Puffinus puffinus*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (n)
Walney Extension	Breeding season	1,417	10	1	2
	Post-breeding season	1,017			2
	Pre-breeding season	183			1
Burbo Bank Extension	Breeding season	2,937			3
Erebus	Breeding season	1,540			2
	Post-breeding season	557			1
	Pre-breeding season	18			1

During the breeding season a total of 7 mortalities are predicted, representing <0.001% of the reference migration free breeding population (974,942; Pritchard et al., 2021). In addition, a total of 2 mortalities are predicted in the post breeding season, corresponding with <0.001% of the post breeding BDMPS (1,580,895 individuals August to October; Furness, 2015) and 2 mortalities are predicted during the pre-breeding season, representing <0.001% of the pre-breeding BDMPS (1,580,895 individuals March to May; Furness, 2015). The other projects scoped in for CEA assess impacts to Manx shearwater from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES. Cumulatively, with the Project, mortality to the regional Manx shearwater population is not likely to be significant.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of disturbance from displacement effects associated with Project and other in-combination developments would lead to a significant level of disturbance or mortalities to Manx shearwater designated at this site. In addition, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well

below the colony-specific productivity (Horswill and Robinson, 2015) and the Manx shearwater population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of Manx shearwater features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

9.5.7.2. Black-legged Kittiwake

Displacement

Table 9.28 summarises the predicted mortality levels based on the mean peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 9.28: Predicted in-combination displacement mortality for black legged kittiwake *Rissa tridactyla*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (n)
Walney Extension	Breeding season	319	30	2	2
	Post-breeding season	1,114		1	4
	Pre-breeding season	1,467			5
Burbo Bank Extension	Breeding season	707		2	5
Erebus	Breeding season	2		2	1
	Post-breeding season	2,022		1	7
	Pre-breeding season	508			2

During the breeding season a total of 8 mortalities are predicted, representing 0.17% of the reference migration free breeding population (4,527; Pritchard et al., 2021). In addition, a total of 11 mortalities are predicted in the post breeding season, corresponding with 0.001% of the post breeding BDMPS (911,586 individuals August to December; Furness, 2015) and 7 mortalities are predicted during the pre-breeding season, representing 0.001% of the pre-breeding BDMPS (691,526 individuals January to April; Furness, 2015).

The other projects scoped in for assessment determined impacts to black-legged kittiwake from displacement effects as minor or negligible within the corresponding ESs. Subsequent monitoring reports show no impacts outside those predicted in the ESs.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of disturbance from displacement effects associated with Project and other in-combination developments would lead to a significant level of disturbance or mortalities to black-legged kittiwake designated at this site. In addition, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) and the black-legged kittiwake population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of black-legged kittiwake features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

Collision Risk

The cumulative predicted collision risk mortality for black-legged kittiwake is presented in Table 9.29.

Table 9.29: Predicted in-combination collision risk mortality for black-legged kittiwake *Rissa tridactyla*

Project	Erebus	Burbo Bank Extension	Walney Extension	Total
Predicted Mortalities (*n*)	58	21	188	**267**

A mortality rate of 267 individuals represents 0.03% of the BDMPS population of 911,586 individuals August to December, and 0.04% of 691,526 individuals January to April (Furness, 2015). The other projects scoped in for in-combination assessment determine impacts to black legged kittiwake from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES.

The Skomer and Skokholm SPA is located at least 270 km (at sea distance) from the Walney, Ormonde and Burbo Bank OWFs. The foraging range of black legged kittiwake is 73.2 km (± 80.5 SD) (Woodward *et al.*, 2019) and therefore there is very limited potential for these developments to affect these populations (DONG energy, 2013a-b).

It is noted that the ranges provided by Woodward *et al.* (2019) only account for foraging activities during the breeding season. However, given the small proportion of the relevant BDMPS predicted

to be at risk, it is considered that this level of moralities would result in negligible effects on the wider biogeographic population (with connectivity to UK waters) outside of the breeding season.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of mortalities from collision events associated with Project and other in-combination developments would be significant in terms of the classified population of black-legged kittiwake at this site. The size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the black-legged kittiwake population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of black-legged kittiwake features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with collision events**.

9.5.7.3. Common Guillemot

Displacement

The apportioning analysis for the Project (Volume 3, Technical Appendix 11.2: Apportioning) suggests that 75.4% of common guillemot affected by the Project originate from the Skomer and Skokholm colony and 4.9% from Saltee Island. These colonies are located at least 270 km (at sea distance) from both Walney and Burbo Bank OWFs, and common guillemot foraging range is 73.2 km (± 80.5 SD) (Woodward et al., 2019); therefore, there is very limited potential for these developments to affect the same common guillemot population (DONG energy, 2013a-b). As such, effects during the breeding season are screened out of in-combination assessment and not considered further herein.

Table 9.30 summarises the predicted mortality levels based on the mean peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 9.30: Predicted in-combination displacement mortality for common guillemot *Uria aalge*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (n)
Walney Extension	Non-breeding season	6,544	70	1	46
Burbo Bank Extension	Non-breeding season	3,448			25
Erebus	Non-breeding season	3,558			25

A total of 96 mortalities are predicted in the non-breeding season, corresponding to 0.08% of the post breeding BDMPS (1,139,220 individuals August to February, Furness, 2015). The other projects scoped in for in-combination assessment determine effects on common guillemot from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of disturbance from displacement effects associated with Project and other in-combination developments would lead to a significant level of disturbance or mortalities to common guillemot designated at this site. In addition, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) and the common guillemot population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of common guillemot features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

Collision Risk

All projects scoped in for CEA assess impacts to common guillemot from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES.With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of mortalities from collision events associated with Project and other in-combination developments would be significant in terms of the classified population of common guillemot at this site. The size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the common guillemot population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of common guillemot features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with collision events**.

Combined Effects of Displacement and Collision

SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some level of degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

A total of 467 mortalities are predicted for black-legged kittiwake from displacement effects and collision events due to the presence of the Proposed Development and other projects screened into

in-combination assessment. The represents 0.03% of the total BDMPS population (1,603,112 individuals; Furness, 2015) and 0.07% of the portion of this BDMPS within UK waters (654,888 individuals, Furness, 2105).

9.5.7.4. Razorbill

Displacement

The apportioning analysis for the Project (Volume 3, Technical Appendix 11.2: Apportioning) suggests that 89.2% of razorbill affected by the Project originate from the Skomer and Skokholm colony and 3.9% from Saltee Island. These colonies are located at least 275 km (at sea distance) from both Walney and Burbo Bank OWFs, and razorbill foraging range is 88.7 km (± 75.9 SD) (Woodward *et al.*, 2019); therefore, there is very limited potential for these developments to affect the same razorbill population (DONG energy, 2013a-b). As such, effects during the breeding season are screened out of in-combination assessment and not considered further herein.

Table 9.31 summarises the predicted mortality levels based on the mean peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 9.31: Predicted in-combination displacement mortality for razorbill *Alca torda*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (n)
Walney Extension	Post-breeding season	3,812	70	1	27
	Non-breeding season	3,931			28
	Pre-breeding season	2,008			15
Erebus	Post-breeding season	1,228	70	1	9
	Non-breeding season	566			4
	Pre-breeding season	460			4

A total of 36 mortalities are predicted during the post-breeding season, representing 0.005% of the reference migration free breeding population (606,914 individuals; August to October; Furness, 2015). In addition, a total of 32 mortalities are predicted in the non-breeding season, corresponding to 0.009% of the non-breeding BDMPS (341,422 individuals; November to December; Furness, 2015) and 19 mortalities predicted in the pre-breeding season, representing 0.005% of the pre-breeding BDMPS (341,422 individuals; November to December; Furness, 2015). The other projects scoped in

for in-combination assessment determine impacts to Manx shearwater from displacement effects as minor or negligible.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of disturbance from displacement effects associated with Project and other in-combination developments would lead to a significant level of disturbance or mortalities to razorbill designated at this site. In addition, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) and the razorbill population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of razorbill features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

9.5.7.5. Atlantic Puffin

Displacement

Table 9.32 summarises the predicted mortality levels based on the mean peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 9.32: Predicted in-combination displacement mortality for Atlantic puffin *Fratercula arctica*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (n)
Walney Extension	Breeding season	191	70	5	7
	Non-breeding season	187		1	2
Burbo Bank Extension	Breeding season	493		5	18
Erebus	Breeding season	449		5	16
	Non-breeding season	32		1	1

During the breeding season a total of 41 mortalities are predicted, representing 0.07% of the reference migration free breeding population (55,622; Pritchard et al., 2021). In addition, a total of 3 mortalities are predicted in the non-breeding season, corresponding with <0.001% of the non-breeding BDMPS (304,557 individuals August to March; Furness, 2015).

The other projects scoped in for assessment determine impacts to Atlantic puffin from displacement effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of disturbance from displacement effects associated with Project and other in-combination developments would lead to a significant level of disturbance or mortalities to Atlantic puffin designated at this site. In addition, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) and the Atlantic puffin population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites or that there will be a measurable decrease in the breeding population or that there will be a measurable decrease in the breeding population. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of Atlantic puffin features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with displacement effects**.

9.5.7.6. Lesser Black-backed Gull

Collision Risk

The cumulative predicted collision risk mortality for lesser black-backed gull is presented in Table 9.33. It should be noted that the mortality rate associated with Ormonde is considered highly precautionary and should be considered to represent an upper threshold that is not expected to be exceeded.

Table 9.33: Predicted in-combination collision risk mortality for lesser black-backed gull *Larus fuscus*

Project	Erebus	Burbo Bank Extension	Walney 1 and 2	Walney Extension	West of Duddon Sands	Total
Predicted Mortalities (*n*)	6	26	58	13	45	**148**

A mortality rate of 148 individuals represents 0.09% of the BDMPS population of 163,304 individuals August to October and March to April, and 0.36% of 41,159 individuals November to February (Furness, 2015). The other projects scoped in for in-combination assessment determine impacts to lesser black backed gull from collision risk effects as minor or negligible, and monitoring reports for these projects show no impacts outside those predicted in the corresponding ES.

The Skomer and Skokholm SPA is located at least 270 km (at sea distance) from the projects listed in in Table 9.33 putting these projects at the outside foraging range for the species (127 km ± 109 SD)

(Woodward *et al.*, 2019); therefore, there is very limited to no potential for these developments to affect the same lesser black backed gull population (DONG energy, 2013a-b).

It is noted that the ranges provided by Woodward *et al.* (2019) only account for foraging activities during the breeding season. However, given the small proportion of the relevant BDMPS predicted to be at risk, it is considered that this level of moralities would result in negligible effects on the wider biogeographic population (with connectivity to UK waters) outside of the breeding season.

Other projects, where only qualitative assessments of collision risk on lesser black backed gull are available, assess the risk to the species as very low or negligible.

With respect to the conservation objectives of the Skomer, Skokholm and the Seas off Pembrokeshire SPA, there is no indication that the potential levels of mortalities from collision events associated with Project and other in-combination developments would be significant in terms of the classified population of lesser black-backed gull at this site. The size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the lesser black-backed gull population will remain sustainable within the Skomer, Skokholm and the Seas off Pembrokeshire SPA in the long term. There is no evidence to suggest that displacement effects will reduce access to nesting sites. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of lesser black-backed gull features of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from any pressure associated with collision events**.

9.5.7.7. Summary

There is **no potential for any adverse effects on the integrity of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from the Project alone or in-combination in relation to the conservation objectives for all features**.

9.6. Grassholm Special Protection Area

Formally classified in 1986, the Grassholm SPA covers the entire of the island of Grassholm approximately 18 km off the southwest coast of Wales, as well as several small islets and rocks, down to the mean low water mark (NRW, 2013). Following the 2001 SPA review, it was proposed that the SPA boundary be extended to include a 2 km radius of marine area around Grassholm to better represent the most suitable territory for northern gannet, based on JNCC advice (McSorley *et al.*, 2003; Reid and Webb, 2005; McSorley *et al.*, 2008). The original SPA covered a total of 10.77 ha (0.18 km^2), with the marine extension, this increased to 17.4 km^2.

The SPA is classified for the Annex I bird species: northern gannet *Morus bassanus* (A016).

As the SPA is classified for a single feature, there are no site-wide or generic conservation objectives for the Grassholm SPA. Feature-specific conservation objectives are included in the following subsection.

9.6.1. Northern Gannet *Morus bassanus*

Feature Summary

When first classified, the island supported the second largest breeding population of northern gannet in the world (NRW, 2013). The northern gannet population on Grassholm grew from 16,128 apparently occupied sites (AOS) in 1969 to 26,300 AOS in 1994. In the 2001 review of SPAs, the total population was reviewed, giving a new estimate of around 33,000 breeding pairs, representing at least 12.5% of the North Atlantic breeding population.

Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the SPA was classified and therefore feature condition is **unknown**.

CCW (2008c) outline the conservation objectives for the northern gannet population of the Grassholm SPA:

"*The vision for this feature is for it to be in a favourable conservation status, where all the following conditions are satisfied:*

- *The population will not fall below 30,000 pairs in 3 consecutive years,*
- *It will not drop by more than 25% of the previous year's figures in any one year.*
- *There will be no decline in this population significantly greater than any decline in the North Atlantic population as a whole*".

CCW (2008c) also set out performance indicators for the feature, which form part of the conservation objective, these include:

- Number of pairs;
- Measurable change (in population);
- Pollution;
- Litter;
- Human disturbance;
- Fisheries management.

9.6.2. Assessment of Adverse Effects Alone

9.6.2.1. Construction/Decommissioning

Northern Gannet

Accidental Pollution

The presence of numerous works vessels in and around the Project area (array area and ECC), introduces risk of pollution from leaks or spills of fuels carried on-board these vessels, in addition to the potential for pollution by construction materials accidently released into the marine environment.

The majority of structures used in construction operations will have been manufactured and pre-assembled on land. However, the use of plant and associated machinery for final installation introduces risk of chemical contamination. In addition, there is potential for chemicals found as standard on marine vessels, such as oils or antifouling paints, to be accidently released into the marine environment.

Best practice techniques will be employed at all times to reduce the risk of pollution events as far as possible. An MPCP will be produced and agreed with stakeholders post consent. This document will detail mitigation measures that will be employed to prevent pollution events, and the emergency response procedure and notifications that would be required should an incident occur.

The response of a species to accidental release of pollutants will be dependent upon its sensitivity in combination with its physical environment. For example, fresh oil spills occurring directly into sheltered waters supporting foraging habitats are likely to have a greater degree of adverse effect than if spilled subtidally, where oil sinks and becomes emulsified and adsorbed onto particles. The strong hydrodynamic regime across the Study Area, means that should an accidental release occur, the substance should rapidly disperse, and thus minimise its potential for adverse effect on seabird foraging grounds. In consideration of the standard mitigation and adoption of best practice it is expected if any accidental pollution event(s) do(es) occur, this will be rare and will be contained rapidly and effectively. Therefore, this pressure is considered to pose a negligible risk to designated northern gannet populations.

During construction and decommissioning Project phases there is a risk of accidental pollution events. However, in view of the mitigation measures that will be employed to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no evidence to suggest that accidental pollution would adversely affect available food resources or habitats available to support classified bird populations. It is considered that any pollution event that did occur would be rapidly contained, avoiding contamination of potential prey species and ensuring that if this did occur it would not exceed concentrations potentially harmful to physiological health, reproductive success or behaviour. As such, the classified population of northern gannet is unlikely to decline as a response to accidental pollution events. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of northern gannet features of the Grassholm SPA from any pressure associated with accidental pollution**.

Underwater Noise (UXO Clearance)

The Project is seeking consent for one UXO detonation via deflagration (low-order). This is presented as the realistic worst-case scenario (with regards to UXO clearance) and has formed the basis of the impact assessment undertaken. However, in line with the recommendations outlined within the recent position statement on UXO clearance, this assessment includes an assessment for high-order detonations, though this is considered unrealistic to occur in practice.

Deflagration (low-order) is the Project's preferred method for UXO clearance and, based on current industry knowledge and precedent set by other offshore projects (e.g., Greenlink Interconnector, Sofia Offshore Wind Farm (GoBe, 2021) and Seagreen Offshore Wind Farm), is considered the realistic worst case scenario. High order UXO detonation, as an absolute worst case, has been

modelled and reported in Volume 3, Technical Appendix 12.2: Underwater Noise and Vibration Technical Report. However, this has been considered for completeness and is not deemed realistic as the Project intends to employ deflagration (low-order) as the clearance method.

This approach is informed by the UXO Threat and Risk Assessment (6-Alpha Associates, 2020) completed to inform project specific geotechnical surveys, which provides an assessment of potential threat sources and the likelihood of contamination across the Project array area and offshore export cable corridor. The Project is also cognisant of the recently consented Marine Licence for the Greenlink Interconnector and the UXO approach adopted for the cable route in Welsh waters, i.e., the same as proposed for the Project.

Furthermore, a pre-installation (post-consent) geophysical survey will also be carried out and include a magnetometer survey, designed to identify any potential UXO targets in the vicinity of the planned cable route. If a UXO target is identified the intention would be to route around the UXO and avoid interacting with it. The offshore export cable corridor has sufficient width, built in, to allow this to occur. However, if it is not possible to route around the UXO a more detailed assessment of the specific target would be undertaken (potentially via ROV) to determine UXO risk and only if no alternative existed, would the Project undertake UXO clearance via deflagration (low-order). This is considered the realistic worst case.

A full assessment on the effects of underwater noise within the marine environment is presented in Technical Appendix 12.2: Underwater Noise and Vibration. Within Crowell *et al.* (2015) the hearing sensitivity of a number of diving bird species including red throated diver, northern gannet and a number of duck species all showed greatest hearing sensitivity at 1,000-3,000 Hz using auditory brainstem response techniques. A similar study undertaken by Hansen *et al.* (2016) showed similar findings within great cormorant in response to underwater noise.

Although these studies indicate that diving birds are receptive to underwater noise, assessments on the risk of injury to these species has not been conducted, and no thresholds for temporary threshold shift (TTS) or mortality as a result of exposure have been quantified. Diving birds may however be alerted to potential underwater noise through exposure to airborne noise, which is likely to act as a deterrent.

This will allow a rapid fleeing response to take place, following which the foraging behaviour of the diving bird receptors will be able to take place outside of the area of underwater noise influence until construction activities cease. Additionally, noise-making construction activities will be both short-term and restricted to a small portion of available foraging birds. Therefore, the magnitude of this impact is assessed as being negligible.

Some diving birds (e.g., common guillemot, razorbill, and Atlantic puffin) can spend considerable amounts of time underwater (Thaxter *et al.*, 2010; Spencer, 2012). However, northern gannet tend to conduct shorter, shallower dives, with mean depths of 4.2 m and dive durations generally under 10 seconds (Garthe *et al.*, 2014), although some studies have shown depths up to 34 m (Brierley and Fernandes, 2001).

Should exposure to underwater noise occur this will be limited to the time in which the individual is underwater, typically less than a minute. It is expected that dives would be aborted in the presence

in noise levels high enough to have the potential for injury, allowing for the impact to be limited via exposure minimisation. Although these species can spend large periods of time underwater during foraging activities, the potential for fleeing behaviour will result in a low sensitivity to this impact. However due to current limitations in available research on the sensitivities of diving birds to underwater noise, the sensitivity of this impact has conservatively been assessed as medium.

Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of the northern gannet feature of the Grassholm SPA from any pressure associated with underwater noise (UXO clearance).**

9.6.2.2. Operation and Maintenance

Northern Gannet

Barrier Effects

Following construction, the Project has the potential to act as a barrier to seabirds' movement. Regular seabird flight routes associated with migration and foraging behaviour may change as a result. A number of seabird species are known to exhibit avoidance behaviour following the introduction of offshore infrastructure. This assessment is limited to the Project infrastructure only, with the impact of vessels being assessed separately above.

Modelling of the additional energy requirements of bird species resulting from barrier effects have been conducted within Masden *et al.* (2010) where a number of factors including foraging range, number of trips, flight speed was considered for each bird species modelled. This study indicates that heavier seabird species including shag and great cormorant, followed by auks including common guillemot and Atlantic puffin, will have the most significant increase in energy expenditure per foraging trip should they be required to circumnavigate a barrier in order to access foraging grounds. However, as auks tend to undertake a larger number of smaller foraging trips, this group was determined to expend the most energy overall as a result of barrier effects.

The array area is limited to 7 km at its widest point, with a maximum of 10 WTG being considered. This limited array size, combined with significant empty sea space within the region means that diversion in response to barrier effects for any seabirds travelling offshore from the Grassholm SPA will be limited to approximately 2.6 km. As the array area is located approximately 26.5 km from Grassholm, this results in a worst-case scenario being a 10% increase in distance between nesting and foraging grounds. The energy consumption required for this additional flight distance is small when compared to the impact of wind conditions, which can increase energy consumption during foraging flights for some seabirds by up to 100% in poor conditions (Furness and Bryant, 1996).

For migratory species the barrier effects of the Project will only impact individuals once per migration. The impact of barrier effects is therefore more limited when compared to the impact of barrier effects on foraging behaviour. The impact of single instance avoidances is assessed within Speakman *et al.* (2009), with worst-case assessments determining that migratory birds will consume an additional 2% of available fat reserves. Due to the small size of the windfarm, and the low energy costs associated with potential avoidance behaviour when compared to natural variation in weather conditions, the magnitude of this potential effect is therefore considered to be low.

Not all species are sensitive to the barrier effects of OFWs. The avoidance and attraction of a number of seabird species is considered within Dierschke *et al.* (2016). Of the seabirds observed as a part of the project specific DAS (Volume 3, Technical Appendix 11.6: 2-Year Bird Survey Report), northern gannet showed consistent and strong avoidance behaviour in associated with OWFs. Although this avoidance behaviour is primarily considered to constitute a displacement effect, such avoidance of a specific area may lead to increased distances travelled when travelling to or from foraging areas, i.e. barrier effects. Species including Manx shearwater, razorbill and common guillemot showed a reduced level of avoidance, whilst gull species showed a level of attraction to these structures. Species known to displaced from OWFs, and therefore may potentially be affected by barrier effects have been recorded in the Project study area. However, northern gannet have very large foraging ranges and therefore would be expected that avoidance of a relatively small OWF would have a relatively small impact on energy expenditure per foraging trip. As such, this species is not considered sensitive to barrier effects.

Due to the relatively low increase in energy expenditure, relative total foraging requirement and natural variation, it is considered that this pressure will not result in measurable population level changes. The size of the population is expected to remain stable, and the distribution of the population maintained the classified populations of the Grassholm SPA in the long-term. There is no evidence to suggest that barrier effects will result in a reduction in the population relative to the North Atlantic population as a whole. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of northern gannet features of the Grassholm SPA from any pressure associated with barrier effects.**

Displacement

Risk calculations presented in Furness *et al.* (2013) indicates that northern gannet have low sensitivity to displacement and disturbance by offshore wind developments. The paper states any species with a Species Concern Index value above 15 should be considered as a focal point for concern with regards to potential disturbance and disturbance; northern gannet is assessed as having a Species Concern Index value of 3 and are therefore considered unlikely to be affected by displacement. However, in their consultation response to the Project HRA Screening Report JNCC advised of "*emerging (largely unpublished as yet) evidence that they may be displaced in some instances*". In view of this information, northern gannet are included with respect to risk of disturbance/displacement.

Vanerman *et al*. (2014) recorded an 85% decrease in gannets in their study, with further reported displacement effects up to 3 km away. Significant avoidance of both the PAWP and OWEZ wind farms was also displayed by gannets (Leopold *et al*., 2013), and a drop in abundance was reported after construction of Alpha Ventus (Mendel *et al*., 2014). Krijgsveld *et al*. (2011) reported that flying gannets displayed a 64% macro-avoidance rate at OWEZ. The species has since been ranked higher in the revised publication by Wade *et al*. (2016), reflecting increased vulnerability to disturbance and displacement by offshore windfarms.

In view of the low certainty with regards to the likely disturbance/displacement effects on northern gannet, a displacement rate of 70% has been applied from the Project array area and 2 km buffer, during the breeding and non-breeding seasons.

There is a scarcity of evidence to determine likely levels of mortality for displaced northern gannet. The present assessment is carried out based on species-specific mortality rates for displaced birds of 2% in the breeding season and 1% in the non-breeding season. These rates are considered appropriate given the extensive amount of similar foraging habitat available and the wide-ranging foraging range attributed to this species.

Breeding Season

Project-specific survey outputs concluded that the mean-peak number of northern gannet present in the Project array area, inclusive of a 2 km buffer is 224. Based on apportioning outputs (as described in Volume 3, Technical Appendix 11.2: Apportioning) it can be projected that 223 of these birds are from the Grassholm SPA breeding population. Displacement analysis predicts mortality of 4 gannets, based on 70% displacement, and 2% mortality within displaced birds (Table 9.34). Of these mortalities, 4 are apportioned to the Grassholm SPA.

The breeding population of northern gannet within the Grassholm SPA is reported to be 61,376 (Seabird 2000 census)and therefore a loss of 4 birds due to displacement related mortality would constitute a decrease of <0.01% of the SPA population, which constitutes 0.08% increase above background mortality (8.1%).

Table 9.34: Predicted mortality levels for northern gannet (no apportioning) SPA due to displacement from the Project array area during the breeding season

Apr-Aug Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	1	1	2	3	4	5	7	12	18	23
20	1	1	2	2	3	5	7	9	14	23	36	45
30	1	2	3	3	4	7	11	14	21	34	54	68
40	1	2	3	4	5	9	14	18	27	45	72	90
50	2	3	4	5	6	12	17	23	34	56	90	112
60	2	3	5	6	7	14	21	27	41	68	108	135
70	2	4	5	7	8	16	24	32	48	79	126	157
80	2	4	6	8	9	18	27	36	54	90	144	180
90	3	5	7	9	11	21	31	41	61	101	162	202
100	3	5	7	9	12	23	34	45	68	112	180	224
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Post-breeding Migration

Apportioning outcomes for the post-breeding season allocated 334 birds from the mean-peak northern gannet population present in the Project array area, inclusive of a 2 km buffer, to the Grassholm SPA. Application of displacement analysis to this value estimates a mortality of 3 gannet individuals, based on 70% displacement and 1% mortality within displaced birds (Table 9.35). Of these mortalities, 1 is apportioned to the Grassholm SPA.

Table 9.35: Predicted mortality levels for northern gannet (no apportioning) SPA due to displacement from the Project array area during the pre-breeding migration

Sep-Nov Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	2	2	2	4	6	7	11	17	27	34
20	1	2	3	3	4	7	11	14	21	34	54	67
30	2	3	4	5	6	11	16	21	31	51	81	101
40	2	3	5	6	7	14	21	27	41	67	107	134
50	2	4	6	7	9	17	26	34	51	84	134	167
60	3	5	7	9	11	21	31	41	61	101	161	201
70	3	5	8	10	12	24	36	47	71	117	188	234
80	3	6	9	11	14	27	41	54	81	134	214	268
90	4	7	10	13	16	31	46	61	91	151	241	301
100	4	7	11	14	17	34	51	67	101	167	268	334
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Pre-breeding Migration

Apportioning outcomes for the pre-breeding season allocated 100 birds from the mean-peak northern gannet population present in the Project array area, inclusive of a 2 km buffer, to the Grassholm SPA. Application of displacement analysis to this value estimates a mortality of 1 gannet, based on 70% displacement and 1% mortality within displaced birds (Table 9.36). Of these mortalities, 1 is apportioned to the Grassholm SPA.

Table 9.36: Predicted mortality levels for northern gannet (no apportioning) due to displacement from the Project array area during the pre-breeding migration

Dec-Mar Proportion of Birds Displaced	Mortality Rate											
	1	2	3	4	5	10	15	20	30	50	80	100
10	1	1	1	1	1	1	2	2	3	5	8	10
20	1	1	1	1	1	2	3	4	6	10	16	20
30	1	1	1	2	2	4	5	7	10	16	25	31
40	1	1	2	2	2	4	6	8	12	20	32	40
50	1	1	2	2	3	5	8	10	15	25	40	50
60	1	2	2	3	4	7	10	13	19	31	49	61
70	1	2	3	3	4	8	11	15	22	35	57	70
80	1	2	3	4	4	8	12	16	24	40	64	80
90	1	2	3	4	5	9	14	18	27	45	72	90
100	1	2	3	4	5	10	15	20	30	50	80	100
	<1% background mortality				>1% background mortality but <1% SPA population					>1% SPA population		

Conclusion

SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some level of degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

These combined values are provided together with additional PVA below. The overall conclusion regarding potential for adverse effects from both displacement and collision are provided together with the outcomes of PVA (see section on Population Viability follow Collision Risk below).

Collision Risk

Collision risk model analysis was carried out based on sCRM. Seasonal collision mortalities were modelled for the most realistic scenario of 7 x 14 MW turbines assuming worst case site-specific flight height data (Table 9.37).

Table 9.37: Gannet seasonal collision mortalities

Season	Number of Collisions Predicted (No Apportioning)	Proportion	Predicted Number of Collisions Apportioned to the Grassholm SPA
Breeding	88	0.995	88
Pre-breeding	14	0.196	3
Post-breeding	14	0.237	3
Total	**116**		**94**

Collision risk model analysis predicts that a total of 116 mortalities due to collision events at the Project array area across a full annual cycle (based on an avoidance rate of 98.9%). Of these birds, 94 are apportioned to the Grassholm SPA. This represents 0.15% of the classified SPA population (61,376 adults), which constitutes a 1.89% above background mortality (8.1%).

Conclusion

SNCB (2017) guidance notes that, where applicable, effects of displacement and effects of collision impacts should be added together for assessment of total adverse effects. Whilst it is acknowledged that this may involve some level of degree of double counting, it is considered to represent a precautionary approach until it becomes feasible to distinguish between birds which might be subject to collision and those that may be displaced.

These combined values are provided together with additional PVA below. The overall conclusion regarding potential for adverse effects from both displacement and collision are provided together with the outcomes of PVA (see 'Population Viability Analysis' below).

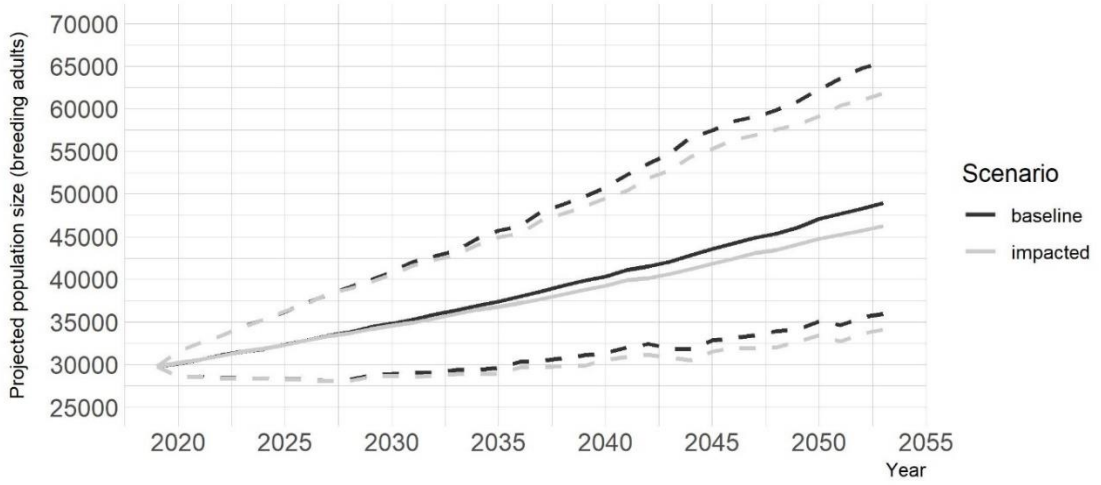
Population Viability Analysis

PVA was completed for common guillemot in recognition of the high number of mortalities predicted for this receptor (100 mortalities during breeding, pre- and post-breeding seasons due to Project displacement effects and collision events).

Modelled outputs show that both baseline and impacted populations increased steadily between the census year (2015) and the commencement of effects (2027) (Figure 9.2). After 2027, the baseline population increases slightly more rapidly than the impacted population. At the end of the 25 years of effect (2052), the difference in median population size between the two scenarios was 2.7% and the median counterfactual of population size (i.e. the predicted size of impacted population expressed as a proportion of the predicted size of the non-impacted population) was 0.973.

Figure 9.2: Median population trajectory and 95% confidence intervals for the Grassholm SPA classified population of northern gannet

Values as estimated from PVA modelling outputs for both baseline and impacted populations



Modelling outcomes demonstrate that both the baseline and impacted population sizes show stable growth. The counterfactual (ratio) of population growth rate and population size, suggest that the estimates of mortality due to the operational phase of the Project (collision risk and displacement) would not have a large effect on the viability of the SPA population.

Although median growth rate is lower for the impacted scenario, which consequently reduces the median population size over the projected 25-year period, final median population size is 0.973 of the non-impacted baseline.

The fact that even in impacted conditions, the population size for northern gannet shows consistent growth gives confidence that the Project will not lead to adverse effects on the viability of the breeding population at the Grassholm SPA.

In view of the outcomes of PVA, demonstrating that the classified population of northern gannet from the Grassholm SPA will continue to grow despite the level of mortalities predicted to result from the presence of the Proposed Development, the northern gannet population is expected to remain sustainable within the Grassholm SPA in the long term. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of northern gannet features of the Grassholm SPA from any pressure associated with displacement effects or collision events**.

Accidental Pollution

Planned and unplanned operation and maintenance activities (mooring, sub-structure inspection, cable repairs etc) throughout the O&M phase of the Project may be required, that may increase the risk of spillage or chemical contamination. Accidental spillage of lubricants, oils or chemicals may occur directly from the WTG themselves or from vessels present on site during maintenance activities.

It is expected that vessel presence for O&M activities will not exceed 2 x 12 h periods per platform per year and thus vessels on site will be less frequent than required during the shorter construction period. As detailed in Section 9.6.2.1, best practice will be employed at all times to reduce the risk of a pollution event and a MPCP will be produced and agreed with stakeholders post-consent. As determined in Section 9.6.2.1, in consideration of the strong hydrodynamic regime of the area and adoption of best practice to reduce the likelihood of such events, and contain any that do occur, it is considered that this pressure would only result in highly localised and small-scale effects. There is no indication to suggest that accidental pollution would result in a measurable change in numbers associated with the Grassholm classified northern gannet population; any pollution event that did occur would be rapidly contained, avoiding contamination of potential prey species and ensuring that if this did occur it would not exceed concentrations potentially harmful to physiological health, reproductive success or behaviour. As such, the classified population of northern gannet is unlikely to decline relative to the North Atlantic population as a whole due to accidental pollution events. Therefore, it is assessed that **no potential for an adverse effect on integrity, having regard to the conservation objectives of northern gannet features of the Grassholm SPA from any pressure associated with accidental pollution**.

9.6.3. Assessment of Adverse Effects In-combination

The screening of potential in-combination pressures for classified seabird populations identified a number of plans and projects within the relevant species-specific foraging range that were considered to have the potential to have ‘in-combination’ pressures (Table 9.26).

The plans and projects selected as relevant to the in-combination assessment of pressures classified SPA populations are based on an initial screening exercise undertaken on a long list prepared for the ES cumulative effects assessment (see Chapter 30: Cumulative Effects Assessment and Volume 3, Technical Appendix 30.1: Cumulative Effects Assessment Zones of Influence and Long List Consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales has been given to select projects for a topic-specific short-list. For the potential pressures for ornithological receptors, projects were screened into the assessment based on the spatial extent of the relevant specie-specific foraging range (as reported by Woodward *et al.*, 2019).

Certain pressures assessed for the Project alone have not been considered for in-combination effect. See Section 9.5.7 for details of which pressures have been screened out in-combination assessment and the corresponding justification.

Following the screening process undertaken above, and considering the outcome of the assessments made for the Project alone, and for other projects, the following pressures are scoped in for in-combination assessment:

- Displacement of northern gannet during the operation and maintenance stage of the Project, in-combination cumulatively with other planned/proposed, in-construction, and installed offshore wind projects; and
- Collision risk to northern gannet during the operation and maintenance stage of the Project, in-combination cumulatively with other planned/proposed, in-construction, and installed offshore wind projects.

The long list prepared for the ES cumulative effects assessment (see Chapter 31: Cumulative Effects Assessment and Volume 3, Technical Appendix 30.1: Cumulative Effects Assessment Zones of Influence and Long List was screened based on consideration of pressure-receptor-pathways, data confidence and temporal and spatial scales in order to select projects for a topic-specific short-list. See Section 9.5.7 for details of this screening process. However it should be noted that screening for the Grassholm SPA in terms of spatial scale was completed based on the species-specific foraging range for northern gannet (315.2 ±194.2; Woodward *et al.*, 2019) as opposed to that of Manx shearwater.

The list of projects screened in for CEA, including relevant details and justification, is provided in Table 9.26.

The in-combination assessment assumes that the Project will be operational from 2027-2052.

9.6.3.1. Northern Gannet

The majority of other projects listed in Table 9.26 do not have suitable data nor a quantitative risk assessment for displacement effects for northern gannet and therefore only qualitative assessments or indications of effects are available. Although this has been considered where possible, this lack of data lowers confidence in determination of associated risk of in-combination displacement effects.

Due to the absence of appropriate apportioning values for the majority of projects screened into in-combination assessment it is not practically possible to draw any confident conclusions regarding the in-combination effects on the specific Grassholm SPA population. *In lieu* of this, predicted mortality levels are contextualised against regional BDMPS populations.

Displacement

Table 9.38 summarises the predicted mortality levels based on the mean peak population estimates, displacement rates and mortality estimates provided for assessment.

Table 9.38: Predicted in-combination displacement mortality for northern gannet *Morus bassanus*

Project	Peak Population Estimate		Displacement Rate (%)	Mortality Rate (%)	Predicted Mortalities (n)
Walney Extension	Breeding season	172	70	2	3
	Post-breeding season	292		1	3
	Pre-breeding season	509			4
Burbo Bank Extension	Breeding season	429		2	7
Erebus	Breeding season	224		2	4
	Post-breeding season	334		1	3
	Pre-breeding season	100			1

During the breeding season a total of 14 mortalities are predicted, representing 0.02% of the reference migration free breeding population (72,022; Pritchard et al., 2021). In addition, a total of 6 mortalities are predicted in the post breeding season, corresponding with 0.001% of the post breeding BDMPS (545,954 individuals September to November; Furness, 2015) and 5 mortalities are predicted during the pre-breeding season, representing <0.001% of the pre-breeding BDMPS (661,888 individuals December to March; Furness, 2015). Monitoring reports for the other projects scoped into assessment show no impacts outside those predicted in the corresponding ES. This provides increased confidence in the values applied for in-combination assessment.

With respect to the conservation objectives of the Grassholm SPA, there is no indication that the potential levels of disturbance from displacement effects associated with Project and other in-combination developments would lead to a significant level of disturbance or mortalities to northern gannet designated at this site. In addition, the size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the mortality remains well below the colony-specific productivity (Horswill and Robinson, 2015) and the northern gannet population will remain sustainable within the Grassholm SPA in the long term. There is no evidence to suggest that displacement effects will lead to a reduction in the population relative to the North Atlantic population as a whole. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of northern gannet features of the Grassholm SPA from any pressure associated with displacement effects**.

Collision Risk

The cumulative predicted collision risk mortality for northern gannet is presented in Table 9.39. It should be noted that the mortality rate associated with Ormonde is considered highly precautionary and should be considered to represent an upper threshold that is not expected to be exceeded.

Table 9.39: Predicted in-combination collision risk mortality for northern gannet *Morus bassanus*

Project	Erebus	Burbo Bank Extension	Walney Extension	Total
Predicted Mortalities (*n*)	116	11	38	**165**

A mortality rate of 165 individuals represents 0.03% of the BDMPS population of 545,954 individuals September to November, 0.02% of the BDMPS population of 661,888 individuals December to March (Furness, 2015), and 0.02% of the migration free breeding season population of 72,022 individuals (Pritchard et al., 2021). However, it should be noted that these values assume that all mortalities occur in a single season. It is highly likely that mortalities will be split between seasons and as such the actual proportion or respective seasons affected will be smaller than those reported.

Other projects, where only qualitative assessments of collision risk on northern gannet are available, assess the risk to the species as very low or negligible.

With respect to the conservation objectives of the Grassholm SPA, there is no indication that the potential levels of mortalities from collision events associated with Project and other in-combination developments would be significant in terms of the classified population of northern gannet at this site. The size of the population is expected to remain stable, and the distribution of the population maintained. Despite the small increase in mortality relative to background levels, the northern gannet population will remain sustainable within the Grassholm SPA in the long term. There is no evidence to suggest that displacement effects will reduce numbers within this population relative to the North Atlantic population as whole. Therefore, it is assessed that **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of northern gannet features of the Grassholm SPA from any pressure associated with collision events**.

9.6.3.2. Summary

There is **no potential for any adverse effects on the integrity of the Grassholm SPA from the Project alone or in-combination in relation to the conservation objectives for northern gannet**.

9.7. Irish Sea Front Special Protection Area

The Irish Sea Front SPA is a 100% marine area covering 180 km^2 to the south of the Isle of Man in the Irish Sea (JNCC, 2021h). The SPA boundaries were defined based on identification of hot spots of seabird activity associated with the tidal mixing front that occurs between spring and late summer every year. The front located here contains the highest density of zooplankton in the western Irish Sea and supports a high abundance of marine life, notably herring (Scrope-Howe and Jones, 1985;

Schneider, 1990), making it ideal foraging habitat for seabirds. The SPA is classified solely for at sea aggregations of Manx shearwater, and due to their extensive foraging range of >2,000 km (Woodward *et al.*, 2019), there is potential for over 394,000 individuals from 18 colonies to utilise this area (JNCC, 2021h).

JNCC (2016a) outline the background, or overarching, conservation objectives for the SPA:

"*To avoid significant deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long term and makes an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species.*

This contribution would be achieved through delivering the following objectives for each of the sites qualifying features:

A. *Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term;*
B. *Maintain the habitats and food resources of the qualifying features in favourable condition.*
C. *Ensure access to the site from linked breeding colonies*".

9.7.1. Manx Shearwater *Puffinus puffinus*

9.7.1.1. Feature Summary

Manx shearwater aggregate at the SPA in spring and remain in the locale until late summer, with peak abundance recorded in August. Based on European Seabirds at Sea (ESAS) data (collected from 1983-1998), the population of Manx shearwater within the Irish Sea Front SPA is estimated to be 12,039 individuals (JNCC, 2016b), with density ranging from 27-136 birds/km^2. More recent data (collected by Centrica Energy in 2010 and 2011) put the density estimate at around 34 birds/km^2 (JNCC, 2016b). It should be noted that Manx shearwater tend to cluster in dense aggregations for foraging and rafting, leading to highly variable density estimates within individual surveys.

Due to the extensive foraging range of Manx shearwater, a wide number of SPAs where the species is a classified feature, and also non-classified colonies, are within foraging distance of the Irish Sea Front SPA. Therefore, it is possible that a large number of individual birds utilise the area during the spring and summer seasons (JNCC, 2016b). The official population of Manx shearwater in Britain is 295,000 pairs, however, JNCC (2016b) note that this may need to be revised as studies have estimated the Welsh population to be 316,000 pairs (Perrins *et al.*, 2012). The most populous colonies can be found on the Scottish island of Rum and the Welsh island of Skomer, supporting over 100,000 pairs between them. As such, the highest at sea abundance of Manx shearwater are found in the Irish Sea and The Minches (Kober *et al.*, 2010).

Census data collected from 1969-1970, 1985-1988, and 1998-2002 for Manx shearwater show that individuals that utilise the Irish Sea Front SPA for foraging during the breeding season predominantly originate from colonies in the wider region (JNCC, 2021h):

- Skomer, Skokholm and the Seas off Pembrokeshire SPA;
- Lundy SSSI;

- Copeland SPA;
- Saltee Islands SPA;
- Skelligs SPA.

It should be noted that Skomer, Skokholm and the Seas off Pembrokeshire SPA is located to the north of the Project, and therefore, there is no potential for barrier effects to occur; and Copeland SPA, Saltee Islands SPA, and Skelligs SPA are located in Northern Ireland, and southeast and southwest coast of Eire, and similarly, there is not potential for barrier effects to occur. Lundy is located to the southeast of the Project, and therefore, the Project is located en route from this SSSI colony to the Irish Sea Front SPA; as such, potential for barrier effects cannot be ruled out. The following summary focuses on the connectivity between the Irish Sea Front and the Lundy SSSI colony. It should be noted that assessment of effects on SSSI sites is outside the scope of HRA, and is considered within the Project ES.

Tracking data collected from Manx shearwater at Lundy show that the majority of trips are localised and relatively short range (Dean *et al.*, 2010). The data suggest that most foraging trips are within 100 km of the colony, with tracks predominantly constrained to the Bristol Channel and Celtic Sea, particularly the North Devon coast. However, it is important to note that some foraging trips were over substantially longer distances, including to the Irish Sea, specifically between the Isle of Man and Dundalk Bay (Dean *et al.*, 2010). Similar trips were observed in both survey years (2009 and 2010), suggesting Manx shearwater from the Lundy SSSI colony commonly utilise the Irish Sea and waters around the Isle of Man for foraging in the breeding season. Individuals making such trips may be affected by the Project due to displacement (i.e. barrier) effects.

9.7.1.2. Feature Condition and Conservation Objectives

A feature condition assessment has not been conducted since the Irish Sea Front SPA was classified and therefore the current feature condition is **unknown**.

As Manx shearwater is the only qualifying feature of the SPA, the overarching conservation objectives for the site are applicable to this species. Of particular note is conservation objective C:

- Ensure access to the site from linked breeding colonies.

In relation to the above objective, JNCC (2016b) state that:

"*Manx shearwaters have large foraging ranges, with a mean maximum foraging range from the colony of 330 km (Thaxter* et al. *2012). There are therefore several Manx shearwater colonies within foraging range of the Irish Sea Front pSPA (see Appendix I for more information). Although the Manx shearwaters from existing SPA colonies receive some level of protection, via the current HRA process, whilst at sea, this objective should seek to ensure that Manx shearwater can continue to access the site without being subject to significant additional energetic costs whilst commuting to/from the site from linked colonies*".

9.7.2. Assessment of Adverse Effects Alone

As noted in Table 9.1, the outcome of the screening for classified SPA breeding populations shows that construction and decommissioning pressures were determined as no LSE for Manx shearwater,

due to low risk of disturbance during these phases. During the operation phase, collision risk was also determined to result in no LSE due to low flight height of Manx shearwater (below 20 m, and therefore entirely within the 22 m air gap, resulting in zero collision risk).

Risk to the Manx shearwater population of the Irish Sea Front SPA is associated with connectivity between the SPA and breeding colonies. Therefore, only displacement (i.e. barrier) effects have been screened in, as no LSE could not be determined.

9.7.2.1. Displacement (Barrier) Effects

Conservation objective C for the Irish Sea Front SPA is to "*ensure access to the site from linked breeding colonies*" (JNCC, 2016b).

As described in Section 9.7.1.1, the Project lies en route between the Lundy SPA colony of Manx shearwater and the foraging grounds at the Irish Sea Front SPA (Dean *et al.*, 2010). Therefore, individuals that make the journey between the Lundy colony and the Irish Sea Front SPA must pass through or around the Project. As previously noted, there is zero collision risk to Manx shearwater, and therefore, no risk to individuals passing through the array area. However, where individuals are displaced from the array area, energy expenditure may be higher as flight paths are increased to avoid the Project.

There is an absence of empirical evidence of displacement effects from offshore wind farms on Manx shearwater. The majority of evidence available for other receptors species originates from studies in the North Sea, where Manx shearwater is uncommon. As such, these studies do not include findings for Manx shearwater. Due to this lack of species-specific information, Manx shearwater susceptibility to displacement is informed by the species sensitivity scores as reported by Furness *et al.* (2013) and Bradbury *et al.* (2014). Furness *et al.* (2013) states that species with a displacement and disturbance sensitivity score below 8 should be considered very unlikely to be affected by displacement; Manx shearwater scored 2. Similarly, Bradbury *et al.* (2014) scored Manx shearwater 1, the lowest classification in terms of population vulnerability to displacement. In view of the very low risk of the likely disturbance/displacement effects on Manx shearwater, a displacement rate of 10% has been applied from the Project array area and 2 km buffer; during the breeding and non-breeding seasons.

There is a scarcity of evidence to determine likely levels of mortality for displaced Manx shearwater. The present assessment is carried out based on species-specific mortality rates for displaced birds of 1% in the breeding season and non-breeding season. These rates are considered appropriate given their wide-ranging pelagic nature and high flexibility of habitat use attributed to this species.

During the breeding season (i.e. when individuals are making trips from Lundy to the Irish Sea Front SPA), Project-specific surveys concluded that the mean peak number of Manx shearwater present within the array area, inclusive of the 2 km buffer, is 1,540 individuals. Based on apportioning outputs (as described in Volume 3, Technical Appendix 11.2: Apportioning), it can be projected that of the 1,540 individuals, 1,533 of these are from the Skomer, Skokholm and the Seas off Pembrokeshire SPA breeding population, 5 are from the Saltee Islands SPA population, and 3 from the Skelligs SPA population (note: numbers are rounded up). As such, <0.01% of birds (proportionate to zero of 1,540 individuals) are attributed to the Lundy breeding population; however, it is noted

that tracking data specific to the Lundy SSSI population (Dean *et al.*, 2010) show the possibility of interaction.

Based Furness *et al.* (2013) and Bradbury *et al.* (2014) sensitivity assessments, a displacement rate of 10% and a mortality rate of 1% within displaced birds suggests that of the 1,540 individuals, total mortality from displacement is predicted to be 2 birds per annum. On a highly precautionary basis, assuming that all mortalities are of individuals from the Lundy SSSI population (2,200 individuals (Dean *et al.*, 2010)), this would represent 0.09% of the breeding population; or 0.02% of the Irish Sea Front SPA population (12,039 individuals (JNCC, 2016b)).

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the Manx shearwater feature of the Irish Sea Front SPA from barrier to species movement (i.e. displacement effects)**.

9.7.3. Assessment of Adverse Effects In-combination

9.7.3.1. Barrier Effect/Displacement

None of the other projects that screened in for in-combination effects (Burbo Bank Extension and Walney Extension OWFs) are located between Manx shearwater breeding populations and the Irish Sea Front SPA (DONG energy, 2013a-b), and as such, there is no pathway for these developments to act as a barrier to species movement between breeding populations and the foraging habitat at the Irish Sea Front SPA.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the Manx shearwater feature of the Irish Sea Front SPA from barrier to species movement (i.e., displacement effects) arising from the Project in addition to other OWF projects screened in for in-combination effects**.

9.7.4. Summary

There is **no potential for any adverse effects on the integrity of the Irish Sea Front SPA from the Project alone or in-combination in relation to the conservation objectives for all features**.

9.8. Balearic Shearwater

9.8.1. Displacement

Balearic shearwater were not recorded on-site during the digital aerial surveys, but were identified as an important receptor during pre-application discussion with NRW, JNCC, RSPB and WTSWW. Therefore, an assessment of magnitude for this species has been made using Manx shearwater as a proxy.

Balearic shearwater are of very high conservation value; red-listed as a Bird of Conservation Concern in Wales since 2016 and listed as a UKBAP priority species and is listed on Annex I of the EU Birds Directive (2009/147/EEC). Most importantly, they are also 'critically endangered' on the IUCN red-list. Given this notable conservation value, any adverse effects on the population would present risk of adverse effect on classified Natura 2000 populations. However, given that the extremely low level of displacement risk determined for Manx shearwater, and the absence of Balearic shearwater

from DAS data, it is determined that there will be **no potential for an adverse effects on site integrity for any classified populations of Balearic shearwater from any SPA in relation to pressure associated with displacement effects**.

9.9. Migratory Populations

9.9.1. Skomer, Skokholm and the Seas off Pembrokeshire/Sgomer, Sgogwm a Moroedd Penfro Special Protection Area

As well as breeding Annex I seabirds and the seabird assemblage (refer to Section 9.5), the Skomer, Skokholm and the seas off Pembrokeshire SPA is also classified for several migratory species, listed under Article 4.2 of the Birds Directive. A description of the SPA can be found in Section 9.5 of this report, the overarching conservation objective is to "*ensure that the* [qualifying features'] *condition is maintained or enhanced*" (JNCC, 2019c).

The regularly occurring migratory bird species that are qualifying features of the SPA include (NRW, 2015a; JNCC, 2019c):

- Manx shearwater *Puffinus puffinus* (A200);
- Lesser black-backed gull *Larus fuscus* (A183);
- Atlantic puffin *Fratercula arctica* (A204).

9.9.1.1. Assessment of Adverse Effects Alone and In-combination

Assessment of potential for adverse effects on classified migratory populations listed for the Skomer, Skokholm and the Seas off Pembrokeshire SPA are provided within the relevant receptor species text within Sections 9.5.7 and9.6.3. Assessment therein described both effects in the breeding, post-breeding, non-breeding, and pre-breeding seasons. It is considered that the potential effects on pre- and post-breeding populations capture all risk of adverse effects on migratory populations. In accordance with the outcomes of those assessments, it is concluded that there is **no potential for any adverse effects on the integrity of the Skomer, Skokholm and the Seas off Pembrokeshire SPA from the Project alone or in-combination in relation to the conservation objectives for migratory features**.

9.9.2. Special Protection Areas with Overwintering Qualifying Features

There are several coastal, mostly estuarine, SPAs in Wales with overwintering bird features that may be exposed to collision and/or barrier effects during migration. The Welsh wintering SPAs and the qualifying features considered in this section are outlined in Table 9.40.

As noted in Table 9.40, the majority of sites are a substantial distance from the offshore array area (>50 km) and are all classified for overwintering features. Therefore, there is very little to no chance of interaction between the offshore array and the classified populations whilst they are present at these sites during the winter period.

However, it is noted that these overwintering species migrate to and from their respective SPAs in autumn and spring, and as such, may interact with the offshore array area during these migrations. As no detailed tracking data are available for the sites, and the species for which they are classified

were either not recorded, or recorded in very low numbers, in the offshore array area during the project-specific DAS surveys, a robust quantitative assessment could not be completed.

Therefore, a qualitative assessment of the potential pressures on overwintering features of the following SPAs has been conducted:

- Bae Caerfyrddin/Carmarthen Bay SPA;
- Burry Inlet SPA;
- Northern Cardigan Bay/Gogledd Bae Ceredigion SPA;
- Dyfi Estuary/Aber Dyfi SPA;
- Severn Estuary SPA;
- Traeth Lafan/Lavan Sands, Conway Bay SPA;
- The Dee Estuary SPA.

Using the SOSSMAT approach, and migratory routes published in SOSS-05 (Wright *et al.*, 2012), an assessment of potential interaction between the offshore array area and qualifying overwintering populations of the aforementioned SPAs has been made.

Of the species listed in Table 9.40, the following do not have migratory routes that interact with the offshore array area (Wright *et al.*, 2012):

- Bewick's swan *Cygnus columbianus bewickii* (Severn Estuary SPA);
- European white-fronted goose *Anser albifrons albifrons* (Severn Estuary SPA);
- Greenland white-fronted goose *Anser albifrons flavirostris* (Dyfi Estuary/Aber Dyfi SPA).

As such, it can be determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the features listed above of any of the SPAs listed in Table 9.40 from any pressures associated with the offshore array area**.

Table 9.40: Welsh coastal/estuarine Special Protection Areas with qualifying overwintering features (Source: CCW, 2008d; NRW, 2018g, 2021d)

Site Code	Site Name	Qualifying Wintering Feature(s)	Distance to Offshore Array Area (km)
UK9014091	Bae Caerfyrddin / Carmarthen Bay SPA	Common scoter *Melanitta nigra*	64
UK9015011	Burry Inlet SPA	Oystercatcher *Haematopus ostralegus*; Knot *Calidris canutus*; Turnstone *Arenaria interpres*; Pintail *Anas acuta*; Shoveler *Anas clypeata*; Teal *Anas crecca*; Wigeon *Anas Penelope*; Dunlin *Calidris alpina*; Curlew *Numenius arquata*; Grey plover *Pluvialis squatarola*; Redshank *Tringa totanus*; Shelduck *Tadorna tadorna*; Wintering waterbird assemblage.	90
UK9020327	Northern Cardigan Bay / Gogledd Bae Ceredigion SPA	Red-throated diver *Gavia stellata*	134
UK9020284	Dyfi Estuary / Aber Dyfi SPA	Greenland white-fronted goose *Anser albifrons flavirostis*	158
UK9015022	Severn Estuary SPA	Bewick's swan *Cygnus columbianus bewickii*; European white-fronted goose *Anser albifrons albifrons*; Dunlin *Calidris alpina*; Redshank *Tringa totanus*; Shelduck *Tadorna tadorna*; Gadwall *Anas strepera*; Wintering waterbird assemblage.	164
UK9013031	Traeth Lafan / Lavan Sands, Conway Bay SPA	Oystercatcher *Haematopus ostralegus*; Curlew *Numenius arquata*; Great-crested grebe *Podiceps cristatus*; Red-breasted merganser *Mergus serrator*.	218

Site Code	Site Name	Qualifying Wintering Feature(s)	Distance to Offshore Array Area (km)
UK9013011	The Dee Estuary SPA	Shelduck *Tadorna tadorna*; Teal *Anas crecca*; Pintail *Anas acuta*; Oystercatcher *Haematopus ostralegus*; Grey plover *Pluvialis squatarola*; Knot *Calidris canutus*; Dunlin *Calidris alpina*; Black-tailed godwit *Limosa limosa*; Curlew *Numenius arquata*; Redshank *Tringa totanus*; Wintering waterbird assemblage.	257

Ducks (including Dabbling Ducks and Seaducks)

For the purpose of this assessment, the duck (including dabbling ducks and seaducks) species have been grouped together as they share similar phenology and migration routes with respect to UK waters. These species include shelduck *Tadorna tadorna*, gadwall *Anas strepera*, pintail *Anas acuta*, shoveler *Anas clypeata*, wigeon *Anas penelope*, teal *Anas crecca*, common scoter *Melanitta nigra*, and red-breasted merganser *Mergus serrator*.

Wright *et al.* (2012) indicates that the duck species have a vast migration area, mostly travelling between mainland Europe and the UK and Ireland. Unlike the majority of seabirds, duck species typically fly over land, and therefore, individuals from SPAs in Wales are able to travel in a westerly direction in the spring, and thus have very limited interaction with the offshore array area. The array area occupies a negligible proportion of the migration area presented in SOSS-05 (Wright *et al.*, 2012) and an insignificant (<1%) proportion of individuals may interact with the area on passage. However, it should be noted that this does not account for avoidance behaviour, and as such, the real-world level of interaction is expected to be below this.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the duck features of any of the SPAs listed in Table 9.40 from any pressures associated with the offshore array area.**

Divers

Red-throated diver *Gavia stellata* are known to be highly sensitive to displacement from anthropogenic objects, including offshore wind farm infrastructure (Bradbury *et al.*, 2014). The wintering population is a qualifying feature of the Northern Cardigan Bay/Gogledd Bae Ceredigion SPA, located approximately 134 km to the north of the offshore array area.

Ringing studies suggest that red-throated diver individuals that winter in Great Britain are predominantly those that breed in the UK, Greenland, Iceland, and Scandinavia (O'Brien *et al.*, 2008). These areas located to the north or northeast of the wintering grounds. Individuals migrate from their northern breeding grounds, travelling southwards to wintering grounds, arriving from September onwards. The birds aggregate at the wintering SPAs, with numbers peaking in February and March (O'Brien *et al.*, 2008; NRW, 2015b; Lawson *et al.*, 2016; HiDef, 2018), before individuals depart in the spring to return north for the summer (breeding) season. In Welsh waters, abundance peaks during the winter months and declines from late February onwards (NRW, 2015b).

As Cardigan Bay is located to the north of the Project, and individuals migrate northwards, there is very limited to no potential for interaction between migrating individuals and the offshore array area. Considering the SOSSMAT approach, <1% of individuals are expected to interact with the offshore array area, and therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the overwintering red-throated diver feature of the Northern Cardigan Bay/Gogledd Bae Ceredigion SPA from any pressures associated with the offshore array area**.

Grebes

Wright *et al.* (2012) suggest that great crested grebe *Podiceps cristatus* utilise waters between Ireland and the UK, and the UK and continental Europe for migration. However, most movement of the species is within the UK itself, with individuals travelling from inland water bodies at the end of the breeding season to coastal areas for the winter period (Wernham *et al.*, 2002). Additionally, ringing studies show that a relatively low proportion of birds (13%) move between the UK and continental Europe, however, it is noted that there are limited data on migration movements (Wright *et al.*, 2012).

The wintering population of great crested grebe is a qualifying feature of the Traeth Lafan/Lavan Sands, Conway Bay SPA, which is located approximately 218 km to the north of the Project, on the northern coast of Wales. Individuals migrating from these wintering grounds are unlikely to travel south through the Irish and Celtic Seas, but instead are likely to fly eastwards, over the UK mainland to get to continental Europe. Further to this, as the Project occupies a negligible proportion of the area used, applying the SOSSMAT approach suggests that <1% of individuals will interact with the offshore array area. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the overwintering great crested grebe feature of the Traeth Lafan/Lavan Sands, Conway Bay SPA from any pressures associated with the offshore array area**.

Waders

Due to similar behaviour and migration characteristics, the waders that are qualifying wintering species of the SPAs listed in Table 9.40 (oystercatcher *Haematopus ostralegus*, grey plover *Pluvialis squatarola*, knot *Calidris canutus*, turnstone *Arenaria interpres*, dunlin *Calidris alpina alpina*, redshank *Tringa totanus*, black-tailed godwit *Limosa limosa islandica*, and curlew *Numenius arquata*) have been grouped together for the purpose of this assessment. The majority of the aforementioned species migrate between the UK and breeding grounds in the north or east, including Iceland, Greenland, Canada, Russia, Scandinavia, and the Baltic States (Wright *et al.*, 2012). However, it should be noted that a limited number of individuals may travel between the UK and Ireland, via the Irish Sea, or between the UK and France, via the English Channel.

The SOSSMAT approach has been applied and, taking into consideration that the Project occupies a negligible proportion of the total migration area used by waders, the results show that <1% of individuals of any species are likely to interact with the offshore array area. Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the wader features of any of the SPAs listed in Table 9.40 from any pressures associated with the offshore array area**.

9.9.2.1. Summary

Considering the distance between the array area and the coastal and estuarine SPAs with qualifying wintering populations, the limited potential for interaction between the array area and migratory routes, and the qualitative assessments made using the SOSSMAT approach, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation**

objectives of the features of any of the SPAs listed in Table 9.40 from any pressures associated with the offshore array area.

10. Annex I Onshore Habitats Assessment

10.1. Introduction

A Habitats Regulations Assessment (HRA) screening exercise was completed with respect to onshore Annex I habitats where exposure pathways and the potential impacts were identified that could result in potential Likely Significant Effect (LSE) to onshore Annex 1 habitats (Volume 3, Technical Appendix 8.2: HRA Screening Report). It is assumed that for Annex I Habitats, any Natura 2000 or Ramsar site that overlaps with the direct Project footprint will be affected.

The potential pressure pathways for Annex I Habitat were identified as direct and indirect impacts from Horizontal Directional Drilling (HDD), trenching and/or cable burial.

There is considered to be potential risk from the Project to Annex I habitats through the following pressures:

- Physical change of habitat;
- Physical disturbance;
- Physical loss of habitat;
- Pollution/contamination;
- Introduction or spread of Invasive Non-Native Species (INNS).

10.2. Project Details

A total of 2 Natura 2000 designations were considered relevant when screening for LSE specifically for onshore habitats assessment:

- Pembrokeshire Marine/Sir Benfro Forol SAC;
- Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru SAC.

The qualifying habitat features of the Pembrokeshire Marine SAC and Limestone Coast of South West Wales SAC are presented in Table 5.1 of this report.

The Limestone Coast of South West Wales SAC has been screened out of AA due to no LSE being determined.

The approach to breaching landfall, as well as the precise route, is still to be determined but will be undertaken either by trenching or HDD, with HDD remaining the preferred option. There is 1 Annex I primary qualifying feature habitat within proximity to either landfall option areas, Annex I Reefs, and 2 non-primary Annex I Habitat features, “mudflats and sandflats not covered by seawater at low tide” and “submerged or partially submerged sea caves”, all of which are features of the Pembrokeshire Marine SAC.

Although the Pembrokeshire Marine SAC borders both landfall options, as the qualifying habitat features are considered as part of the marine and intertidal benthic habitats assessment (see Section 6.5), there is no further consideration of potential LSE in terms of onshore terrestrial habitats or the remaining onshore cable route as part of this Report to Inform Appropriate Assessment (RIAA).

11. Annex II Onshore Mammals Assessment

11.1. Introduction

As part of the Habitats Regulations Assessment (HRA) screening exercise (Volume 3, Technical Appendix 8.2: HRA Screening Report), exposure pathways and potential impacts were identified that could result in potential Likely Significant Effect (LSE) to onshore Annex II species of mammal. For the purposes of considering onshore Annex II species of mammal other than bats, a 2 km buffer was applied from the Project onshore cable corridor, and was used to identify Natura 2000 sites needing to be considered. Bats have a variable commuting or foraging range, depending on the species being assessed; potential for connectivity with the proposed works is therefore assessed out to 10 km for species known to range further from roost and/or *hibernacula*.

For the purposes of clarity, grey seal has been included as an Annex II species of mammal qualifying feature of the Pembrokeshire Marine SAC, and is assessed in full in Section 8.6.1 of this Report to Inform Appropriate Assessment (RIAA). It is not considered any further in terms of the onshore pressure pathways.

The potential pressure pathways for Annex II species of mammal were identified as direct and indirect impacts from Horizontal Directional Drilling (HDD), trenching, and/or cable burial.

There is considered to be potential risk from the Project to Annex II species of mammal through the following pressures:

- Physical change of habitat;
- Physical loss of habitat;
- Physical disturbance;
- Visual and noise disturbance;
- Pollution/contamination.

11.2. Onshore Field Surveys

In order to adequately assess the baseline conditions, the following field surveys were conducted with respect to the onshore cable route and included for both the northern and southern landfall options:

- Extended Phase 1 habitat survey (see Volume 3, Technical Appendix 20.2);
- Protected Species survey (see Volume 3, Technical Appendix 20.4);
- Bat Roost surveys (see Volume 3, Technical Appendix 20.5).

Details of the specific methods used, and the results of each survey, can be found in the respective Technical Appendix.

11.3. Project Details

Of the 2 landfall options, the southern landfall would be accessed by HDD drilling down from land back from the cliff faces towards the seabed. In this scenario, it is expected that the HDD entry point

at landfall will be a minimum of ~60 m back from the cliff edge, with an additional wayleave of ~200 m behind the entry point.

It is proposed that the onshore cable be buried in open-cut trenches along public highway routes (in-road or within verges) and through agricultural land (on headlands or adjacent to hedgerows where possible). Within the onshore cable corridor, HDD will be used to circumnavigate existing infrastructure, ditches, watercourses and major road crossings with up to four crossings being required. It is anticipated that cable ducting will be required along the full onshore cable route. Various approaches to construction are anticipated to be needed; those of relevance to onshore terrestrial ecology are as follows:

Trenching: A significant portion of the cable route will be trenched using open cut trenches and primarily within green fields. The trench will typically be made by digging up ground along the route with an excavator. A 5 m width will be required for heavy vehicle access (earth digging equipment and lifting equipment for the cable drums) along the side of the trench, with a further 5 m required for lay down of equipment, topsoil, and spoil from the trenching. Another 21.5 m (depending on method of trench shoring) is required from the edge of the trench on each side, for safety and to prevent trench collapse under load, and 3-5 m will be provided on the far side of the trench for access, storage or working as required.

After installation, the trench is backfilled with sand and/or stabilised material to approximately 300 mm above the top of the cables. The native material that was removed during construction is replaced on top of the stabilised material with any large and sharp stones removed. Finally, the trench is topped up with a minimum of 300 mm topsoil, using the native topsoil whenever possible, up to the surface level, and the temporary access land is to be restored as close as possible to its original conditions.

Depending on the route and obstacles, various sections may use ducts, and/or protective tiles may be installed in the trench above the cables.

Horizontal Directional Drilling: With HDD the pipeline is bored under the crossing to emerge at a target point on the opposite side. The directional drilling unit is placed at the start location and is elevated at the rear to the correct entrance angle. The rig is then anchored in position. The drilling operation begins by drilling a pilot hole using the drill bit, the drill head, and the pressure injection of drilling fluid. The drilling is carried out continuously, in intervals equivalent to one length of drill pipe.

Bentonite clay is used to facilitate drilling operations to lubricate and stabilise ground. Once the drill bit exits the other end of the drill hole, the drill head is removed, and a reamer is attached to the drill string. As the drill rig pulls the reamer back, drill pipe is attached continuously behind the reamer for the subsequent reaming and pipe pulling operations.

When the bore hole has been reamed out to the correct diameter, the back reamer is typically sent back down the bore one or two more times, to ensure that the hole is clear of any large objects and that the slurry in the hole is well mixed. Once the driller is satisfied that the hole is clear and ready for the high-density polyethylene (HDPE) ducting, the pull head is connected to the drill string via a

swivel. The swivel prevents the duct from rotation during the pullback. The duct is then pulled back toward the exit area by the drill rig.

Surface water: During construction earthworks may increase local soil erosion and increase sediment mobilisation. Similarly, pollutants from construction activity could be transported by surface water run-off. Measures to reduce such run-off will be implemented and include (but not limited to): avoiding construction during and following wet weather, where possible; use of sediment traps and silt fences, and tyre wash facilities.

11.4. Pembrokeshire Marine/Sir Benfro Forol Special Area of Conservation

11.4.1. Site Details

The general designated site description for the Pembrokeshire Marine SAC is provided in Section 6.5 of this RIAA. The coastal edge of the Pembrokeshire Marine SAC runs from Porth Egr (west of Porthgain) to immediately south of Manorbier, providing hundreds of kilometres of coastline habitat. In terms of Annex II onshore mammals, European otter *Lutra lutra* is present as a qualifying feature but is not a primary reason for site selection of the designation.

11.4.1.1. European Otter *Lutra lutra*

Feature Summary

European otter are considered to be semi-aquatic mammals with a wide range of favoured habitats and conditions, including freshwater and coastal environments. Currently, the majority of the UK otter population is found in Scotland, although healthy populations exist in Wales. Populations in coastal areas can be found using shallow, inshore marine areas for feeding but will require freshwater for bathing, as well as terrestrial areas for resting and breeding dens. Preferential coastal habitat for otter can vary greatly, from sheltered wooded inlets to more open, low-lying coastal stretches.

In Wales, the recovery of otter populations is considered to be as a result of a ban on certain pesticides in the 1960s and early 1970s; the introduction of otter-specific protection through legislation since 1978; and ongoing improvements in water quality of Welsh rivers since the 1970s (Strachan, 2015).

As part of the statutory Common Standards Monitoring (CSM) of the features of interest, the Pembrokeshire Coast SAC was surveyed for otter between 2002 and 2009 (NRW and SMG, 2015). These surveys included both open coast and estuarine sites. In total, 85.9% sites were found to contain signs of otter and the report makes specific reference to the quality and amount of suitable habitat available to otter close to the coast and Milford Haven waterway shoreline (NRW and SMG, 2015).

Feature Condition and Conservation Objectives

Despite otter being assessed as being in favourable condition with high confidence as recently as 2018 (NRW, 2018b), a 2020 review conducted by NRW of the baseline conditions of protected sites

assessed the overall condition of the otter feature of the Pembrokeshire Marine SAC to be **unfavourable** with medium confidence (NRW, 2020b). NRW was consulted to establish the reasons for this decline in condition and in response (Cooper, A. (2021); email to King R., 09 Nov. 2021) the NRW Senior Marine Advisor explained that:

"*…the reason for the drop in reported* [otter] *status is the 2017/18 Wales Otter Survey. Unfortunately it is still not published but it has apparently shown a drop in otter numbers across Wales since the previous 2009/10 survey. I understand the Wales otter survey is much more river than coastal focus and has few if any survey sites in Pembrokeshire Marine SAC*".

As part of the same consultation email, the Pembrokeshire Marine SAC officer stated (Burton S. (2021); email to King R., 10 Nov. 2021) that they were not aware of the change in assessment (i.e. from favourable condition (high confidence)), but stressed that:

"*…further assessment work remains outstanding.*"

Although the 2017/18 Wales Otter Survey report is not available, the baseline review states that the basis of condition assessment was completed in June 2020 (NRW, 2020b). Given the historical decline and recovery of the UK otter population, earlier assessments indicate that a combination of water quality, pollution events, entrapment in fishing equipment, habitat fragmentation, and collision with vehicles are likely contributors (NRW and SMG, 2015; NRW, 2018b).

There are several general conservation objectives relating to otter as a feature of the Pembrokeshire Marine SAC (NRW, 2018a):

- "*The population is maintaining itself on a long-term basis as a viable component of its natural habitat. Important elements include:*
    - *population size*
    - *structure, production*
    - *condition of the species within the site*.
- *As part of this objective it should be noted that for otter* [*and grey seal*]*;*
    - *contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression*.
- *The species population range within the site is such that the natural range of the population is not being reduced or likely to be reduced for the foreseeable future. As part of this objective it should be noted that for otter* [*and grey seal*]*:*
    - *Their range within the SAC and adjacent inter-connected areas is not constrained or hindered;*
    - *There are appropriate and sufficient food resources within the SAC and beyond;*
    - *The sites and amount of supporting habitat used by these species are accessible and their extent and quality is stable or increasing.*
- *The presence, abundance, condition and diversity of habitats and species required to support this species is such that the distribution, abundance, and populations dynamics of the species within the site and population beyond the site is stable or increasing. Important considerations include:*
    - *Distribution;*

  - *Extent;*
  - *Structure;*
  - *function and quality of habitat;*
  - *prey availability and quality.*

  As part of this objective:
  - *The abundance of prey species subject to existing commercial fishing needs to be equal to or greater than that required to achieve maximum sustainable yield and secure in the long term;*
  - *The management and control of activities or operations likely to adversely affect the species feature is appropriate for maintaining it in favourable condition and is secure in the long term;*
  - *Contamination of potential prey species should be below concentrations potentially harmful to their physiological health;*
  - *Disturbance by human activity is below levels that suppress reproductive success, physiological health, or long-term behaviour;*
  - *For otter there are sufficient sources within the SAC and beyond of high quality freshwater for drinking and bathing.*
- *In the Milford Haven waterways complex inputs of nutrients and contaminants to the water column and sediments derived from human activity must remain at or below levels at the time the site became a candidate SAC.*
  As part of this objective it should be noted that for the otter, populations should be increasing."

Feature-specific conservation objectives include the following, some of which overlap with the general objectives (NRW, 2018a):

- *"With reference to populations:*
  - *Contaminant burdens derived from human activity are below levels that may cause physiological damage, or immune or reproductive suppression.*
- *With reference to range:*
  - *Their range within the SAC and adjacent inter-connected areas is not constrained or hindered:*
  - *There are appropriate and sufficient food resources within the SAC and beyond; and*
  - *The sites and amount of supporting habitat used by otter are accessible and their extent and quality is stable or increasing;*
- *With reference to Supporting Habitats and Species:*
  - *For otter there are sufficient sources within the SAC and beyond of high quality freshwater for drinking and bathing.*
- *With reference to restoration and recovery:*
  - *In the Milford Haven waterways complex inputs of nutrients and contaminants to the water column and sediments derived from human activity must remain at or below levels at the time the site became a candidate SAC.*

  As part of this objective it should be noted that for the otter, populations should be increasing."

11.4.2. Assessment of Adverse Effects Alone

There is direct overlap between the Project footprint and the Pembrokeshire Marine SAC boundary at both the northern and southern landfall option areas although, as the southern landfall option involves HDD, the habitats supporting otter here would effectively be bypassed through the underground route taken. As such, potential for effects on otter would only result from the northern landfall option route being adopted.

Otter are opportunistic and may forage or use the rocky shore as a place of rest/for denning. Targeted protected species surveys (undertaken in February and March 2021, see Volume 3, Technical Appendix 20.4 for further details) revealed limited field signs of otter along the West Angle Bay and wider coastline. Field signs along the Angle Bay coastline were limited to two otter spraints (both located along the northern part of the Bay) and several trails (assumed to be used by otter). A number of additional field signs were found further inshore, but these were limited to another four spraints. Additional trails (assumed to be otter) were identified, as well as some areas of preferential/optimal holt/denning habitat; however, no further evidence was found indicating use by otter.

West Angle beach is accessible by the public, and parking for 60 vehicles is available adjacent to the beach, as well as a café located immediately overlooking the beach. Ease of access and the presence of amenities leads to relatively high levels of footfall within the Bay and coastal walking routes, lending itself to high levels of visitor disturbance in this area of the Pembrokeshire Marine SAC.

Given the limited activity of otter within the two landfall options, relatively high levels of visitor disturbance, as well as the wide availability of preferential foraging and resting habitat, any potential for impacts on otter along the coastline and within potential connective distance of the Pembrokeshire Marine SAC is considered to be negligible.

Physical Change of Habitat

There is anticipated to be a temporary physical change experienced by the habitats immediately adjacent to the Pembrokeshire Marine SAC as a result of the array cable as it makes landfall at the northern location. However, any change in habitat is anticipated to be temporary and short temporal duration, with only potential for a small spatial extent given the relatively narrow cable route corridor and the low number of Pembrokeshire Marine SAC otters present in the area. Following cable installation, the ground conditions are to be reinstated as close to the baseline conditions as possible, with the operational wayleaves excluding regular access and facilitating further regeneration of vegetation directly either side of the cable route corridor. It is anticipated that over time this will result in an overall positive impact in terms of enhancement of quality of habitat to otter.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of otter feature of the Pembrokeshire Marine SAC from any pressure associated with physical change of habitat**.

Physical Loss of Habitat

There is anticipated to be a temporary physical change experienced by the habitats immediately adjacent to the Pembrokeshire Marine SAC, as a result of the array cable as it makes landfall. However, any loss of habitat is anticipated to be temporary and short temporal duration, with only small spatial extent given the availability of the wider Pembrokeshire coastline (along the Pembrokeshire Marine SAC boundary) and the low number of qualifying otter present in the area.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of otter feature of the Pembrokeshire Marine SAC from any pressure associated with physical loss of habitat**.

Physical Disturbance

There is anticipated to be a relatively brief period during which the construction phase will cause any physical disturbance, particularly to otter, experienced immediately adjacent to the Pembrokeshire Marine SAC as a result of the array cable as it makes landfall. However, any disturbance is anticipated to be of short temporal duration with only potential for small spatial extent given the relatively narrow width and duration of the required excavations and the low number of qualifying otter present in the area.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of otter feature of the Pembrokeshire Marine SAC from any pressure associated with physical disturbance**.

Visual and Noise Disturbance

There is anticipated to be a relatively brief period during which the construction phase will cause any visual and noise disturbance, particularly to otter, experienced immediately adjacent to the Pembrokeshire Marine SAC as a result of the array cable as it makes landfall. However, any disturbance is anticipated to be of short temporal duration with only potential for a small spatial extent given the relatively narrow width of the required excavations and the low number of qualifying otter present in the area.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of otter feature of the Pembrokeshire Marine SAC from any pressure associated with visual noise and disturbance**.

Pollution/Contamination

The potential for effects resulting from pollution/contamination is primarily via potential spillages during works while making landfall and further inland. The effects of this would materialise in the short term but would be expected to dissipate quickly as well. Given the relatively small scale and limited duration of the works at either of the northern and southern landfall options, any spillage or pollution incident is considered unlikely to be at a scale where it would cause a significant reduction in habitat quality within the Pembrokeshire Marine SAC.

In a worst-case scenario where a fuel spill within the land adjacent to the Pembrokeshire Marine SAC was to occur, immediately following making landfall for example, this could impact on habitat

quality within the SAC although at a very localised level. Such a spillage could also have direct toxicity impacts on individual otter as well as their prey although, given the relatively narrow onshore cable corridor and the limited activity recorded for otter within the area, the scale of effects from such an event are thought to be minimal. The vast majority of the Pembrokeshire Marine SAC would not be susceptible to such an effect due to limited connectivity with the onshore cable corridor (i.e. no watercourses), although the potential magnitude would depend on the amount of pollutants being released and their type. It is concluded that the works could result in localised contamination of habitats leading to reduced habitat quality and prey availability, although this would not be within the Pembrokeshire Marine SAC.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of otter feature of the Pembrokeshire Marine SAC from any pressure associated with pollution/contamination**.

11.4.3. Assessment of Adverse Effects In-combination

Little evidence was found indicating use of the West Angle Bay by otter during the baseline survey, and the extensive stretch of shoreline and suitable habitat available to otter along the Pembrokeshire coastline may prove to be more attractive, particularly given the high levels of footfall/disturbance at the peninsula. As such, the proportion of qualifying otter likely to experience impacts is likely to be low. Although, as mentioned above in Section 11.4.1.1, the most recent assessment of the otter population in Wales is not currently available and, as indicated by the NRW officer (Cooper, A. (2021); email to King R., 09 Nov. 2021), this survey concentrated more on riverine rather than coastal habitats and so may not be a true reflection on the coastal population that forms the Pembrokeshire Marine SAC qualifying feature.

Projects that have been identified for inclusion within the in-combination assessment for onshore mammals include:

- Greenlink Interconnector;
- Marine Energy Test Area (META);
- Valero CHP Cogeneration Unit.

While the META planning documents were not available for consideration at the time of writing (December 2021), both the Greenlink Interconnector and Valero CHP projects did not anticipate any residual effects on otter or any other terrestrial mammal ecological receptors.

In view of the low use of West Angle Bay by the qualifying population and the expectation that the other projects screened into in-combination assessment would not result in residual adverse effects on otter or any other terrestrial mammal ecological receptors, the following determination is made: there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the otter feature of the Pembrokeshire Marine SAC from any pressures associated with Project activities**.

11.4.4. Summary

Few signs indicative of otter activity were recorded during the protected species survey, (see Volume 3, Technical Appendix 20.4). Given the relatively small width of the anticipated working zone

of the onshore cable route installation (i.e. maximum of 60 m), no significant effects either for pressures or related impacts alone, or in combination are likely.

On this basis**, it is determined that there is no potential for an adverse effect on integrity, having regard to the conservation objectives of the otter feature of the Pembrokeshire Marine SAC from any pressures associated with any effect associated with the Project (alone or in-combination)**.

11.5. Limestone Coast of South West Wales/Arfordir Calchfaen de Orllewin Cymru Special Area of Conservation

11.5.1. Site Details

The general designated site description for the Limestone Coast of South West Wales SAC is provided in Section 6.6.1 of this RIAA. In terms of Annex II onshore mammals, greater horseshoe bat *Rhinolophus ferrumequinum* are present as a primary feature for the selection of this site. The SAC overlies a collection of 9 SSSIs which are each further separated into "management units" (MUs) in order to facilitate a more targeted approach to site management according to each of the relevant qualifying features (CCW, 2008a). Of the 9 MUs associated with the Limestone Coast of South West Wales SAC, 4 SSSIs have greater horseshoe bat as a notified feature:

- Castlemartin Cliffs and Dunes SSSI (key species in MUs 2c-2g);
- Stackpole SSSI (not a key species but considered to benefit from management of another key feature(s) of MUs 3a-3f);
- Stackpole Quay to Trewent Point SSSI (not a key species but considered to benefit from management of another key feature(s) of MU 4);
- Lydstep Head – Tenby Burrows SSSI (not a key species but considered to benefit from management of another key feature(s) of MUs 5a-5e).

The NRW (CCW, 2008a) Core Management Plan refers to the Gower Coast: Rhossili to Port Eynon SSSI site having greater horseshoe bat as a key species (as part of MU 9); however, it is not listed as a feature of the SSSI any longer (NRW, 2020). The reasons for this exclusion are currently unknown and NRW has been consulted on the reasons for this, and is still investigating at the time of writing.

11.5.1.1. Greater Horseshoe Bat *Rhinolophus ferrumequinum*

Feature Summary

The greater horseshoe bat is one of the largest bat species found in the UK. There are 11 SAC sites designated within the UK featuring greater horseshoe bat, of which 3 are found in Wales. Typically this species' summer and winter roosts are less than 20-30 km apart (JNCC, 2021i). Their preferred foraging habitats include a mosaic of open grazed pasture, woodland edges and tall hedgerows. On average their foraging range is an ~5 km radius of their roost site (Dietz and Kiefer, 2016). Similar distances were found during a more recent study (Finch *et al*., 2020) which determined a mean distance from a roost, recorded by individuals during radio telemetry studies, of 5.4 km, with a maximum of 9.1 km; while Pinaud *et al.* (2018) found distances of 4.2 km and 7.6 km, respectively. Greater horseshoe bat are particularly dependent on grazed pasture, due to the associated prey

species population of dung beetles and other Coleoptera, which form a high proportion of their diet during the breeding season.

The current population size estimate for greater horseshoe bat in the UK is 9,210-18,500, with the Welsh population estimated to be 1,930-3,850 individuals (Matthews *et al*., 2018). The Limestone Coast of South West Wales SAC contains the main hibernation site for the population associated with Pembrokeshire Bat Sites and Bosherton Lakes SAC (see Section 11.6). It is thought that the SAC may be utilised by up to 5.5% of the UK population of greater horseshoe bat (JNCC, 2021i).

Feature Condition and Conservation Objectives

There are several general conservation objectives relating to greater horseshoe bat as a feature of the Limestone Coast of South West Wales SAC (CCW, 2008a):

- "*The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' when:*
    - *population dynamics data on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
    - *the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
    - *There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis*."

A 2020 review conducted by NRW of protected sites' baseline conditions assessed the overall condition of the greater horseshoe bat feature of the Limestone Coast of South West Wales SAC as being of **favourable** condition, with high confidence (NRW, 2020).

Objectives relating specifically to greater horseshoe bat include:

- *"Greater horseshoe bats will continue to utilise known caves roosts undisturbed by the public.*
- *Distinctive droppings indicate presence at any time of year but largest numbers of bats are likely to be found in the period November to March.*
- *The peak winter population in the main Castlemartin Cave is equivalent to approximately 20% of the Pembrokeshire Bat Sites and Bosherston lakes SAC greater horseshoe bat population.*
- *The greater horseshoe bat population within the caves being monitored is stable or increasing.*
- *Natural processes such as rock falls will be tolerated but other factors affecting the achievement of these conditions are under control."*

The conservation objectives for greater horseshoe bat focus primarily on the cave roosts situated along the coastal edges of the Limestone Coast of South West Wales SAC. Factors recognised as affecting greater horseshoe bat as a feature of the SAC include the condition of the caves and access and recreation (by climbers, cavers and water users). However, levels of disturbance in the vicinity of the caves along the Castlemartin Peninsula is thought to be low (CCW, 2008a).

11.5.2. Assessment of Adverse Effects Alone

There is no direct overlap between the Project footprint and the Limestone Coast of South West Wales SAC boundary at any point of the onshore cable route, although the edge of the SAC lies 50 m away at its closest point, but this part of the SAC (i.e. MU 1c of the Broomhill Burrows SSSI) does not support greater horseshoe bat (CCW, 2008a). The Castlemartin Cliffs and Dunes SSSI supports the nearest MU (2c), located ~4 km distant at its nearest point to the Proposed Development. The next closest MU is 2d, which is ~4.9 km at its nearest point from the Proposed Development.

Although roosting greater horseshoe bats are more associated with the caves of the SAC they are recognised as using temporary and summer roosts outside cave environments. The protected species surveys and subsequent bat roost feature surveys (see Volume 3, Technical Appendix 20.4 and 20.5 for further details) surveyed for roost features within 50 m of the cable route corridor (including both landfall options) and revealed no signs or evidence of use by bats within the features identified at the time of survey in July, August and September 2021.

Physical Change of Habitat

Given that horseshoe bat are recognised as having a foraging range of ~5 km from roost sites (Dietz and Kiefer, 2016), changes to habitat may affect foraging potential as well as commuting corridors, through change or removal of linear features used by bats for navigation (Ransome, 1996). The hedgerows found along much of the onshore cable corridor are described as fragmented or defunct (see Volume 3, Technical Appendix 20.2), and as part of the approach to construction it is proposed to either reinstate or enhance all hedgerows found along the final route that fall within the construction zone (i.e. within the 18.25 m either side of the final cable route). This is to be undertaken regardless of whether there is a need to temporarily remove a specific section of hedgerow, and is anticipated to result in an overall beneficial impact on the condition of the hedgerows adjacent to the entirety of the onshore cable corridor.

Consequently, because the nearest MUs supporting greater horseshoe bats are located at distances approaching the upper end of this species' typical foraging range, the availability of similar and suitable foraging habitat within this range, and because of the temporary, short-term nature of construction works and the subsequent enhancement of the habitat features, it is highly unlikely that greater horseshoe bat of the Limestone Coast of South West Wales SAC population will be significantly affected by the Proposed Development.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Limestone Coast of South West Wales SAC from any pressure associated with physical change of habitat**.

Physical Loss of Habitat

As for physical change of habitat, any physical loss of habitat associated with the Proposed Development is anticipated to be temporary (with the exception of the footprint of the substation and transition joint bay) and short-term, temporally. Following the cable installation, there will be a temporary loss of habitat to the footprint of the construction workings; however, such loss is only expected in the short term. Furthermore, the cable route footprint will maintain a wayleave (15 m wide) throughout its operational lifetime that is to be either reinstated or enhanced through seeding

of meadow grassland mix suitable for this region of Wales. Where the cable route traverses farmland, the field margins will be followed. As such, these areas will be effectively enhanced in terms of habitat quality and overall value for biodiversity from intensively farmed arable and/or grazing land to wider margins improved to support more species of plants and invertebrates, including prey species for bats.

Areas of woodland that are temporarily lost will be reinstated, up to the wayleave margins, wherever possible, and hedgerows are to be reinstated or enhanced wherever possible along the entirety of the cable route corridor. The excluded wayleaves will be promoted to develop scrub (dependant on root exclusion zones appropriate for the installed cable) and rank grassland left to enhance conditions suitable for invertebrates. As such, it is anticipated that despite the initial loss of habitat resulting from the construction it will recover very quickly and subsequently provide an enhanced landscape for foraging and commuting for bats that will complement the existing habitats in the wider area.

The nearest MUs supporting greater horseshoe bats are at locations approaching the upper end of this species' typical foraging range, and the overall condition of hedgerows along the onshore cable route is expected to experience an overall beneficial impact over time. However, it is acknowledged that the construction phase will require the intermittent severance of hedgerows. Ransome (1996) determined that greater horseshoe bat are vulnerable to the severance of linear features when light levels are lighter (i.e. earlier and later stages of the night), with gaps of ~10 m wide affecting their movements under such conditions. As such, mitigation measures are presented in order to maintain linear commuting features used by bats.

Additional mitigation measures for greater horseshoe bat include:

- If construction works results in the removal of hedgerows within the active bat season (April October, inclusive), linear connections throughout the night time will be provided to maintain connectivity for commuting bats. Installations will be at the height of the hedgerow that has been removed to maintain continuity of the linear feature. It is expected that this can be completed by standing the removed sections of hedgerow using supports which can be easily relocated in line with the remaining hedgerow at the end of each working day;
- Sections of removed hedgerow, as well as existing gaps, will be reinstated as soon as possible. Semi-mature planting will also be installed to complement the existing species mix and additional native species of local or regional provenance, if available;
- The boundary of the proposed substation will be planted with a combination of native trees, hedgerows and meadow grass mix consisting of species typical of this part of Wales. Where possible, seeds or staves of local or regional provenance will be used in order to maintain genetic consistency. Please refer to Chapter 22: Landscape and Visual Impact for details on the LEMP.

With the inclusion of the standard and additional mitigation measures (outlined in Section 4.6.1 and above, respectively), it is determined that there is **no potential for adverse effect on integrity, having regard to the conservation objectives of the greater horseshow bat feature of the Limestone Coast of South West Wales SAC from any pressure associated with physical loss of habitat**.

Physical Disturbance

Given the distance of the proposed cable route from the nearest MUs supporting greater horseshoe bat roosts, there are considered to be no significant effects in terms of physical disturbance presented to greater horseshoe bat as a qualifying feature of the Limestone Coast of South West Wales SAC.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Limestone Coast of South West Wales SAC from any pressure associated with physical disturbance**.

Visual and Noise Disturbance

The core working hours during construction are assumed to be 0700-1900 hrs BST Monday-Saturday. However 24 hrs working may be required for some operations (such as oil filling or negotiating sensitive crossings).

As some works may need to take place during night time hours and during darkness, additional mitigation measures are outlined below and in Section 4.6.2:

- Construction works will not be undertaken after dusk, wherever possible. When this cannot be avoided, works will be overseen by the appointed ECoW and ensuring sensitive lighting (as per BCT and ILP, 2018) will be used and the extent of the lit area will be restricted to works areas, as far as possible, to avoid light-spill on to any nearby features attractive to bats;
- The potential pressures of lighting on bats using habitats in the vicinity of the substation is to be reduced by adopting the following principles within security lighting (as per BCT and ILP, 2018):
    - Where and if possible, infra-red lighting will be used;
    - Low-level at the minimum intensity possible, and using diffusers and/or screening, as necessary to limit light-spill across the wider area;
    - Lighting across the planted areas of trees, hedgerow and grassland (i.e. the landscape planting at the substation) will be avoided, if possible, or maintained at a minimum.

With the inclusion of the standard and additional mitigation measures (outlined in Section 4.6.1 and above, respectively), it is determined that there is **no potential for adverse effect on integrity, having regard to the conservation objectives of the greater horseshow bat feature of the Limestone Coast of South West Wales SAC from any pressure associated with visual and noise disturbance**.

Pollution/Contamination

Given the distance of the proposed cable route from the nearest MUs supporting greater horseshoe bats and their roosts, there are considered to be no significant effects in terms of pollution or contamination presented to greater horseshoe bat as a qualifying feature of the Limestone Coast of South West Wales SAC.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Limestone Coast of South West Wales SAC from any pressure associated with pollution/contamination**.

11.5.3. Assessment of Adverse Effects In-combination

Projects that have been identified for inclusion within the in-combination assessment for onshore mammals, specifically for greater horseshoe bat, include:

- Greenlink Interconnector;
- META;
- Valero CHP Cogeneration Unit.

The META planning documents were not available for consideration at the time of writing (December 2021).

The Valera CHP application identified potentially significant effects to greater horseshoe bat making the use of habitats (for foraging and commuting) immediately south of the refinery site (~1.5 km north of the onshore cable corridor). However, the screening assessment found no likely significant effects on the greater horseshoe bat feature from the development alone or in-combination with other projects.

The Greenlink Interconnector assessment identified the potential for impacts on greater horseshoe bat and mitigation was presented to avoid potential effects or reduce them to non-significant levels. The Greenlink projects is anticipated to commence construction in 2022, with commissioning expected in 2024. While mitigation is presented to avoid significant effects on bats for the Greenlink onshore cable construction period, this is to cover the specific sections of cable as construction progresses over time along the route (i.e. any potential for severance of bat linear commuting features, where encountered, would be sequential as construction progresses long the route) and not at once in its entirety, and so effects from construction are highly localised and effectively mitigated for. As such, the Greenlink project found no likely significant effects on the greater horseshoe bat features from the development alone or in-combination with other projects.

With the inclusion of the additional mitigation measures outlined above and in Section 4.6.2 for the proposed Project, none of the identified potential pressure pathways are anticipated to have significant effects on greater horseshoe bat. The proposed Project is anticipated to be in late 2024 with commissioning in 2026, therefore avoiding concurrent construction with the approved Greenlink project. Any construction works for the proposed Project that result in the severance of linear features is to be limited to minimal lengths at any one time (i.e. no more than ~10 m lengths of hedgerow removed at any one time) and stands of scrub and/or trees returned at the end of each working day to maintain any gaps and continuity of the feature each night for commuting and foraging bats. As per the Greenlink construction approach, the proposed Project onshore cable route construction phase will take place sequentially long the cable route assuming that any severance of hedgerows or other linear features for bats can be effective mitigated for. The proposed Project has also made a commitment in terms of enhancing the connectivity of the hedgerows (that form linear commuting features for bats) within the onshore site boundary, this is anticipated to have an overall moderate beneficial effect for bats. Not only will this reconnect currently defunct or poor-quality

commuting features for bats, but will also facilitate access for foraging potential of the wider landscape.

Given the lack of residual negative effects and overall beneficial enhancement of habitat connectivity as a result of the proposed Project mitigation presented in Section 4.6.2, it is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Limestone Coast of South West Wales SAC from any pressure associated with physical loss of habitat or visual and noise disturbance**.

It is also considered that there would be **no contribution in terms of adverse effects on greater horseshoe bat either in-combination with any other development on the integrity of the Limestone Coast of South West Wales SAC and its conservation objectives**.

11.5.4. Summary

The nearest MU associated with the Limestone Coast of South West Wales SAC that is recognised as supporting roosting greater horseshoe bat is located ~4 km at its nearest point and none of the potential roost features located within 50 m of the onshore site boundary showed any signs indicative of roosting bats (see Volume 3, Technical Appendix 20.5). As such, roosting bats associated with the Limestone Coast of South West Wales SAC are considered unlikely to roost within the Zone of Influence of the Proposed Development.

Greater horseshoe bat are recognised as having a core foraging range of ~5 km of a roost site (Dietz and Kiefer 2016; Pinaud *et al.*, 2018; Finch *et al*., 2020), and so the nearest SAC roost lies within this range at its closes point to the onshore site boundary. The proposed onshore cable route is planned to traverse primarily arable and improved grazing farmland, following field margins, and these habitats form the overwhelming majority of the wider landscape.

With the adoption of the proposed additional mitigation (as outlined above and in Section 4.6.2), none of the identified potential pressure pathways are anticipated to have any significant effect on greater horseshoe bat, either in-combination with any other development or independently, as a feature, nor on the conservation objectives of the Limestone Coast of South West Wales SAC designation. Furthermore, the commitment to reinstate stretches of hedgerow that are removed to a better condition by way of enhancement along the length of the onshore cable route is expected to result in a net benefit to commuting and foraging bats.

On this basis, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the greater horseshoe bat feature of the Limestone Coast of South West Wales SAC from any pressures associated with any effect associated with the Project (alone or in-combination)**.

11.6. Pembrokeshire Bat Sites and Bosherton Lakes/Safleoedd Ystlum Sir Benfro a Llynnoedd Bosherton Special Area of Conservation

11.6.1. Site Details

The Pembrokeshire Bat Sites and Bosherston Lakes SAC is underpinned by a collection of 8 SSSI designations. Of these, 7 are associated with greater horseshoe bat (CCW, 2008e):

- Stackpole SSSI (greater horseshoe bat not a key species but considered to benefit from management of another key feature(s) of MUs 1C and 1D);
- Stackpole Courtyard Flats and Walled Garden SSSI (greater horseshoe bat is a key species of MU 2A. It is not a key species but considered to benefit from management of another key feature(s) of MU 2B);
- Slebech Stable Yard Loft, Cellars and Tunnels SSSI (greater horseshoe bat is a key species of MUs 3A and 3B);
- Felin Llwyngwair SSSI (greater horseshoe bat is a key species of MU 4);
- Carew Castle SSSI (greater horseshoe bat is key species of MU 5);
- Orielton Stable Block and Cellars SSSI (greater horseshoe bat is not a key species but considered to benefit from management of another key feature(s) of MU 7);
- Park House Outbuildings SSSI (greater horseshoe bat is not a key species but considered to benefit from management of another key feature(s) of MU 8).

Only Orielton Stable Block and Cellars SSSI is considered to be within likely connective distance, and is therefore screened into this assessment. The remaining 6 SSSIs are >6.3 km from the Proposed Development. The Orielton Stable Block and Cellars SSSI is primarily noted for its significant nursery roost of lesser horseshoe bat *Rhinolophus hipposideros*, which has been screened out from this assessment, but as indicated above the MU is also recognised as being of importance for greater horseshoe bat (see 11.6.1.1 below) (CCW, 2008e).

11.6.1.1. Greater Horseshoe Bat *Rhinolophus ferrumequinum*

Feature Summary

The greater horseshoe bat is one of the largest of bat species found in the UK. There are 11 SAC sites designated within the UK featuring greater horseshoe bat, of which three are found in Wales. Typically this species' summer and winter roosts are less than 20-30 km apart (JNCC, 2021i). Their preferred foraging habitats include a mosaic of open grazed pasture, woodland edges and tall hedgerows. On average their foraging range is a ~5 km radius of their roost site (Dietz and Kiefer, 2016). They are particularly dependent on grazed pasture due to the associated prey species population of dung beetles and other Coleoptera, which form a high proportion of their diet during the breeding season.

The current population size estimate for greater horseshoe bat in the UK is 9,210–18,500, with the Welsh population estimated to be between 1,930-3,850 individuals (Matthews *et al*., 2018). The Pembrokeshire Bat Sites and Bosherston Lakes SAC is thought to support approximately 9.5% of the UK greater horseshoe bat population. It represents the species at the northwestern extremity of its

range. The Limestone Coast of South West Wales SAC (see Section 11.5) contains the main hibernation site for the population associated with Pembrokeshire Bat Sites and Bosherton Lakes SAC.

Feature Condition and Conservation Objectives

There are several general conservation objectives relating to greater horseshoe bat as a feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC (CCW, 2008e):

- "*The conservation status of a species is the sum of the influences acting on the species that may affect the long-term distribution and abundance of its populations. The conservation status will be taken as 'favourable' when:*
    - *population dynamics data on the species indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and*
    - *the natural range of the species is neither being reduced nor is likely to be reduced for the foreseeable future, and*
    - *There is, and will probably continue to be, a sufficiently large habitat to maintain its populations on a long-term basis*."

A 2020 review conducted by NRW of protected sites baseline conditions assessed the overall condition of the greater horseshoe bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC as being of **favourable** condition, with high confidence (NRW, 2020).

The vision for the conservation objectives for this feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC is for it to be in a favourable conservation status where all of the following conditions are satisfied:

- "*The greater horseshoe bat population will be capable of maintaining itself on a long-term basis as a viable component of its natural habitats.*
- *The natural range of greater horseshoe bats will neither be reduced nor will be likely to be reduced for the foreseeable future, and*
- *There will be sufficient habitat to maintain its populations on a long-term basis.*
- *At least three SSSI maternity roosts will be occupied annually by adult greater horseshoe bats and their babies:*
    - *Stackpole Courtyard Flats and Walled Garden SSSI;*
    - *Slebech Stable Yard Loft, Cellars and Tunnels SSSI;*
    - *Felin Llwyngwair SSSI;*
- *Carew Castle SSSI will continue to be used as an intermediate greater horseshoe bat roost, during the spring and autumn, as a male summer roost and an autumn/spring mating roost.*
- *The greater horseshoe bat population at the component SSSI's will be stable or increasing.*
- *There will be a sufficiently large area of suitable habitat surrounding these roosts to support the bat population, including continuous networks of sheltered, broadleaved woodland, tree lines and hedgerows connecting the various types of roosts with areas of insect-rich grassland and open water.*
- *All factors affecting the achievement of these conditions are under control.*".

11.6.2. Assessment of Adverse Effects Alone

There is no direct overlap between the Project footprint and the Pembrokeshire Bat Sites and Bosherton Lakes SAC boundary at any point of the onshore cable corridor. The closest part of the SAC, i.e. the Orielton Stable Block and Cellars SSSI, is located ~2.9 km away. The Orielton Stable Block and Cellars SSSI is primarily noted for supporting a significant roost of lesser horseshoe bat, which are scoped out of this assessment due to their more restricted foraging behaviour, but the management of them as the key feature at this site is considered to also benefit greater horseshoe bat. All other conglomerate parts of the Pembrokeshire Bat Sites and Bosherton Lakes SAC are beyond likely connective distance to the onshore site boundary.

The protected species surveys and subsequent bat roost feature surveys (see Volume 3, Technical Appendix 20.4 and 20.5 for further details) surveyed for roost features within 50 m of the onshore cable corridor (including both landfall options) and revealed no signs or evidence of use by bats within the features identified at the time of survey. As such, only commuting and foraging greater horseshoe bats are scoped into the assessment.

Physical Change of Habitat

Given that horseshoe bats are recognised as having an average foraging range of ~5 km from roost sites (Dietz and Kiefer, 2016; Pinaud *et al.*, 2018; Finch *et al*., 2020), changes to habitat may affect foraging potential as well as commuting corridors, through change or removal of linear features used for navigating (Ransome, 1996). The hedgerows found along much of the onshore cable corridor are described as fragmented or defunct (see Volume 3, Technical Appendix 20.2) and, as part of the approach to construction, it is proposed to either reinstate or enhance all hedgerows found along the final route that fall within the construction zone (i.e. within the 18.25 m either side of the final cable route). This is to be undertaken regardless of whether there is a need to temporarily remove a specific section of hedgerow.

Following the cable installation there will be a temporary loss of habitat to the footprint of the construction workings, however such loss is only expected in the short term. Furthermore, the onshore cable corridor footprint will maintain a wayleave (15 m wide) throughout its operational lifetime that is to be either reinstated or enhanced through seeding of meadow grassland mix suitable for this region of Wales. Where the onshore cable corridor traverses farmland the field margins will be followed. As such, these areas will be effectively enhanced in terms of habitat quality and overall value for biodiversity from intensively farmed arable and/or grazing land, to wider margins improved to support more species of plants and invertebrates.

Areas of woodland that are temporarily lost are to be reinstated, up to the wayleave margins, wherever possible, and hedgerows are to be reinstated or enhanced wherever possible along the entirety of the onshore cable corridor. The excluded wayleaves will be promoted to develop scrub (dependant on root exclusion zones appropriate for the installed cable) and rank grassland left to enhance conditions suitable for invertebrates. As such, it is anticipated that despite the initial change to habitat resulting from the construction, it will recover in the short term and subsequently provide an enhanced landscape for foraging and commuting for bats that will complement the existing habitats in the wider area.

Consequently, despite greater horseshoe bat not being a key species for Orielton Stable Block and Cellars SSSI MU 7, it is considered to benefit from management of another key feature(s) of MU 7. This MU is within the typical foraging range for this species. Given the temporary, short-term nature of the construction phase, availability of additional foraging habitat in the wider area, and the overall enhancement of the habitat features, there is considered to be no significant effects in terms of physical change of habitat presented to greater horseshoe bat as a qualifying feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC from any pressure associated with physical change of habitat**.

Physical Loss of Habitat

As for physical change of habitat, any physical loss of habitat associated with the Proposed Development is anticipated to be temporary (with the exception of the footprint of the substation building and transition joint bay) and short-term. Loss or fragmentation of the hedgerow network as a result of the construction phase may sever linear commuting features used by bats.

Additional mitigation measures for greater horseshoe bat include:

- If construction works results in the removal of hedgerows within the active bat season (April October, inclusive), linear connections throughout the night time will be provided to maintain connectivity for commuting bats. Installations will be at the height of the hedgerow that has been removed to maintain continuity of the linear feature. It is expected that this can be completed by standing the removed sections of hedgerow using supports which can be easily relocated in line with the remaining hedgerow at the end of each working day;
- Sections of removed hedgerow, as well as existing gaps, will be reinstated as soon as possible. Semi-mature planting will also be installed to complement the existing species mix and additional native species of local or regional provenance, if available;
- The boundary of the proposed substation will be planted with a combination of native trees, hedgerows and meadow grass mix consisting of species typical of this part of Wales. Where possible, seeds or staves of local or regional provenance will be used in order to maintain genetic consistency. Please refer to Chapter 21: Landscape and Visual Impact for details on the LEMP.

With the inclusion of the standard and additional mitigation measures (outlined in Section 4.6.1 and above, respectively), it is determined that there is **no potential for adverse effect on integrity, having regard to the conservation objectives of the greater horseshow bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC from any pressure associated with physical loss of habitat**.

Physical Disturbance

Given the distance of the proposed onshore cable corridor from the nearest MUs supporting greater horseshoe bats and their roosts, there is considered to be no significant effects in terms of physical disturbance presented to greater horseshoe bat as a qualifying feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC.

Therefore it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC from any pressure associated with physical disturbance**.

Visual and Noise Disturbance

The core working hours during construction are assumed to be 7am-7pm Monday-Saturday, however 24hrs working may be required for some operations (such as oil filling or negotiating sensitive crossings).

As some works may need to take place during night time hours and during darkness, additional mitigation measures are outlined below and in Section 4.6.2:

- Construction works will not be undertaken after dusk, wherever possible. When this cannot be avoided, works will be overseen by the appointed ECoW and ensuring sensitive lighting (as per BCT and ILP, 2018) will be used and the extent of the lit area will be restricted to works areas, as far as possible, to avoid light-spill on to any nearby features attractive to bats;
- The potential pressures of lighting on bats using habitats in the vicinity of the substation is to be reduced by adopting the following principles within security lighting (as per BCT and ILP, 2018):
    - Where and if possible, infra-red lighting will be used;
    - Low-level at the minimum intensity possible, and using diffusers and/or screening, as necessary to limit light-spill across the wider area;
    - Lighting across the planted areas of trees, hedgerow and grassland (i.e. the landscape planting at the substation) will be avoided, if possible, or maintained at a minimum.

With the inclusion of the standard and additional mitigation measures (outlined in Section 4.6.1 and above, respectively), it is determined that there is **no potential for adverse effect on integrity, having regard to the conservation objectives of the greater horseshow bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC from any pressure associated with visual and noise disturbance**.

Pollution/Contamination

Given distance of the proposed cable route from the nearest MUs supporting greater horseshoe bats and their roosts, there is considered to be no significant effects in terms of pollution or contamination presented to greater horseshoe bat as a qualifying feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC.

Therefore it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC from any pressure associated with pollution/contamination**.

11.6.3. Assessment of Adverse Effects In-combination

Projects that have been identified for inclusion within the in-combination assessment for onshore mammals, specifically for greater horseshoe bat, include:

- Greenlink Interconnector;
- META;
- Valero CHP Cogeneration Unit.

The META planning documents were not available for consideration at the time of writing (December 2021).

The Valera CHP application identified potentially significant effects to greater horseshoe bat making the use of habitats (for foraging and commuting) immediately south of the refinery site (~1.5 km north of the onshore cable corridor). However, the screening assessment found no likely significant effects on the greater horseshoe bat feature from the development alone or in-combination with other projects.

The Greenlink Interconnector assessment identified the potential for impacts on greater horseshoe bat and mitigation was presented to avoid potential effect or reduce them to non-significant levels. The Greenlink project is anticipated to commence construction in 2022, with commissioning expected in 2024. While mitigation is presented to avoid significant effects on bats for the Greenlink onshore cable construction period, this is to cover the specific sections of cable as construction progresses over time along the route (i.e. any potential for severance of bat linear commuting features, where encountered, would be sequential as construction progresses along the route) and not at once in its entirety and so effects from construction are highly localised and effectively mitigated for. As such, the Greenlink project found no likely significant effects on the greater horseshoe bat features from the development alone or in-combination with other projects.

With the inclusion of the additional mitigation measures outlined above and in Section 4.6.2 for the proposed Project, none of the identified potential pressure pathways is anticipated to have significant effects on greater horseshoe bat. The proposed Project construction is anticipated to be in late 2024 with commissioning in 2026, therefore avoiding concurrent construction with the approved Greenlink project. Any construction works for the proposed Project that result in the severance of linear features is to be limited to minimal lengths at any one time (i.e. no more than ~10m lengths of hedgerow removed at any one time) and stands of scrub and/or trees returned at the end of each working day to maintain any gaps and continuity of the feature each night for commuting and foraging bats. As per the Greenlink construction approach, the proposed Project onshore cable route construction phase will take place sequentially along the cable route assuring that any severance of hedgerows or other linear commuting features for bats can be effectively mitigated for. The proposed Project has also made a commitment in terms of enhancing the connectivity of the hedgerows (that form linear commuting features for bats) within the onshore site boundary, this is anticipated to have an overall moderate beneficial effect on bats. Not only will this reconnect currently defunct or poor-quality commuting features for bats but will facilitate access for foraging potential of the wider landscape.

Given the lack of residual negative effects and overall beneficial enhancement of habitat connectivity as a result of the proposed Project mitigation presented in Section 4.6.2, it is therefore determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of greater horseshoe bat feature of the Pembrokeshire Bat Sites and Bosherton Lakes SAC from any pressure associated with physical loss of habitat or visual and noise disturbance**.

Therefore, it is also considered that there would be **no contribution in terms of adverse effects on greater horseshoe bat in combination with any other development on the integrity of the Pembrokeshire Bat Sites and Bosherton Lakes SAC and its conservation objectives**.

11.6.4. Summary

Greater horseshoe bat are recognised as having an average core foraging range of c.5km of a roost site (Dietz and Kiefer 2016, Pinaud *et al.* 2018, Finch *et al*. 2020), and so the nearest SAC roost specifically for this species lies beyond this range at its closes point to the onshore site boundary (i.e. at the Stackpole Courtyard Flats and Walled Garden SSSI, c. 6.3km southeast of the onshore site boundary). As such, the nearest MU associated with the Pembrokeshire Bat Sites and Bosherton Lakes SAC that is recognised as supporting roosting greater horseshoe bats is located beyond the core foraging range of 5km at its nearest point. Furthermore, none of the potential roost features located within 50m of the onshore site boundary showed any signs indicative of roosting bats (see Volume 3, Technical Appendix 20.5: Bat Survey Report).

As such, following implementation of the mitigation outlined in Section 4.6, none of the identified potential pressure pathways are anticipated to have significant effects on greater horseshoe bat, either in combination with any other development or independently, as a feature nor on the conservation objectives of the Pembrokeshire Bat Sites and Bosherston Lakes SAC designation. Furthermore, the commitment to reinstate stretches of hedgerow that are removed to a better condition by way of enhancement along the length of the onshore cable route is expected to result in a net benefit to commuting and foraging bats.

On this basis, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the greater horseshoe bat feature of the Pembrokeshire Bat Sites and Bosherston Lakes SAC from any pressures associated with any effect associated with the Project (alone or in-combination)**.

12. Annex I Terrestrial Birds Assessment

12.1. Introduction

As part of the Habitats Regulations Assessment (HRA) screening exercise (Volume 3, Technical Appendix 8.2: HRA Screening Report), exposure pathways and the potential impacts were identified that could result in potential Likely Significant Effect (LSE) to onshore Special Protection Area (SPA)/Ramsar qualifying features. For the purposes of considering onshore species of bird, a 5 km buffer was applied from the Project onshore cable corridor and was used to identify relevant Natura 2000 sites needing to be considered.

The potential pressure pathways for species of SPA/Ramsar qualifying bird were identified as direct and indirect impacts from Horizontal Directional Drilling (HDD), trenching, and/or cable burial.

The following potential pressure pathways have been identified which may lead to adverse impacts on the SPA/Ramsar qualifying feature:

- Disturbance/displacement;
- Loss/change of habitat.

12.2. Onshore Field Surveys

In order to adequately assess the baseline conditions for birds, the following field surveys were conducted with respect to the onshore cable route and included for both the Northern and Southern landfall options:

- Breeding Bird Survey (see Volume 3, Technical Appendix 20.7: Breeding Bird Survey Report);
- Wintering Bird Survey (see Volume 3, Technical Appendix 20.8: Wintering Bird Survey Report).

Details of the specific methods used, and the results of each survey can be found in the respective Technical Appendix.

Surveys for wintering birds were undertaken in the 2020/2021 winter period and the breeding bird survey was completed in 2021 in relation to the onshore cable corridor and associated infrastructure. The vegetation survey was also completed in 2021 as a National Vegetation Classification (NVC) survey (see Section 0 and Volume 3, Technical Appendix 20.3: National Vegetation Classification Study Report) which defines the specific habitats within the cable corridor and associated infrastructure.

12.3. External Data Consultation

As part of the desk study to inform the baseline conditions an external data consultation was undertaken in which the British Trust for Ornithology (BTO) and the Royal Society for the Protection of Birds (RSPB) were consulted on any historical data of relevance they may hold. The details of the consultation and the data obtained can be found in Volume 3, Technical Appendix 20.8: Wintering Bird Survey Report.

12.4. Castlemartin Coast Special Protection Area

12.4.1. Site Details

Castlemartin Coast SPA is designated for supporting between 12-14 breeding pairs of chough *Pyrrhocorax pyrrhocorax*, which equates to approximately 4% of the UK population. The SPA overlies much of the Limestone Coast of South West Wales Special Area of Conservation (SAC) and the chough rely heavily on the associated habitats of the SAC for both nesting and foraging. As such, the conservation objectives of the Castlemartin Coast SPA are dependent on the management of the Limestone Coast of South West Wales SAC land parcels, and the habitats therein, and are therefore also incorporated into the core management plan for the SAC. The SAC overlies a collection of nine Sites of Special Scientific Interest (SSSIs), which are each further separated into Management Units (MUs) in order to facilitate a targeted approach to site management according to each of the relevant qualifying features (CCW, 2008d). Of the nine SSSIs associated with the SAC, three are associated with chough:

- Broomhill Burrows SSSI (key species in MU 1b and not a key species but considered to benefit from management of another key feature(s) of MU 1a);
- Castlemartin Cliffs and Dunes SSSI (key species in MUs 2a-2g);
- Stackpole SSSI (key species in MU 3c and not a key species but considered to benefit from management of another key feature(s) of MUs 3a, 3b, 3d, 3e and 3f).

12.4.1.1. Chough *Pyrrhocorax pyrrhocorax*

Feature Summary

Chough is an Annex I and Schedule 1-listed species of corvid that is primarily found breeding amongst the deep cracks of rocky cliff and coastlines, with some birds having been found breeding within sea caves (Pembrokeshire Biodiversity Partnership, 2014). The chough associated with Pembrokeshire and the Castlemartin Coast SPA are monitored carefully, given that the 12-14 breeding pairs here constitutes approximately 4% of the UK population. The breeding chough of the Castlemartin Coast SPA have been shown to be reasonably stable, although concerns relating to genetic diversity have been made, and the areas used for breeding along the coast are well known (CCW, 2008a). Chough have specific dietary requirements and so the habitats where such prey are found can be derived: unimproved grassland and coastal heath for invertebrates, as well as yellow ants found amongst the dune networks of the southern Pembrokeshire coastline (Pembrokeshire Biodiversity Partnership, 2014).

Feature Condition and Conservation Objectives

Given the specific nature of chough ecology, the conservation objectives for the SPA are more targeted than for other species at other National Sites (CCW, 2008a):

- "*A breeding chough population will occur along the limestone coast, between Freshwater West and Barafundle Bay.*
- *This population will be maintained at a minimum of 12 breeding pairs (representing 3.5% of the GB population, at the 1993 SPA designation level).*

- *Choughs will continue to, feed, roost and breed successfully, unhindered by human recreational activities (e.g. climbing).*
- *The majority of pairs will rear young each year, with an annual average productivity of at least two young per occupied territory.*
- *Choughs will continue to have access to large amounts of optimal feeding habitat (open areas with very short grassland and heath vegetation <1cm to <3cm in height) within all cliff-top management units and within dune grassland management units at Broomhill Burrows, Brownslade and Linney Burrows and on Stackpole Warren.*
- *Yellow ant-hills, an important summer food resource, will occur in coastal turf, throughout the SPA, at densities up to approximately 550 ant-hills per ha.*
- *A non-breeding chough population (variable in number between 10 and 50 birds) made up largely of juvenile and sub-adult birds will occur at any season*."

A 2020 review conducted by NRW of protected sites baseline conditions assessed the overall condition of the chough feature of the Castlemartin Coast SPA as being of **favourable** condition with high confidence (NRW, 2020).

12.4.2. Assessment of Adverse Effects Alone

There is no direct overlap between the Project footprint and the SPA boundary at any point of the onshore cable corridor. The edge of the SPA lies 150 m away, at its closest point from the onshore site boundary, adjacent to MU 1b of the Broomhill Burrows SSSI, which forms part of the designated optimal foraging dune grassland habitat (CCW, 2008a).

The breeding bird survey completed in 2021 identified 2 breeding chough territories, although these are located further west along the coastline, and within the cliffs and rocky faces north of Sheep Island and adjacent to Guttle Hole; both areas being located c.550 m away, at their closest, to the onshore site boundary. Adjacent to these locations, areas considered optimal foraging for chough were noted, with the habitat coming as close as 350 m to the onshore site boundary (Volume 3, Technical Appendix 20.7: Breeding Bird Survey Report).

Disturbance/Displacement

The onshore site boundary comes within 150 m of the foraging habitat within MU 1b for chough, an area that is managed as a feature of the SPA. A study on disturbance from tourism on chough in northern France (Kerbiriou *et al.,* 2009) established average flush distances of 147 m (± 23 SD) for mixed groups of adults and juvenile birds, while this distance reduced to 75 m (± 9 SD) for flocks excluding juveniles. Although MU 1b lies at the upper limit of this analysis for mixed groups of birds, there is a public road that lies between the designation boundary and the onshore site boundary with regular traffic along the Pembrokeshire peninsula; indicating that birds using this area are accustomed to a background level of mechanical disturbance and continue to forage within the MU.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the chough feature of the Castlemartin Coast SPA from any pressure associated with disturbance/displacement**.

Loss/Change of Habitat

The onshore cable corridor is located inland and is not going to pass through habitat considered to be of foraging or breeding interest to chough, as determined through the baseline survey and external consultation data.

As such, there is considered to be no significant effects in terms of habitat loss presented to chough as a qualifying feature of the SPA.

Therefore, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the chough feature of the Castlemartin Coast SPA from any pressure associated with loss/change of habitat**.

12.4.3. Assessment of Adverse Effects In-combination

Of the in-combination projects considered (i.e., the Greenlink Interconnector and Valero CHP Cogeneration Unit developments), none identified any anticipated effects on chough as a feature of the SPA.

There will be no significant adverse effects on chough from the identified individual impacts of the Proposed Development.

It is therefore concluded that there is **no potential for an in-combination adverse effect on integrity, having regard to the conservation objectives of the chough feature of the Castlemartin Coast SPA from any pressures associated with Project activities**.

12.4.4. Summary

Potential pressure pathways identified in relation to chough included disturbance/displacement and loss/change of habitat. The baseline assessment included both breeding and wintering bird surveys in 2020-2021 to establish use of the onshore cable route and wider area by priority birds of conservation value. The breeding bird survey identified two breeding chough territories as well as located areas of preferred and optimal feeding habitat. The baseline surveys were complimented through consultation and purchasing of historical data form the BTO and RSPB. Of nine SSSIs underlying the Castlemartin Coast SPA, three are associated with chough and subject to management objectives within their respective MUs.

Due to the lack of proximity and the proposed route taken by the onshore cable there was determined to be no significant effects presented to chough as a qualifying feature of the SPA. On this basis, it is determined that there is **no potential for an adverse effect on integrity, having regard to the conservation objectives of the chough feature of the Castlemartin Coast SPA from any pressures associated with any effect associated with the Project (alone or in-combination)**.

13. Consideration of MCZ Assessment Outcomes

Whilst assessment of Marine Conservation Zones (MCZs) is carried out within a distinct assessment process to HRA, MCZs, Natura 2000 sites and Ramsar sites serve as complimentary components of the ecologically coherent network of Marine Protected Areas and National Sites Network. Volume 3, Technical Appendix 8.1: Marine Conservation Zone Assessment provides formal assessment of risk from Project activities to MCZ sites. This assessment screened in Skomer MCZ, which includes grey seal as a species Feature of Conservation Interest (FOCI).

However, grey seal at the Skomer MCZ site are not considered to be a discrete population, but rather part of the wider OSPAR region III MU (NRW 2020), which includes the designated Annex II population of the Pembrokeshire Marine/Sir Benfro Forol SAC. As such, consideration of potential effects from Project activities on the grey seal FOCI at Skomer MCZ was deferred to the Project HRA.

The assessment of the designated Annex II grey seal population of the Pembrokeshire Marine/Sir Benfro Forol SAC (Section 8.6) concluded that there is no potential for any adverse effects on the integrity of the site and its associated Annex II population from the Project alone or in combination, in relation to the conservation objectives for grey seal; or for the wider grey seal population within OSPAR region III MU. As such, it is also concluded that **No Likely Significant Risk** can be concluded for the grey seal FOCI designated at Skomer MCZ.

14. References

6-Alpha Associates, 2020. Unexploded Ordnance (UXO) Threat & Risk Assessment: Meeting the requirements of CIRIA C754 'Assessment and Management of Unexploded Ordnance (UXO) Risk in the Marine Environment' Risk Management Framework. Client Draft V1.0

ABPmer, 2021. Erebus Floating Offshore Wind Farm Volume 3, Annex 6.1: Marine and Coastal Processes Technical Annex. ABPmer Report No.: R3639.

Aprahamian MW, Baglinière JL, Sabatie MR, Alexandrino PA, Thiel RA, Aprahamian CD, 2003. Biology, status, and conservation of the anadromous Atlantic twaite shad *Alosa fallax fallax*. American Fisheries Society Symposium, 35: pp.103-124.

Ashley M, 2016. Polychaetes in littoral fine sand. In: Tyler-Walters H, and Hiscock K, (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth. Available online at: https://dx.doi.org/10.17031/marlinhab.1125.1 [Accessed June 2021].

Band W, 2012. Using a collision risk model to assess bird collision risks for offshore wind farms. Report to The Crown Estate Strategic Ornithological Services (SOSS).

BCT (Bat Conservation Trust), and ILP (Institution of Lighting Professionals), 2018. Bats and artificial lighting in the UK. Bats and the Built Environment Series, Guidance Note 08/18. Available online at: https://cdn.bats.org.uk/uploads/pdf/Resources/ilp-guidance-note-8-bats-and-artificial-lighting-compressed.pdf?v=1542109349 [Accessed December 2021].

BEIS (Department for Business, Energy & Industrial Strategy), 2020. New plans to make UK world leader in green energy. Available online at: https://www.gov.uk/government/news/new-plans-to-make-uk-world-leader-in-green-energy [Accessed August 2021].

Benhemma-Le Gall AP, Thompson I, Graham N, and Merchant. 2020. Lessons learned: harbour porpoises respond to vessel activities during offshore windfarm construction.

Benjamins S, Harnois VH, Smith L, Johanning L, Greenhill C, and Wilson B, 2014. Understanding the potential for marine megafauna entanglement risk from marine renewable energy developments.

Berrow SD, and Rogan E, 1995. Stomach contents of harbour porpoises and dolphins in Irish waters. European Research on Cetaceans 9: pp.179-181.

Booth C, Harwood J, Plunkett R, Mendes S, and Walker R, 2017. Using The Interim PCoD Framework To Assess The Potential Effects Of Planned Offshore Wind Developments In Eastern English Waters On Harbour Porpoises In The North Sea – Final Report. SMRUC-NEN-2017-007, Provided to Natural England and the Joint Nature Conservation Committee, March 2017, SMRU Consulting.

Bradbury G, Trinder M, Furness B, Banks AN, Caldow RWG, and Hume D, 2014. Mapping Seabird Sensitivity to Offshore Wind Farms. PLoS one, 9: p.e106366.

Brierley AS, and Fernandes PG, 2001. Diving Depths of Northern Gannets: Observations of *Sula Bassana* from an Autonomous Underwater Vehicle. The Auk, 118: pp.529-534.

Bunker F, and Holt R, 2003. Surveys of sea caves in Welsh Special Areas of Conservation 2000-2002. Report to Countryside Council for Wales by Marine Seen.

CCW (Countryside Council for Wales), 2008a. Core Management Plan Including Conservation Objectives for the Limestone Coast of South West Wales SAC (Incorporating Castlemartin Coast SPA). Countryside Council for Wales. Available at: https://naturalresources.wales/media/672656/Limestone%20Coast%20of%20South%20West%20Wales%20English.pdf [Accessed September 2021].

CCW (Countryside Council for Wales), 2008b. Core Management Plan including Conservation Objectives for Skomer and Skokholm SPA (Special Protection Area). Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/find-protected-areas-of-land-and-sea/?lang=en [Accessed June 2021].

CCW (Countryside Council for Wales), 2008c. Core Management Plan including Conservation Objectives for Grassholm SPA. Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/find-protected-areas-of-land-and-sea/?lang=en [Accessed June 2021].

CCW (Countryside Council for Wales), 2008d. Core Management Plan including Conservation Objectives for Dyfi Estuary / Aber Dyfi SPA. Available online at: https://naturalresources.wales/media/671834/Dyfi%20SPA-Plan%20English.pdf [Accessed November 2021].

CCW (Countryside Council for Wales), 2008e. Core Management Plan including Conservation Objectives for Pembrokeshire Bat Sites and Bosherston Lakes SAC (Special Area of Conservation). Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/find-protected-areas-of-land-and-sea/?lang=en [Accessed July 2021].

Colles A, Liow LH, and Prinzing A, 2009. Are specialists at risk under environmental change? Neoecological, paleoecological and phylogenetic approaches. Ecology Letters, 12: pp.849-863.

Crabb M, Wright P, Humphrey O, Johnson G, Rush S, van Rein H, and Hinchen H, 2019. Unmanned aerial vehicles for use in marine monitoring. Marine Monitoring Platform Guidelines, No.3. Joint Nature Conservation Committee, Peterborough. ISSN: 2517-7605.

Crowell SE, Wells-Berlin AM, Carr CE, Olsen GH, Therrien RE, Yannuzzi SE, and Ketten DR, 2015. A comparison of auditoru responses across diving bird specioes. Journal of Comparative Physiology, 201: pp.803-815.

Davies J, Baxter J, Bradley M, Connor D, Khan J, Murray E, Sanderson W, Turnball C, and Vincent M, 2001. Marine Monitoring Handbook. Joint Nature Conservation Committee, Peterborough. 405pp.

Defra (Department for Environment, Food and Rural Affairs), JNCC (Joint Nature Conservation Committee), NE (Natural England), MMO (Marine Management Organisation), DAERA (Department of Agriculture, Environment and Rural Affairs) Northern Ireland, BEIS (Department for Business Energy and Industrial Strategy), and OPRED (Offshore Petroleum Regulator for Environment and Decommissioning), 2021. Policy paper overview: Marine environment: unexploded ordnance clearance joint interim position statement.

Diederichs AG, Nehls M, Dähne S, Adler S, Koschinski, and Verfuß U, 2008. Methodologies for measuring and assessing potential changes in marine mammal behaviour, abundance or distribution arising from the construction, operation and decommissioning of offshore windfarms.

Dietz C, and Kiefer A, 2016. Bats of Britain and Europe. Bloomsbury Publishing, London.

DONG energy, 2006. Walney Offshore Windfarm Environmental Statement.

DONG Energy, 2013a. Burbo Bank Extension offshore wind farm Environmental Statement Volume 2 – Chapter 15: Offshore Ornithology.

DONG Energy, 2013b. Walney Extension Offshore Wind Farm Volume 1 Environmental Statement Chapter 13: Offshore Ornithology.Duraes R, Carrasco L, Smith TB, and Karubian J, 2013. Effects of forest disturbance and habitat loss on avian communities in a Neotropical biodiversity hotspot. Biological Conservation, 166: pp.203-211.

EC (European Commission), 2013. Interpretation Manual of European Union Habitats.

EC (European Commission), 2018. Managing Natura 2000 Sites – The Provisions of Article 6 of the 'Habitats' Directive 92/43/EEC. Office for Official Publications of the European Communities, Luxembourg City. 69pp.

ESS (Environmental Sustainable Systems) Ltd, 2007. Annual FEPA Monitoring Report (2005-6) Rhyl Flats Offshore Wind Farm Interim Ornithology Chapter. Interim report to RWE Group.

Evans P, and Hintner K, 2013. Review of the direct and indirect impacts of fishing activities on Marine Mammals in Welsh Waters.

Feingold D, and Evans PGH, 2013. Bottlenose Dolphin and Harbour Porpoise Monitoring in Cardigan Bay and Pen Llŷn a'r Sarnau Special Areas of Conservation 2011 - 2013. NRW Evidence Report No. 4.

Finch D, Corbacho DP, Schofield H, Davison S, Wright PGR, Broughton RK, Mathew F, 2020. Modelling the functional connectivity of landscapes for greater horseshoe bats *Rhinolophus ferrumequinum* at a local scale. Landscape Ecology, 35: pp.577-589. Available online at: https://doi.org/10.1007/s10980-019-00953-1. [Accessed October 2021].

Fox DA, Desholm M, Kahlert J, Christensen TK, and Krag Petersen IB, 2006. Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis, 148: pp.129-144.

Fox DA, and Krag Peteresen IB, 2019. Offshore wind farms and their effects on birds. Dansk Ornitologisk Forenings Tidsskrift, 113: pp.86-101.

Furness RW, and Bryant DM, 1996. Effect of wind on field metabolioc rates of breeding northern fulmars. Ecology, 77: pp.1181-1188.

Furness RW, Wade HM and Masden EA, 2013. Assessing vulnerability of marine bird populations to offshore wind farms. *Journal of Environmental Management,* 119, pp.56-66.

Furness RW, 2015. *Non-breeding season populations of seabirds in UK waters. Population sizes for Biologically Defined Minimum Population Scales (BDMPS).* Natural England Commissioned Report 164.

Garavelli L, 2020. 2020 State pf the Science Report – Chapter 8: Encounters of Marine Animals with Marine Renewable Energy Device Mooring Systems and Subsea Cables. In: Copping A, and Hemery L (eds) OES-Environmental 2020 State of the Science Report: Environmental Effects of Marine Renewable Energy Development Around the World. Report for Ocean Energy Systems (OES).

Garthe S, Guse N, Montevecchi WA, Rail J-F, and Grégoire F, 2014. The daily catch: Flight altitude and diving behaviour of northern gannets feeding on Altantic mackerel. Journal of Sea Research, 85: pp.456-462.

GB Non-native species secretariat, 2015. Management and guidance. Available online at: http://www.nonnativespecies.org/index.cfm?sectionid=53 [Accessed August 2021].

GIL (Greenlink Interconnector Limited), 2019. Greenlink Interconnector Marine Environmental Statement. Document Ref.: P1975_R4484_RevF1

GIL (Greenlink Interconnector Limited), 2020. Habitat Regulations Assessment Greenlink Interconnector - Marine Wales. Document Ref.: P1975_R4710_RevF4.

GoBe, 2021. Sofia Offshore Wind Farm: Unexploded Ordnance (UXO) Marine Licence Application Supporting Environmental Information and Report to Inform Appropriate Assessment (RIAA).

Goertner JF, 1978. Dynamical Model for Explosion Injury to Fish. Naval Surface Weapons Center White Oak Lab Silver Spring MD.

Goertner JF, Wiley ML, Young GA, and McDonald WW, 1994. Effects of underwater explosions on fish without swimbladders. Naval Surface Warfare Center Silver Spring MD.

Golding N, Albrecht J, and McBreen F, 2020. Refining the criteria for defining areas with a 'low resemblance' to Annex I stony reef. JNCC Report No. 656. Joint Nature Conservation Committee, Peterborough. ISSN: 0963-8091.

Govoni JJ, Settle LR, and West MA, 2003. Trauma to juvenile pinfish and spot inflicted by submarine detonations. Journal of Aquatic Animal Health, 15: pp.111-119.

Gubbay S, 2007. Defining and managing *Sabellaria spinulosa* reefs: Report of an inter-agency workshop 1-2 May, 2007. JNCC Report No. 405. Joint Nature Conservation Committee, Peterborough. ISSN: 0963-8091.

Halvorsen MB, Casper BM, Matthews F, Carlson TJ, and Popper AN, 2012. Effects of exposure to pile-driving sounds on the lake sturgeon, Nile tilapia and hogchoker. Proceedings of the Royal Society B: Biological Sciences, 279: pp.4705-4714.

Hansen KA, Larson ON, Wahlbert M, and Siebert U, 2016. Underwater hearing in the great cormorant (*Phalacrocorax carbo sinensis*): Methodological considerations. Presented at the168th Meeting of the Acoustical Society of America, Indianapolis, Indiana.

Heinänen S, and Skov H, 2015. The identification of discrete and persistent areas of relatively high harbour porpoise density in the wider UK marine area. JNCC Report No. 544. Joint Nature Conservation Committee, Peterborough.

HiDef (HiDef Aerial Surveying Ltd), 2018. Digital video aerial surveys of red-throated diver in the Outer Thames Estuary Special Protection Area 2018. Report for Natural England.

Horswill C, and Robinson RA, 2015. Review of seabird demographic rates and density dependence. JNCC Report No. 522.

Hoskin R, and Tyldesley D, 2006. How the scale of effects on international designated nature conservation sites in Britain has been considered in decision making. A review of authoritative decisions. English Nature Research Reports No. 704.

Irving R, 2009. The identification of the main characteristics of stony reef habitats under the Habitats Directive. Summary report of an inter-agency workshop 26-27 March 2008. JNCC Report No. 532.

JNCC (Joint Nature Conservation Committee), 2004. Common Standards Monitoring Guidance for Sea Caves. Version August 2004. Joint Nature Conservation Committee, Peterborough. ISSN: 1743-8160. Available online at: https://data.jncc.gov.uk/data/9b4bff32-b2b1-4059-aa00-bb57d747db23/CSM-SeaCaves-2004.pdf [Accessed June 2021].

JNCC (Joint Nature Conservation Committee), 2015. The Marine Habitat Classification for Britain and Ireland Version 15.03. Available online at: http://jncc.defra.gov.uk/MarineHabitatClassification [Accessed May 2021].

JNCC (Joint Nature Conservation Committee), 2016a. Irish Sea Front Potential Special Protection Area Draft Conservation Objectives and Advice on Operations. Advice under Regulation 18 of The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended). Available online at: https://hub.jncc.gov.uk/assets/0032da71-db02-44b5-b4e1-022d77ef7ee3 [Accessed July 2021].

JNCC (Joint Nature Conservation Committee), 2016b. DRAFT DEPARTMENTAL BRIEF Irish Sea Front SPA. Available online at: https://hub.jncc.gov.uk/assets/0032da71-db02-44b5-b4e1-022d77ef7ee3 [Accessed July 2021].

JNCC (Joint Nature Conservation Committee), 2019a. At sea densities of all modelled seabird species combined, for the breeding season. Available online at: https://data.gov.uk/dataset/8cb338b3-3c0e-46bd-afb8-3ac008ab31b6/at-sea-densities-of-all-modelled-seabird-species-combined-for-the-breeding-season [Accessed December 2021].

JNCC 2019b - sandbanks

JNCC (Joint Nature Conservation Committee), 2019c. Skomer, Skokholm and the Seas off Pembrokeshire/ Sgomer, Sgogwm a Moroedd Penfro SPA. Available online at: https://jncc.gov.uk/our-work/skomer-skokholm-and-the-seas-off-pembrokeshire-mpa/ [Accessed June 2021].

JNCC (Joint Nature Conservation Committee), 2020. Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland). Report No. 654, JNCC, Peterborough.

JNCC (Joint Nature Conservation Committee), 2021a. 1170 Reefs. Available at: https://sac.jncc.gov.uk/habitat/H1170/ [Accessed: June 2021].

JNCC (Joint Nature Conservation Committee), 2021b. 1110 Sandbanks with are slightly covered by sea water all the time. Available at: https://sac.jncc.gov.uk/habitat/H1110/.

JNCC (Joint Nature Conservation Committee), 2021c. 1140 Mudflats and sandflats not covered by seawater at low tide. Available at: https://sac.jncc.gov.uk/habitat/H1140/ [Accessed: June 2021].

JNCC (Joint Nature Conservation Committee), 2021d. 8330 Submerged or partially submerged sea. Available at: https://sac.jncc.gov.uk/habitat/H8330/ [Accessed: June 2021].

JNCC (Joint Nature Conservation Committee), 2021e. Pembrokeshire Marine/ Sir Benfro Forol. Available online at: https://sac.jncc.gov.uk/site/UK0013116 [Accessed July 2021].

JNCC (Joint Nature Conservation Committee), 2021f. Limestone Coast of South West Wales/ Arfordir Calchfaen de Orllewin Cymru. Available online at: https://sac.jncc.gov.uk/site/UK0014787 [Accessed July 2021].

JNCC (Joint Nature Conservation Committee), 2021g. 1349 Bottlenose dolphin *Tursiops truncatus*. Available online at: https://sac.jncc.gov.uk/species/S1349/ [Accessed November 2021].

JNCC (Joint Nature Conservation Committee), 2021h. Irish Sea Front SPA. Available online at: https://jncc.gov.uk/our-work/irish-sea-front-spa/ [Accessed December 2021].

JNCC (Joint Nature Conservation Committee), 2021i. Species 1304 Greater horseshoe bat *Rhinolophus ferrumequinum*. Joint Nature Conservation Committee, Peterborough. Available online at: https://sac.jncc.gov.uk/species/S1304/ [accessed March 2021].

JNCC (Joint Nature Conservation Committee), and NRW (Natural Resources Wales), 2019a. Consultation response to Project Erebus Habitats Regulations Draft HRA Screening Output – Site Long List Version 1.0. 7pp.

JNCC (Joint Nature Conservation Committee), and NRW (Natural Resources Wales), 2017. Inshore and Offshore Special Area of Conservation (SAC): West Wales Marine / Gorllewin Cymru Forol SAC Selection Assessment Document. Available online at: https://jncc.gov.uk/our-work/west-wales-marine-mpa/ [Accessed June 2021].

JNCC (Joint Nature Conservation Committee), and NRW (Natural Resources Wales), 2019b. Harbour Porpoise (*Phocoena phocoena*) Special Area of Conservation: West Wales Marine / Gorllewin Cymru Forol Conservation Objectives and Advice on Operations. Available online at: https://naturalresources.wales/media/691803/west-wales-marine-conservation-objectives-and-advice-on-operations.pdf [Accessed June 2021].

JNCC (Joint Nature Conservation Committee), and NRW (Natural Resources Wales), 2021. Consultation response to Project Erebus Habitats Regulations Draft HRA Screening Output – Site Long List Version 2.0. 7pp.

JNCC (Joint Nature Conservation Committee), NE (Natural England), and DAERA (Department of Agriculture, Environment and Rural Affairs) Northern Ireland, 2020. Guidance for assessing the significance of noise disturbance against Conservation Objectives of harbour porpoise SACs (England, Wales & Northern Ireland). JNCC Report No. 654.

Johnston A, Cook ASCP, Wright LJ, Humphreys EM, and Burton NHK, 2014. Modelling flight heights of marine birds to more accurately assess collision risk with offshore wind turbines. Journal of Applied Ecology, 51: pp.31-41..

Kerbiriou C, Le Viol I, Robert A, Porcher E, Gourmelon F, Julliard R, 2009. Tourism in protected areas can threaten wild populations: from individual response to population viability of the chough *Pyrrhocorax pyrrhocorax*. Journal of Applied Ecology, 46: pp.657-665.

Kober K, Webb A, Win I, Lewis M, O'Brien S, Wilson LJ, and Reid JB, 2010. An analysis of the numbers and distribution of seabirds within the British Fishery Limit aimed at identifying areas that qualify as possible marine SPAs. Joint Nature Conservation Committee, Peterborough. 162pp.

Krijgsveld KL, Fijn RC, Japnik M, van Horssen PC, Heunks C, Collier MP, Poot MJM, Beuker D, and Dirksen S, 2011. Effect studiues Offshore Wind Farm Egmond aan Zee Final report on fluxes, flight altitudes and behaviour of flying birds.

Laist DW, Knowlton AR, Mead JG, Collet, AS and. Podesta, M. 2001. Collisions between ships and whales. Marine Mammal Science, 17: pp.35-75.

Lane JV, Pollock CJ, Jeavons R, Sheddan M, Furness RW, and Hamer KC, 2020. Post-fledging movements, mortality and migrations of juvenile northern gannets. Marine Ecology Progress Series, 671: pp.207-218.

Lawson J, Kober K, Win I, Allcock Z, Black J, Reid JB, Way L, and O'Brien SH, 2016. An assessment of the numbers and distributions of wintering red-throated diver, little gull and common scoter in the Greater Wash. JNCC Report No. 574. Joint Nature Conservation Committee, Peterborough. 50pp. Available online at: https://hub.jncc.gov.uk/assets/c35b649e-f3bd-42d0-b6c4-96ed66cc2fc2 [Accessed November 2021].

Leopold MF, Dijkman EM, and Teal LR, 2013. Responses of Local Birds to the Offshore Wind Farms PAWP and OWEZ off the Dutch mainland coast. Document No.: C151/12, 108pp.

Lindeboom HJ, Kouwenhoven HJ, Bergman MJ, Bouma S, Brasseur S, Daan R, Fijn RC, de Haan D, Dirksen S, Van Hal R, Hille Ris Lambers R, Ter Hofstede R, Krijgsveld KL, Leopold M, and Scheidat M, 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. Environmental Research Letters, 6: pp.1-13.

Lohrengel K, Evans P, Lindenbaum C, Morris C, and Stringell T, 2018. Bottlenose Dolphin Monitoring in Cardigan Bay 2014-2016. Natural Resources Wales, Bangor.

Lusseau D, 2003. Male and female bottlenose dolphins *Tursiops* spp. have different strategies to avoid interactions with tour boats in Doubtful Sound, New Zealand. Marine Ecology Progress Series, 257: pp.267-274.

Lusseau D, 2006. The short-term behavioral reactions of bottlenose dolphins to interactions with boats in Doubtful Sound, New Zealand. Marine Mammal Science, 22: pp.802-818.

Maitland PS, 2003. Ecology of the river, brook and sea lamprey: *Lampetra fluviatilis*, *Lampetra planeri* and *Petromyzon marinus*. Life in UK Rivers.

Maitland PS, and Hatton-Ellis TW, 2003. Ecology of the Allis and Twaite Shad. Conserving Natura 2000 Rivers Ecology Series No. 3. English Nature, Peterborough.

MarineSpace Ltd, 2019. Project Erebus Habitat Regulations Draft HRA Screening Output – Site Long List. Version 1.0 Issued to NRW on 21 October 2020.

MarineSpace Ltd, 2020a. Project Erebus Habitat Regulations Assessment Strategy. Version 1.0. Document Ref.: J/5/24/20. 55pp.

MarineSpace Ltd, 2020b. Project Erebus Habitat Regulations Assessment Strategy. Version 2.0. Document Ref.: J/5/24/20. 55pp.

MarineSpace Ltd, 2020c. Project Erebus Habitat Regulations Draft HRA Screening Output – Site Long List. Version 2.0 Issued to NRW on 14 January 2020. 35pp.

Masden EA, Haydon DT, Fox AD, Furness RW, Bullman R and Desholm M, 2009. Barriers to movement: impacts of wind farms on migrating birds. *ICES Journal of Marine Science,* 66: 746-753.

Masden EA, Haydon DT, Fox DA, and Furness RW, 2010. Barriers to movement: modelling energetic costs of avoiding marinme wind farms amongst breeding seabirds. Marine Pollition Bulletin, 60: pp.1085-1091.

Matthews F, Kubasiewicz LM, Gurnell J, Harrower CA, McDonald RA, and Shore RF, 2018. A Review of the Population and Conservation Status of British Mammals. A report by the Mammal Society under contract to Natural England, Natural Resources Wales and Scottish Natural Heritage. Natural England, Peterborough.

May J, 2005. Post-construction Results from The North Hoyle Offshore Wind Farm A brief overview of the post construction environmental monitoring at North Hoyle Offshore Wind Farm undertaken by NPower Renewables; and tentative conclusions of the monitoring results. Paper of Copenhagen Offshore Wind International Conference 2005.

McGregor RM, King S, Dovovan CR, Caneco B, and Webb A, 2018. A Stochastic Collision Risk Model for Seabirds inb Fliught. Report for Marine Scotland.

McSorley CA, Dean BJ, Webb A, and Reid JB, 2003. Seabird use of waters adjacent to colonies: Implications for seaward extension to existing seabird breeding colony SPAs. JNCC Report No.: 329.

McSorley CA, Wilson LJ, Dunn TE, Gray C, Dean BJ, Webb A, and Reid JB, 2008. Manx shearwater *Puffinus puffinus* evening rafting behaviour around colonies on Skomer, Rum and Bardsey: its spatial extent and implications for recommending seaward boundary extensions to existing colony Special Protection Areas in the UK. JNCC Report No.: 406.

Mendel B, Kotzerka J, Sommerfeld J, Schwemmer H, Sonntag N, and Garthe S, 2014. Effects of the *alpha ventus* offshore test site on distribution patterns, behaviour and flight heights of seabirds.

Mitchell PI, Newton SF, Ratcliffe N, and Dunn TE (eds), 2004. Seabird Populations of Britain and Ireland. T & AD Poyser, London. ISBN: 0-7136-6901-2. Available online at: https://jncc.gov.uk/our-work/seabird-censuses/ [Accessed June 2021].

Morandi A, Berkman S, Rowe J, Balouskus R, Reich D, Etkin D, and Moelter C, 2018. Environmental Sensitivity and Associated Risk to Habitats and Species on the Pacific West Coast and Hawaii with Offshore Floating Wind Technologies Volume 2: Final Report Appendices OCS Study BOEM 2018-031.

Natural Power, 2002. Environmental Statement Support Applications for an Offshore Wind Farm at Robin Rigg.

Natural Resources Wales (NRW), 2019a. GN030a Benthic habitat assessment guidance for marine developments and activities for characterising and monitoring intertidal rock shore habitats and rock pool habitats. Natural Resources Wales, Bangor. 47pp.

Natural Resources Wales (NRW), 2019b. GN030h Benthic habitat assessment guidance for marine developments and activities: a guide to characterising and monitoring subtidal sediments. Natural Resources Wales, Bangor. 44pp.

NatureScot, 2018. Interim Guidance on apportioning impacts from marine renewable developments to breeding seabird populations in SPAs.

Nedwell JR, Parvin SJ, Edwards B, Workman R, Brooker AG, Kynoch JE, 2007. Measurement and interpretation of underwater noise during construction and operation of offshore windfarms in UK waters. Subacoustech Report No. 544R0738 to COWRIE Ltd. ISBN: 978-0-9554279-5-4.

Nelms SE, Parry HE, Bennett KA, Galloway TS, Godley BJ, Santillo D, and Lindeque PK, 2019. What goes in, must come out: Combining scat-based molecular diet analysis and quantification of ingested microplastics in a marine top predator. Methods in Ecology and Evolution, 10: pp.1712-1722.

Normandeau Associates Inc., Exponent Inc., Tricas T, and Gill A, 2011. Effects of EMFs from Undersea Power Cables on Elasmobranchs and Other Marine Species. U.S. Dept. of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region. BOEMRE, Camarillo, CA.

Nowacek SM, Wells RS, and Solow AR, 2001. Short-term effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, Florida. Marine Mammal Science, 17: pp.673-688.

NPower (NPower Renewables Ltd), 2005. Gwynt y Môr Offshore Wind Farm Environmental Statement Volume 1 Chapter 10 Environmental impact assessment of the offshore components.

NRW (Natural Resources Wales), 2013. Proposed Changes to Grassholm Special Protection Area (SPA) Advice to the Welsh Government. Available online at: https://naturalresources.wales/media/1557/grassholm-spa-advice-to-government.pdf [Accessed June 2021].

NRW (Natural Resources Wales), 2015. Proposals to extend Skokholm and Skomer Special Protection area and rename it as Skomer, Skokholm and the seas off Pembrokeshire / Sgomer, Sgogwm a Moroedd Penfro Special Protection Area Advice to the Welsh Government and UK Government. Available online at: https://cyfoethnaturiol.cymru/guidance-and-advice/environmental-topics/consultations/our-own-consultations/our-own-consultations-closed/closed-2016/new-marine-sac/skomer-skokholm-and-the-seas-off-pembrokeshire/?lang=en [Accessed June 2021].

NRW (Natural Resources Wales), 2015b. Northern Cardigan Bay / Gogledd Bae Ceredigion Draft Special Protection Area Advice to the Welsh Government. Available online at: https://cdn.cyfoethnaturiol.cymru/media/675729/departmental-brief-northern-cardigan-bay-pspa-final.pdf?mode=pad&rnd=131625760740000000 [Accessed November 2021].

NRW (Natural Resources Wales), 2017. Core Management Plan including Conservation Objectives for Afonydd Cleddau / Cleddau Rivers SAC (Special Area of Conservation). Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/find-protected-areas-of-land-and-sea/?lang=en [Accessed June 2021].

NRW (Natural Resources Wales), 2018a. Pembrokeshire Marine / Sir Benfro Forol Special Area of Conservation Advice provided by Natural Resources Wales in fulfilment of Regulation 37 of the Conservation of Habitats and Species Regulations 2017. Available online at: https://naturalresources.wales/media/691808/pembrokeshire_marine-_reg_37_report.pdf [Accessed June 2021].

NRW (Natural Resources Wales), 2018b. Pembrokeshire Marine / Sir Benfro Forol Special Area of Conservation Indicative site level feature condition assessments 2018. NRW Evidence Report No.: 233. Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/indicative-feature-condition-assessments-for-european-marine-sites-ems/?lang=en [Accessed June 2021].

NRW (Natural Resources Wales), 2018c. Limestone Coast of South West Wales / Arfordir Calchfaen de Orllewin Cymru Special Area of Conservation Indicative site level feature condition assessments 2018. NRW Evidence Report No.: 231. Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/indicative-feature-condition-assessments-for-european-marine-sites-ems/?lang=en [Accessed July 2021].

NRW (Natural Resources Wales), 2018d. Cardigan Bay/ Bae Ceredigion Special Area of Conservation Advice provided by Natural Resources Wales in fulfilment of Regulation 37 of the Conservation of Habitats and Species Regulations 2017. Available online at: https://cdn.naturalresources.wales/media/687993/eng-cardigan-bay-reg-37-report-2018.pdf [Accessed June 2021].

NRW (Natural Resources Wales), 2018e. Cardigan Bay / Bae Ceredigion Special Area of Conservation Indicative site level feature condition assessments 2018. NRW Evidence Report No.: 226. Available online at: https://naturalresources.wales/guidance-and-advice/environmental-topics/wildlife-and-biodiversity/protected-areas-of-land-and-seas/indicative-feature-condition-assessments-for-european-marine-sites-ems/?lang=en [Accessed June 2021].

NRW (Natural Resources Wales), 2018f. Pen Llŷn a'r Sarnau / Lleyn Peninsula and the Sarnau Special Area of Conservation Advice provided by Natural Resources Wales in fulfilment of Regulation 37 of the Conservation of Habitats and Species Regulations 2017. Available online at: https://cdn.naturalresources.wales/media/688001/eng-pen-llyn-ar-sarnau-reg-37-report-2018.pdf?mode=pad [Accessed December 2021].

NRW (Natural Resources Wales), 2018g. Special Protection Areas in Welsh waters: Indicative site level feature condition assessments 2018. NRW Evidence Report Series, Report No.: 236. NRW, Bangor, 44pp. Available online at: https://cdn.cyfoethnaturiol.cymru/media/683655/special-protection-areas-in-welsh-waters.pdf [Accessed November 2021].

NRW (Natural Resources Wales), 2020. Project Erebus Habitat Regulations Assessment Strategy Document Consultation Response.

NRW (Natural Resources Wales), 2020b. Protected sites baseline assessment 2020. Available at: https://naturalresources.wales/evidence-and-data/research-and-reports/protected-sites-baseline-assessment-2020/?lang=en (Accessed: October 2021).

NRW (Natural Resources Wales), 2021a. Lle A Geo-Portal for Wales Searbirds at Sea. Available online at: https://lle.gov.wales/catalogue/item/SeabirdsAtSea/?lang=en [Accessed December 2021].

NRW (Natural Resources Wales), 2021b. Environmental Impact Assessment Written Confirmation of the EIA Consent Decision. Available online at: https://publicregister.naturalresources.wales/Search/Download?RecordId=43039 [Accessed September 2021].

NRW (Natural Resources Wales), 2021c. Consultation response to Project Erebus Draft Habitats Regulations Screening Report. 18pp.

NRW (Natural Resources Wales), 2021d. Lle A Geo-Portal for Wales Special Protection Areas (SPA). Available online at: https://lle.gov.wales/catalogue/item/ProtectedSitesSpecialProtectionAreas/?lang=en [Accessed November 2021].

NRW (Natural Resources Wales), and JNCC (Joint Nature Conservation Committee), 2015. Skomer, Skokholm and the seas off Pembrokeshire / Sgomer, Sgogwm an Moroedd Penfro potential Special Protection Area: Draft conservation objectives. Available online at: https://cyfoethnaturiol.cymru/guidance-and-advice/environmental-topics/consultations/our-own-consultations/our-own-consultations-closed/closed-2016/new-marine-sac/skomer-skokholm-and-the-seas-off-pembrokeshire/?lang=en [Accessed June 2021].

Nuuttila HK, Courtene-Jones, W Baulch S, Simon M, and Evans PGH, 2017. Don't forget the porpoise: acoustic monitoring reveals fine scale temporal variation between bottlenose dolphin and harbour porpoise in Cardigan Bay SAC. Marine Biology, 164: p.50.

O'Brien SH, Wilson LJ, Webb A, and Cranswick PA, 2008. Revised estimate of numbers of wintering Red-throated Divers *Gavia stellata* in Great Britain. Bird Study, 55: pp.152-160.

ODPM (Office of the Deputy Prime Minister), 2005. Government Circular: Biodiversity and Geological Conservation – Statutory Obligations and the Impact within the Planning System. ODM Circular and Defra Circular, London. 88pp.

Parry MEV, 2019. Guidance on Assigning Benthic Biotopes using EUNIS or the Marine Habitats Classification of Britain and Ireland (Revised 2019), JNCC Report No 546. Joint Nature Conservation Committee, Peterborough. ISSN: 0963-8091.

Pembrokeshire Biodiversity Partnership, 2014. Species Action Plan: Chough. Pembrokeshire Biodiversity Partnership, Haverfordwest. Available online at: https://www.pembrokeshire.gov.uk/search?q=chough [Accessed March 2021].

Perrins CM, Wood MJ, Garroway CJ, Boyle D, Oakes N, Revera R, Collins P, and Taylor C, 2012. A whole-island census of the Manx Shearwaters *Puffinus puffinus* breeding on Skomer Island in 2011. Seabird, 25: pp.1-13.

Pesante G, Evans PGH, Baines ME, and McMath M, 2008. Abundance and Life History Parameters of Bottlenose Dolphin in Cardigan Bay: Monitoring 2005-2007. CCW Marine Monitoring Report No. 61. 81pp.

Pilot Renewables, 2019. Kincardine Offshore Windfarm Project. Available online at: http://pilot-renewables.com/ [Accessed August 2021].

Pinaud D, Claireau F, Leuchtmann M, and Kerbiriou C, 2018. Modelling landscape connectivity for greater horseshoe bat using an empirical quantification of resistance. Journal of Applied Ecology; 55: pp.2600-2611. Available online at: https://doi.org/10.1111/1365-2664.13228. [Accessed October 2021].

Pinder J, 2020. Method for creating version 3 of the UK Composite Map of Annex I Sandbanks slightly covered by seawater all of the time. Available online at: https://data.jncc.gov.uk/data/f4891fa7-5f9e-417c-af88-073f276a4941/R20200429-UK-Sandbanks-Method-v3.pdf [Accessed June 2021].

PINS (The Planning Inspectorate), 2017. Advice Note Ten: Habitats Regulations Assessment relevant to National Significant Infrastructure Projects.

PINS (The Planning Inspectorate), 2019. Advice Note Seventeen: Cumulative effects assessment relevant to nationally significant infrastructure.

Popper AN, and Hastings MC, 2009. The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology, 75: pp.455-489.

Popper AN, Hawkins AD, Fay RR, Mann DA, Bartol S, Carlson TJ, Coombs S, Ellison WT, Gentry RL, Halvorsen MB, Løkkeborg S, Rogers PH, Southall BL, Zeddies DG, and Tavolga WN, 2014. Sound exposure guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI. Springer Briefs in Oceanography, London.

Pritchard R, Hughes J, Spence IM, Haycock B and Brenchley A, 2021. The Birds of Wales. Liverpool University Press.

Ransome RD, 1996. The management of feeding areas for greater horseshoe bats. English Nature Report No. 174. English Nature, UK. Available online at: http://publications.naturalengland.org.uk/publication/152012. [Accessed October 2021].

RBA (Rudall Blanchard Associates), 2005. Ormonde Project – Environmental Statement. RBA Project No. P761.

Readman JAJ, 2016. Bryozoan turf and erects sponges on tide-swept circalittoral rock. In: TylerWalters H, and Hiscock K (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth. Available online at: https://dx.doi.org/10.17031/marlinhab.9.1 [Accessed June 2021].

Reid JB, and Webb A, 2005. Marine Natura 2000 – Recommendations for the extension of existing seabird (colony) Special Protection Areas into the marine environment. JNCC Paper: 05 P14B.

RPS (RPS Group), 2019a. Marine Energy Wales Marine Energy Test Area (META) Environmental Impact Assessment: Chapter 7: Benthic Subtidal and Intertidal Ecology. Rev 03.

RPS (RPS Group), 2019b. Marine Energy Wales Marine Energy Test Area (META) Environmental Impact Assessment: Chapter 2: Project Description. Rev 04.

RPS (RPS Group), 2020. Arklow Bank Wind Park Phase 2 Offshore Infrastructure Environmental Impact Assessment Scoping Report. Document No.: EOR0765.

RSK (RSK Environmental Ltd), 2006. West of Duddon Sands Offshore Windfarm Environmental Statement Chapter 7 Biological Environment. Project No.: P41096.

RSPB (Royal Society for the Protection of Birds), 2019. Seabird tracking is telling us where th emos timportant marine areas are for the UK's seabirds. Available online at: https://www.rspb.org.uk/our-work/conservation/projects/tracking-seabirds-to-inform-conservation-of-the-marine-environment/ [Accessed December 2021].

Russell DJ, Brasseur SM, Thompson D, Hastie GD, Janik VM, Aarts G, McClintock BT, Matthiopoulos J, Moss SE, and McConnell B, 2014. Marine mammals trace anthropogenic structures at sea. Current Biology, 24: pp.R638-R639.

Sabatini M, 2007. *Spisula solida* A surf clam. In: Tyler-Walters H, and Hiscock K (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth. Available online at: https://www.marlin.ac.uk/assets/pdf/species/marlin_species_2030_2019-03-21.pdf [Accessed June 2021].

Santos M, Pierce GJ, Learmonth JA, Reid R, Ross H, Patterson I, Reid, D and Beare D, 2004. Variability in the diet of harbor porpoises (*Phocoena phocoena*) in Scottish waters 1992–2003. Marine Mammal Science, 20: pp.1-27.

Scheidat MJ, Tougaard S, Brasseur J, Carstensen T, Van Polanen Petel J, Teilmann P, 2011. Harbour porpoises (*Phocoena phocoena*) and wind farms: a case study in the Dutch North Sea. Environmental Research Letters, 6: pp.1-10.

Schneider DC, 1990. Seabirds and fronts: a brief overview. Polar Research, 8: pp.17-21.

SCOS (Special Committee on Seals), 2020. Scientific Advice on Matters Related to the Management of Seal Populations: 2019.

Scrope-Howe S, and Jones DA, 1985. Biological studies in the vicinity of a shallow-sea tidal mixing front. V. Composition, abundance and distribution of zooplankton in the western Irish Sea, April 1980 to November 1981. Philosophical Transactions of the Royal Society of London B, Biological Sciences, 310: pp.501-519.

SeaScape Energy Ltd, 2002. Burbo Offshore Wind Farm Chapter 5: Biological Environment.

SeaScape Energy Ltd, 2009. Burbo Offshore Wind Farm Year 2 Post-construction ornithology report.

Sini M, Canning SJ, Stockin K, and Pierce GJ, 2005. Bottlenose dolphins around Aberdeen harbour, north-east Scotland: a short study of habitat utilization and the potential effects of boat traffic. Marine Biological Association of the United Kingdom. Journal of the Marine Biological Association of the United Kingdom, Plymouth, 85: p.1547.

SNCB (Statutory Nature Conservation Bodies), 2014. SNCB Position Note on avoidance rates for use in collision risk modelling (2014).

SNCB (Statutory Nature Conservation Bodies), 2017. Joint SNCB Interim Displacement Advice Note. [Online]. Available at: https://hub.jncc.gov.uk/assets/9aecb87c-80c5-4cfb-9102-39f0228dcc9a [Accessed December 2021]

SNH (Scottish Natural Heritage), 2001. Natura Casework Guidance: Consideration of Proposals Affecting SPAs and SACs. SNH Guidance Note Series.

Southall BJ, Finneran C, Reichmuth PE, Nachtigall DR, Ketten AE, Bowles WT, Ellison D, Nowacek P, Tyack. 2019. Marine Mammal Noise Exposure Criteria: Updated Scientific Recommendations for Residual Hearing Effects. Aquatic Mammals **45**:125-232.

Spencer SM, 2012. Diving behaviour and identification of sex of breeding Atlantic puffins (*Fratercula arctica*), and nest-site characteristics of alcids on Petit Manan Island, Maine. MS Thesis, Univsersity of Massachusetts Amherst, Amherst, MA.

Stamp TE, 2015. Mixed kelps with scour-tolerant and opportunistic foliose red seaweeds on scoured or sand-covered infralittoral rock. In: Tyler-Walters H, and Hiscock K (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth. Available online at: https://dx.doi.org/10.17031/marlinhab.183.1 [Accessed June 2021].

Stenberg C, Støttrup JG, van Deurs M, Berg CW, Dinesen GE, Mosegaard H, Grome TM, Leonhard SB, 2015. Long-term effects of an offshore wind farm in the North Sea on fish communities. Marine Ecology Progressive Series, 528: pp.257-265.

Strachan R, 2015. Otter Survey of Wales 2009-10 / Arolwg Dyfrgwn yng Nghymru 2009-10. Natural Resources Wales. Available online at: https://naturalresources.wales/media/4590/osw-5-english-24-06-2015.pdf [Accessed September 2021].

Stringell T, Hill D, Rees D, Rees F, Rees P, Morgan G, Morgan L, and Morris C, 2015. Predation of harbour porpoises (*Phocoena phocoena*) by grey seals (*Halichoerus grypus*) in Wales. Aquatic Mammals, 41: pp.188-191.

Strong P, and Morris, 2010. Grey seal (*Halichoerus grypus*) disturbance, ecotourism and the Pembrokeshire Marine Code around Ramsey Island. Journal of Ecotourism, 9: pp.117-132.

Stroud DA, Chambers D, Cook S, Burton N, Fraser B, Clement P, Lewis I, McLean I, Baker H, and Whitehead S, 2001. The UK SPA network: its scope and content (Volumes 1-3). Available online at: https://hub.jncc.gov.uk/assets/3634580a-cabc-4218-872f-8660a1760ad8 [Accessed June 2021].

Thaxter CB, Wanless S, Daunt F, Harris MP, Benvenuti S, Watanuki Y, Grémillet D, and Hamer KC, 2010. Influence of wing loading on the trade-off between pursuit-diving and flight in common guillemots and razorbills. Journal of Experimental Biology, 213: pp.1018-1025.

Thaxter CB, Lascelles B, Sugar K, Cook ASCP, Roos S, Bolton M, Langston RHW, and Burton NHK, 2012. Seabird foraging ranges as a preliminary tool for identifying candidate Marine Protected Areas.

Thomsen F, Lüdemann K, Kafemann R, and Piper W, 2006. Effects of offshore wind farm noise on marine mammals and fish. Biola, Hamburg, Germany on behalf of COWRIE Ltd. 62pp.

Tillin HM, 2016. *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand. In: Tyler-Walters H, and Hiscock K (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth. Available online at: https://www.marlin.ac.uk/assets/pdf/habitats/marlin_habitat_1131_2019-03-12.pdf [Accessed December 2021].

Tillin HM, and Hill JM, 2016. *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock. In: Tyler-Walters H, and Hiscock K, (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews. Marine Biological Association of the United Kingdom, Plymouth. Available online at: https://dx.doi.org/10.17031/marlinhab.199.1 [Accessed June 2021].

Tyler-Walters H, Tillin HM, d'Avack EAS, Perry F, and Stamp T, 2018. Marine Evidence-based Sensitivity Assessment (MarESA) – A Guide. Marine Life Information Network (MarLIN). Marine Biological Association of the United Kingdom, Plymouth.

UK Gov. (Government), 2019. Guidance: Appropriate assessment. Guidance on the use of Habitats Regulations Assessment. Available online at: https://www.gov.uk/guidance/appropriate-assessment [Accessed August 2021].

UK Gov. (Government), 2021. Policy paper. Changes to the Habitats Regulations 2017. Available online at: https://www.gov.uk/government/publications/changes-to-the-habitats-regulations-2017/changes-to-the-habitats-regulations-2017#:~:text=The%202019%20Regulations%20establish%20management%20objectives%20for%20the%20national%20site%20network.&text=The%20network%20objectives%20are%20to,a%20favourable%20conservation%20status%20(%20FCS%20) [Accessed November 2021].

Vanerman N, Stienen EW, Courens W, Onkelinx T, Van de Walle M, and Verstraete, 2014. Bird monitoring at offshore wind farms in the Belgian part of the North Sea Assessmenig seabird displacement effects. The Research Institute for NAure and Forest INBO.

Wade HM, Madsen EA, Jackson AC, and Furness RW, 2016. Incorporating data uncertainty when estimating potential vulnerability of Scottish seabirds to marine renewable energy developments. Marine Policy, 70: pp.108-113.

Wernham CV, Toms MP, Marchant JH, Clark JA, Siriwardena GM, and Baillie SR (eds), 2002. The Migration Atlas: movements of the birds of Britain and Ireland. T & AD Poyser, London.

Whitehouse RJS, Harris JM, Sutherland J, and Rees J, 2011. The nature of scour development and scour protection at offshore windfarm foundations. Marine Pollution Bulletin, 62: pp.73-88.

Wilson S, 2014. The impact of human disturbance at seal haul-outs. A literature review for the Seal Conservation Society.

Woodward I, Thaxter CB, Owens E, and Cook ASCP, 2019. Desk-based revision of seabird foraging ranges used for HRA screening. BTO Research Report No. 724. British Trust for Ornithology, Thetford. ISBN: 978-1-912642-12-0.

Wright LJ, Ross Smith VH, Austin GE, Massimino D, Dadam D, Cook ASCP, Calbrade NA, and Burton NHK, 2012. Strategic Ornithological Support Services Project SSOS-05 Assessing the risk of offshore wind farm development to migratory birds designated as features of UK Special Protection Areas (and other Annex 1 species). BTO Research Report No. 592. British Trust for Ornithology, Thetford. 211pp.

Wyn G, Brazier P, Bunker A, Cooke A, Jones M, and Lough N, 2006. CCW Handbook for Marine Intertidal Phase I survey and mapping. CCW Marine Sciences Report.

Xodus, 2015. Technical Note on Underwater Noise. A-100142-S20-TECH-001

End page left blank