BERWICK BANK WIND FARM
REPORT TO INFORM APPROPRIATE ASSESSMENT

PART TWO: SPECIAL AREAS OF CONSERVATION

Habitats Regulations Appraisal

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HRA Report – Part Two
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CONTENTS

1 Introduction 1
1.1 The Purpose of this Report to Inform Apporpriate Assessment (RIAA) 1
1.2 Structure of the RIAA 1
1.3 Structure of this Document 1
2 Consultation 1
3 Summary of HRA Screening Conclusions for Special Areas of Conservation 11
3.2 Screening Outcomes for the Proposed Development Alone 11
3.2.1 Screening Outcomes for Annex I Habitats 11
3.2.2 Screening Outcomes for Annex II Diadromous Fish 11
3.2.3 Screening Outcomes for Annex II Marine MammalsG 11
3.3 Screening Outcomes for Likely Significant Effects In-Combination 12
3.3.1 LSE In-Combination for Annex I Habitats 12
3.3.2 LSE In-Combination for Annex II Diadromous Fish 12
3.3.3 LSE In-Combination for Marine Mammals. 13
3.4 Summary Table of Likely Significant Effects Identified and Considered in the HRA Stage Two Appropriate Assessment 13
4 Information to Inform the Appropriate Assessments 20
4.1 Maximum design scenarios 20
4.2 Designed in measures 20
4.3 Baseline Information 21
4.4 Conservation Objectives and Conservation Advice 21
4.5 Approach to the In-Combination Assessments 21
5 Appraisal of Potential Adverse Effects on Integrity: Annex I Habitats 32
5.1 Introduction 32
5.2 Assessment Information 32
5.2.1 Maximum Design Scenarios 32
5.2.2 Designed in Measures 32
5.2.3 Baseline Information 32
5.2.4 Conservation Objectives 32
5.2.5 Annex I Habitat Accounts 32
5.2.6 Approach to the In-Combination Assessments 34
5.3 Construction and Decommissioning 37
5.3.1 Increased Suspended Sediment Concentrations and Associated Sediment Deposition 37
5.4 Operation and Maintenance 39
5.4.1 Increased Suspended Sediment Concentrations and Associated Sediment Deposition 39
5.4.2 Alteration of Seabed Habitats arising from effects of Physical Processes 40
5.5 Information to Inform Assessment of Adverse Effects on Integrity 43
5.5.1 Berwickshire and North Northumberland Coast SAC 43
6 Appraisal of Adverse Effects on Integrity: Diadromous Fish 49
6.1 Introduction 49
6.2 Assessment Information 49
6.2.1 Maximum Design Scenarios 49
6.2.2 Designed in Measures 49
6.2.3 Baseline Information 49
6.2.4 Conservation Objectives 50
6.2.5 Species Accounts 50
6.2.6 Approach to the In-Combination Assessments 51
6.3 Construction and Decommissioning 55
6.3.1 Injury and/or Disturbance From Underwater Noise and Vibration 55
6.3.2 Increased Suspended Sediment Concentrations and Associated Sediment Deposition 61
6.4 Operation and Maintenance 63
6.4.1 Electromagnetic Fields (EMF) from Subsea Electrical Cabling 63
6.4.2 Colonisation of Foundations, Scour Protection and Cable Protection 65
6.5 Information to Inform Assessment of Adverse Effects on Integrity 67
6.5.1 Tweed Estuary SAC 67
6.5.2 River Tweed SAC 73
6.5.3 River South Esk SAC 78
6.5.4 River Tay SAC 83
6.5.5 River Dee SAC 88
6.5.6 River Teith SAC 93
7 Appraisal of Adverse Effects on Integrity: Marine Mammals 98
7.1 Introduction 98
7.2 Assessment Information 99
7.2.1 Maximum Design Scenarios 99
7.2.2 Designed in measures 99
7.2.3 Conservation Objectives 99

7.2.4 Species Accounts 99
7.2.5 Approach to the In-combination Assessments 103
7.3 Construction and Decommissioning 107
7.3.1 Underwater Noise 107
7.3.2 Changes in Prey Availability 129
7.4 Operation and Maintenance 133
7.4.1 Underwater Noise 133
7.4.2 Changes in Prey Availability 135
7.5 Relevant Information on Annex II Marine Mammals 136
7.5.1 Sensitivity to Auditory Injury 136
7.5.2 Sensitivity to Behavioural disturbance 138
7.5.3 Sensitivity to TTS 141
7.6 Information to Inform Assessment of Adverse Effects on Integrity 142
7.6.1 Berwickshire and North Northumberland Coast SAC 142
7.6.2 Isle of May SAC 155
7.6.3 Firth of Tay and Eden Estuary SAC 167
7.6.4 Southern North Sea SAC 180
7.6.5 Moray Firth SAC 188
8 Conclusion of the Assessment 199
9 Integrity Matrices 203
9.1 Integrity Matrices for Sites Designated for Annex I Habitats 204
9.2 Integrity Matrices for Site Designated for Annex II Diadromous Fish 205
9.3 Integrity Matrices for Sites Designated for Annex II Marine Mammals 212
10 References 220

Tables

Table 2.1: Consultation Summary 2
Table 3.1: A Summary of all European Sites for which LSE Could not be Discounted at HRA Stage One Screening and for which Appropriate Assessment is Required 14
Table 4.1: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Receptor Groups Considered in the RIAA 23
Table 4.2: Designed in Measures of Relevance to the Assessment of Potential Impacts on European Sites 31
Table 5.1: List of Other Developments with Potential for In-combination Effects on Annex I Habitat Features 35
Table 5.2: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex I Habitat Features from Increased SSC and Associated Sediment Deposition during Construction and Decommissioning 37
Table 5.3: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex I Habitat Features from Increased SSC and Associated Sediment Deposition 38
Table 5.4: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex I Habitat Features from Increases in SSC and Sediment Deposition during Operation and Maintenance 40
Table 5.5: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex I Habitat Features from Changes in Physical Processes 41
Table 5.6: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the Berwickshire and North Northumberland Coast SAC 43
Table 6.1: List of Other Developments with Potential for In-Combination Effects on Annex II Diadromous Fish 52
Table 6.2: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from Underwater Noise during Construction 55
Table 6.3: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Diadromous Fish from Underwater Noise and Vibration during Construction and Decommissioning 56
Table 6.4: Criteria for Onset of Injury to Fish due to Impulsive Piling (Popper *et al.*, 2014) 57
Table 6.5: Summary of Peak Pressure Injury Ranges for Diadromous Fish due to Phase of Impact Piling Resulting in Maximum Peak Sound Pressure Level, for both Wind turbine Foundations and OSP/Offshore Convertor Station Platform Foundations Based on the Peak Pressure Metric 58
Table 6.6: Injury Ranges for Fish due to Impact Pile Driving for the “Realistic” and “Maximum” Pile Driving for Wind turbine Jacket Foundations, and for the Piling of the OSP/Offshore Convertor Station Platform Jackets Based on the Cumulative SEL Metric (N/E denotes where thresholds not exceeded) 58
Table 6.7: TTS Injury Ranges for Fish due to Impact Pile Driving at Two Locations Concurrently, for the “Realistic” and “Maximum” Pile Driving for Wind turbine Jacket Foundations Based on the Cumulative SEL Metric 58
Table 6.8: Injury Ranges for all Fish Groups Relating to Varying Orders of UXO Detonation 59
Table 6.9: Potential Risk for the Onset of Behavioural Effects in Fish from Piling (Popper *et al*., 2014)[a] 59
Table 6.10: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from SSC and Sediment Deposition during Construction and Decommissioning 61
Table 6.11: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Diadromous Fish from Increased SSC and associated Sediment Deposition during Construction and Decommissioning 62
Table 6.12: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from EMF during Operation and Maintenance 64
Table 6.13: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Diadromous Fish from EMF during Operation and Maintenance 64
Table 6.14: Average Magnetic Fields (μT) Generated for AC and DC Offshore Export Cables at Horizontal Distances from the Cable (Assuming Cable Burial to a Depth of 1 m; Source: Modified from Normandeau *et al*., 2011) 65

Table 6.15: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from Colonised Structures during Operation and Maintenance 66
Table 6.16: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the Tweed Estuary SAC 67
Table 6.17: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Tweed SAC 74
Table 6.18: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River South Esk SAC 79
Table 6.19: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Tay SAC 84
Table 6.20: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Dee SAC 89
Table 6.21: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Teith SAC 93
Table 7.1: Harbour Porpoise Modelled Absolute Density Estimates by Season for Proposed Development Array Area Including Lower Confidence Intervals (LCI) and Upper Confidence Intervals (UCI) 101
Table 7.2: Approach to Estimating Abundance in Different Sectors for the Firth of Tay and Adjacent Areas Based on Arso Civil *et al. (*2019) Habitat Preference Map 103
Table 7.3: Summary of Bottlenose Dolphin Densities for Different Sections Within the Regional Marine Mammal Study Area 103
Table 7.4: Density Estimates and Population Assessments for Annex II Marine Mammals in the Proposed Development Marine Mammal Study Area 103
Table 7.5: List of Other Developments with Potential for In-Combination Effects on Annex II Marine Mammal Features 105
Table 7.6: Summary of PTS Criteria for Impulsive and Non-Impulsive Noise (SEL Thresholds in dB re 1 μPa^2s and peak SPL thresholds in dB re 1 µPa) 108
Table 7.7: Summary of TTS Criteria for Impulsive and Non-impulsive Noise (SEL Thresholds in dB re 1 μPa^2s and peak SPL Thresholds in dB re 1 µPa) 108
Table 7.8: Swim Speeds Assumed for Exposure Modelling (SEL_{cum}) for Marine Mammal IEFs 108
Table 7.9: Disturbance Criteria for Marine Mammals Used in Assessment 108
Table 7.10: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Underwater Noise during Construction and Decommissioning 114
Table 7.11: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Marine Mammal Features from Underwater Noise during Construction and Decommissioning 115
Table 7.12: Summary of SPL_{pk} and SEL_{cum} Injury Ranges and Areas of Potential Effect for Harbour Seal and Grey Seal Due to Impact Piling for Wind Turbine and OSP/Offshore Convertor Station Platform Jacket Foundations (Absolute Maximum Hammer Energy) Using 1% Constant Conversion Factor 116
Table 7.13: Summary of SPL_{pk} and SEL_{cum} Injury Ranges and Areas of Effect for Harbour Porpoise due to Impact Piling for Wind Turbine and OSP/Offshore Convertor Station Platform Jacket Foundations (Absolute Maximum Hammer Energy) Using 1% Constant Conversion Factor 117
Table 7.14: Summary of SPL_{pk} and SEL_{cum} Injury Ranges and Areas of Effect for Bottlenose Dolphin Due to Impact Piling for Wind Turbine and OSP/Offshore Convertor Station Platform Jacket Foundations (Absolute Maximum Hammer Energy) Using 1% Constant Conversion Factor 117
Table 7.15: Number of Grey Seals Predicted to be Disturbed within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios Using 1% Constant Conversion Factor 118
Table 7.16: Number of Harbour Seals Predicted to be Disturbed Within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios Using 1% Constant Conversion Factor 119
Table 7.17: Number of Harbour Porpoises Predicted to be Disturbed Within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios 120
Table 7.18: Number of Bottlenose Dolphins Predicted to be Disturbed within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios Using 1% Constant Conversion Factor 121
Table 7.19: Summary of Peak Pressure Injury Ranges for Marine Mammals Due to Single Piling of Wind turbine and OSP/Offshore Convertor Station Platform at 4,000 kJ Hammer Energy Using 1% Constant Conversion Factor, Showing Whether the Individual Can Flee the Injury Range During the 30 Minutes of ADD Activation 122
Table 7.20: Potential PTS Impact Ranges (m) for Annex II Marine Mammals During the Geophysical Site Investigation Surveys 122
Table 7.21: Potential PTS Impact Ranges (m) for Annex II Marine Mammals During the Geotechnical Site Investigation Surveys 122
Table 7.22: Potential Disturbance Ranges for Marine Mammals During the Geophysical and Geotechnical Site Investigation Surveys 123
Table 7.23: Number of Animals Potentially Disturbed Due to the Geophysical and Geotechnical Site Investigation Surveys 123
Table 7.24: Potential PTS Impact Ranges for Marine Mammals Due to UXO High Order Detonation 124
Table 7.25: Potential PTS Impact Ranges for Marine Mammals Due to Low Order Techniques 124
Table 7.26: Number of Animals with the Potential to Experience PTS due to Low Order Techniques 124
Table 7.27: Number of Animals with the Potential to Experience PTS due to High Order Detonation 125
Table 7.28: Recommended ADD Duration for High Order UXO Clearance and Sizes, and Associated Displacement Distance 125
Table 7.29: Potential TTS Impact Ranges for Marine Mammals Due to Low Order Techniques 125
Table 7.30: Number of Animals with the Potential to Experience TTS Due to Low Order Techniques 126
Table 7.31: Number of Animals with the Potential to Experience TTS due to Low Order Techniques 126
Table 7.32: Potential TTS Impact Ranges (m) for Marine Mammals Due to High Order Detonation 126
Table 7.33: Number of Animals with the Potential to Experience TTS due to High Order Detonation 126
Table 7.34: Recommended ADD Duration for High Order UXO Clearance and Sizes, and Associated Displacement Distance 127
Table 7.35: Vessels Involved in the Construction of the Proposed Development and Estimated Potential PTS Ranges for Marine Mammals 128
Table 7.36: Estimated PTS Ranges for Marine Mammals During Other Activities 128

Table 7.37: Estimated Disturbance Ranges for Marine Mammals and Number of Animals Potentially Disturbed as a Result of Vessels and Other Activities 129
Table 7.38: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Changes in Prey Availability during Construction and Decommissioning 130
Table 7.39: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Underwater Noise during Operation and Maintenance 134
Table 7.40: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Marine Mammal Features from Underwater Noise During Operation and Maintenance 134
Table 7.41: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Changes in Prey Availability During Operation and Maintenance 135
Table 8.1: Summary of Conclusions of Adverse Effect on Integrity for SACs 200
Table 9.1: Integrity Matrix for Annex I Habitats of the Berwickshire and North Northumberland Coast SAC 204
Table 9.2: Integrity Matrix for Annex II Diadromous Fish Species of the Tweed Estuary SAC 205
Table 9.3: Integrity Matrix for Annex II Diadromous Fish Species of the River Tweed SAC 206
Table 9.4: Integrity Matrix for Annex II Diadromous Fish (and dependent) Species of the River South Esk SAC 208
Table 9.5: Integrity Matrix for Annex II Diadromous Fish Species of the River Tay SAC 209
Table 9.6: Integrity Matrix for Annex II Diadromous Fish (and dependent) Species of the River Dee SAC 210
Table 9.7: Integrity Matrix for Annex II Diadromous Fish Species of the River Teith SAC 211
Table 9.8: Integrity Matrix for Annex II Marine Mammal Species of the Berwickshire and North Northumberland Coast SAC 212
Table 9.9: Integrity Matrix for Annex II Marine Mammal Species of the Isle of May SAC 214
Table 9.10: Integrity Matrix for Annex II Marine Mammal Species of the Firth of Tay and Eden Estuary SAC 215
Table 9.11: Integrity Matrix for Annex II Marine Mammal Species of the Southern North Sea SAC 217
Table 9.12: Integrity Matrix for Annex II Marine Mammal Species of the Moray Firth SAC 218

Figures

Figure 3.1: Location of European Sites Designated for Annex I Habitats to be Taken Forward for Determination of Adverse Effects on Integrity 19
Figure 3.2: European Sites Designated for Annex II Diadromous Fish Species Taken Forward for Determination of Adverse Effects on Integrity 19
Figure 3.3: European Sites Designated for Annex II Marine Mammal Species Taken Forward for Determination of Adverse Effects on Integrity 20
Figure 6.1: Special Areas of Conservation for Annex II Fish with Underwater Noise Contours (Unweighted SPL_{pk}) Associated with the Southwest Piling Location at 4,000 kJ Hammer Energy 60
Figure 6.2: Special Areas of Conservation for Annex II Fish with Underwater Noise Contours (Unweighted SPL_{pk}) Associated with the Southwest Piling Location at 3,000 kJ Hammer Energy 61
Figure 7.1: Unweighted SEL Contours Due to Concurrent Impact Piling of Wind Turbine Piles at Maximum Hammer Energy (4,000 kJ) Overlaid With Adult Grey Seal Telemetry Tracks 144
Figure 7.2: Unweighted SELss Contours Due to Concurrent Impact Piling Overlaid With 20 km Buffer from the Coast Along the Berwickshire and North Northumberland Coast SAC 145
Figure 7.3: Adult Grey Seal Telemetry Tracks Overlaid with Projects Considered in In-Combination Assessment (Except Moray West Due to Scale) 153
Figure 7.4: Unweighted SEL Contours Due to Concurrent Impact Piling of Wind Turbine Piles at Maximum Hammer Energy (4,000 kJ) Overlaid with Adult Grey Seal Telemetry Tracks 157
Figure 7.5: Unweighted SEL Contours Due to Concurrent Impact Piling Overlaid With 20 km Buffer from the Isle of May SAC 158
Figure 7.6: Unweighted SELss Contours Due to Concurrent Impact Piling of Wind Turbine Piles at Maximum Hammer Energy (4,000 kJ) Overlaid With Adult Harbour Seal Telemetry Tracks 169
Figure 7.7: Adult Harbour Seal Telemetry Tracks Overlaid with Projects Considered in In-Combination Assessment (Except Moray West Due to Scale) 175
Figure 7.8: Unweighted Single Pulse SEL Contours Due to Concurrent Impact Piling at Maximum Hammer Energy (4,000 kJ) Overlaid with Proposed Development and Projects Located Within a Distributional Range of Bottlenose Dolphin Population 195

GLOSSARY

Term	Description
Appropriate Assessment	An assessment to determine the implications of a plan or project on a European site in view of that site's conservation objectives. An Appropriate Assessment forms part of the Habitats Regulations Appraisal (HRA) and is required when a plan or project (either alone or in combination with other plans or projects) is likely to have a significant effect on a European site.
Annex I Habitat	A natural habitat type of community interest, defined in Annex I of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these habitats. The protection afforded to sites designated prior to EU Exit persists in UK law.
Annex II Species	Animal or plant species of community interest, defined in Annex II of the Council Directive 92/43/EEC on the Conservation of natural habitats and of wild fauna and flora (Habitats Directive). The designation of Special Areas of Conservation (SAC) is required in the UK to ensure the conservation of these species. The protection afforded to sites designated prior to EU Exit persists in UK law.
EU Exit	The withdrawal of the United Kingdom from the European Union.
European Site	A Special Area of Conservation (SAC), or candidate SAC, (cSAC), a Special Protection Area (SPA), a site listed as a site of community importance (SCI), or, as per Scottish Planning Policy (SPP), a possible SAC (pSAC) or potential SPA (pSPA).
Habitats Directive	The Habitats Directive is the short name for European Union Council Directive 92/43/EEC on the conservation of natural habitats and of wild fauna and flora. The Directive led to the establishing of European sites and setting out how they should be protected, it also extends to other topics such as European protected species.
Habitats Regulations	The Conservation (Natural Habitats, &c.) Regulations 1994, the Conservation of Habitats and Species Regulations 2017 and the Conservation of Offshore Marine Habitats and Species 2017.
Habitats Regulations Appraisal	A process required by the Habitats Regulations of identifying likely significant effects of a plan or project on a European site and (where likely significant effects are predicted or cannot be discounted) carrying out an appropriate assessment to ascertain whether the plan or project will adversely affect the integrity of the European site. If adverse effects on integrity cannot be ruled out, the latter stages of the process require consideration of the derogation provisions in the Habitats Regulations.
In-combination Effect	The combined effect of the Proposed Development in-combination with the effects from a number of different projects on the same feature/receptor.
Likely Significant Effect	Any effect that may reasonably be predicted as a consequence of a plan or project that may affect the conservation objectives of the features for which the European site was designated but excluding trivial or inconsequential effects. A likely effect is one that cannot be ruled out on the basis of objective information. A 'significant' effect is a test of whether a plan or project could undermine the site's conservation objectives (SNH, 2014).
Natura 2000 Network	A coherent European ecological network of Special Areas of Conservation and Special Protection Areas comprising sites located within European Union Member States.
Proposed Development	The offshore components of the Project, as described in section 5 and volume 1, chapter 3 of the Offshore EIA Report.
Special Area of Conservation (SAC)	Special Areas of Conservation (SACs) are areas designated for the conservation of certain plant and animals species listed in the Habitats Directive.
Site of Community Importance (SCI)	Defined in the Habitats Directive as a site which, in the biogeographical region or regions to which it belongs, contributes significantly to the maintenance or restoration at a favourable conservation status of a natural habitat type in Annex I, or of a species in Annex II, of the Habitats Directive and may also contribute significantly to the coherence of the Natura 2000 network. The site may also contribute significantly to the maintenance of biological diversity within the biogeographic region or regions concerned. For animal species ranging over wide areas, SCIs shall correspond to the places within the natural range of such species which represent the physical or biological factors essential to their life and reproduction.
Special Protection Area (SPA)	Special Protection Areas (SPAs) are sites that are designated to protect rare or vulnerable birds (as listed on Annex I of the Directive 2009/147/EC on the conservation of wild birds), as well as regularly occurring migratory species.

ACRONYMS

Acronym	Description
ADD	Acoustic Deterrent Device
AfL	Agreement for Lease
ASA	Acoustical Society of America
BOWL	Beatrice Offshore Wind Farm
CaP	Cable Plan
CBRA	Cable Burial Risk Assessment
CEA	Cumulative Effects Assessment
CES MU	Coastal East Scotland MU
CI	Confidence Interval
CoCP	Code of Construction Practice
CPT	Core Penetration Test
CTV	Crew Transfer Vessel
CV	Coefficient of Variation
DEFRA	Department for Environment, Food and Rural Affairs
ECOMMAS	East Coast Marine Mammal Acoustic Study
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
EPS	European Protected Species
EU	European Union
FeAST	Feature Activity Sensitivity Tool
FTOWDG	Forth and Tay Offshore Wind Developers Group
GIS	Geographic Information System
HDD	Horizontal Directional Drilling
HF	High Frequency
HRA	Habitats Regulations Appraisal
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IAMMWG	Inter Agency Marine Mammal Working Group
iPCoD	Interim Population Consequences of Disturbance Model
JCP	Joint Cetacean Protocol
JNCC	Joint Nature Conservation Committee
LCI	Lower Confidence Interval
LF	Low Frequency
LSE	Likely Significant Effects
LSEI	Likely Significant Effects In-Combination
MarESA	Marine Evidence-based Sensitivity Assessment
MBES	Multi-Beam Echo-Sounder
MMMP	Marine Mammal Mitigation Plan
MSS	Marine Science Scotland
MU	Management Unit
N/A	Not Applicable
NPF	National Planning Framework
NEE MU	North East England MU
NEQ	Net Explosive Quantity
NRA	Navigational Risk Assessment
NS MU	North Sea MU

Acronym	Description
NSP	Navigational Safety Plan
ORJIP	Offshore Renewables Joint Industry Programme
OSP	Offshore Substation Platforms
PTS	Permanent Threshold Shift
PW	Pinnipeds in Water
RIAA	Report to Inform Appropriate Assessment
RMS	Root Mean Square
SAC	Special Area of Conservation
SBES	Single Beam Echosounder
SBP	Sub-Bottom Profilers
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCI	Site of Community Importance
SEL	Sound Exposure Level
SEL_{cum}	Cumulative Sound Exposure Level
SEL_{ss}	Sound Exposure Level Single Strike
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOV	Service Operations Vessel
SOWEC	Scottish Offshore Wind Energy Council
SPA	Special Protection Area
SPL	Sound Pressure Level
SPL_{pk}	Peak Sound Pressure Level
SPP	Scottish Planning Policy
SSC	Suspended Sediment Concentrations
SSS	Sidescan Sonar
TTS	Temporary Threshold Shift
UCI	Upper Confidence Interval
UHRS	Ultra High Resolution Seismic
UK	United Kingdom
USBL	Ultra-short Baseline
UXO	Unexploded Ordnance
ZoI	Zone of Influence

UNITS

Unit	Description
%	Percentage
dB	Decibel (sound)
GW	Gigawatt (power)
Hz	Hertz (frequency)
km	Kilometres (distance)
km^2	Square kilometres
m	Metre (distance)
m^2	Square metres
mG	Milligauss
mg/l	Milligrams per litre
m/s	Metre per second
MW	Megawatt
nm	Nautical mile (distance)
s	second
µPa	Micropascal
µT	Microtesla

SPECIES GLOSSARY

Unit	Description
Bottlenose dolphin	*Tursiops truncatus*
Harbour porpoise	*Phocoena phocoena*
Grey seal	*Halichoerus grypus*
Harbour seal	*Phoca vitulina*
Atlantic salmon	*Salmo salar*
Sea lamprey	*Petromyzon marinus*
River lamprey	*Lampetra fluviatilis*
Freshwater pearl mussel	*Margaritifera margaritifera*

1 INTRODUCTION

1.1 THE PURPOSE OF THIS REPORT TO INFORM APPORPRIATE ASSESSMENT (RIAA)

1 The Report to Inform Appropriate Assessment (RIAA) has been prepared by RPS and Royal HaskoningDHV, on behalf of the Applicant, to support the Habitats Regulations Appraisal (HRA) of the Proposed Development in the determination of the implications for European sites. The RIAA builds upon the Offshore HRA Stage One LSE Screening Report (SSE Renewables, 2021b) completed in October 2021 and subsequent joint Environmental Impact Assessment (EIA) Scoping and Likely Significant Effect (LSE) screening advice received in the Berwick Bank Wind Farm Scoping Opinion (MS-LOT, 2022) in February 2022 and considers the environmental effects of the Proposed Development as they relate to relevant European site integrity at Stage Two of the HRA process.

1.2 STRUCTURE OF THE RIAA

2 As detailed in section 1.5 of Part One of this RIAA for the Proposed Development, for clarity and ease of navigation, this RIAA is structured and reported in several 'Parts', as follows:

- Executive Summary and Conclusions;
- Part One – Introduction and Background;
- Part Two (this document) – Consideration of Special Areas of Conservation (SACs); and
- Part Three – Consideration of Special Protection Areas (SPAs).

3 Each 'Part' of the RIAA is supported by a series of topic specific appendices and relevant documentation including European Site Summaries.

1.3 STRUCTURE OF THIS DOCUMENT

4 This document constitutes Part Two of the RIAA and provides consideration of the implications of the Proposed Development on SACs.

5 This document is structured as follows:

- Chapter 1: Introduction – this section detailed the purpose and structure of the RIAA.
- Chapter 7: Consultation – this section provides a summary of the consultation undertaken with regards to Annex I habitat, Annex II diadromous fish and Annex II marine mammal features of SACs, the responses provided, and how these have been addressed within this Part of the RIAA.
- Chapter 3: Summary of HRA Screening – this section presents the SACs potentially at risk of LSE and the features and pathways for which HRA Stage Two Appropriate Assessment is required, both alone and in-combination.

6 Information for the HRA Stage Two Appropriate Assessment is then provided in:

- Chapter 4: Information to inform the Appropriate Assessments, including maximum design scenarios, designed in measures, an outline of the approach taken to baseline data, conservation objectives, and the in-combination assessment.
- Chapter 5: Appraisal of Adverse Effects on Integrity on European sites designated for Annex I habitats, alone and in-combination.
- Chapter 6: Appraisal of Adverse Effects on Integrity on European sites designated for Annex II diadromous fish species, alone and in-combination.
- Chapter 7: Appraisal of Adverse Effects on Integrity on European sites designated for Annex II marine mammals, alone and in-combination.
- Chapter 8: Site conclusions – the conclusions of chapters 5 to 7 are summarised for clarity and the overall finding of this Part of the RIAA is provided.
- Chapter 9: Integrity matrices – summary tables showing how under each separate designation, all features of each designation, for which likely significant effects could not be excluded at HRA Stage One Screening, have been fully considered in the assessment of adverse effects on integrity.

7 The scope of this Part of the RIAA covers all relevant SACs and relevant qualifying interest features where LSEs have been identified due to impacts arising from the Proposed Development. This report will provide the competent authority with the information required to undertake an HRA Stage Two Appropriate Assessment (see Part One of the RIAA for more detail on the HRA process).

2 CONSULTATION

8 Consultation has been undertaken with statutory stakeholders during key stages of the Proposed Development with regards to Annex I habitat (coastal and subtidal), Annex II diadromous fish and Annex II marine mammal features of SACs.

9 A summary of the details of all consultation undertaken to date which is relevant to this Part of the RIAA on SACs, and the HRA process in general, is presented in Table 2.1. Where consultees raised similar points, these have been grouped.

Table 2.1: Consultation Summary

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
Relevant Consultation to Date (Relevant Advice Received for 2020 Berwick Bank Proposal)					
30 June 2020	General	Marine Scotland Licensing Operations Team (MS-LOT), Marine Scotland Science (MSS), Scottish Natural Heritage (SNH) Teleconference	Pre-scoping meeting which included presentation of the approach to the LSE screening and confirmation that it will be a single report including consideration of designated sites for ornithology, marine mammals, fish and shellfish and benthic ecology. Nationally/locally designated sites and the relevant qualifying features screened will be fully considered and assessed in the relevant Offshore EIA Report chapter. Programme for submission of Berwick Bank LSE Screening for stakeholder review is September 2020.	No	Both the HRA Stage One LSE Screening Report and the Stage Two RIAA follow the same approach and include designated sites for ornithology, marine mammals, fish and shellfish and benthic ecology.
11 May 2020	General	MS-LOT Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	The HRA must fully align with the impact pathways identified for assessment in the scoping opinion adopted by the Scottish Ministers in relation to the Proposed Development, dated 9th March 2021.	No	Updated throughout section 5 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
	General	NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Issues with report formatting and viewing embedded hyperlinks.	No	The HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) was reformatted to A3 and all hyper-links were checked and updated.
	Annex I habitats (benthic ecology)	MS-LOT/MSS Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	In agreement with the conclusions regarding impact pathways and LSE on Annex I habitat features at the Berwickshire and Northumberland Coast SAC.	No	Noted.
	Annex I habitats (benthic ecology)	MSS Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Agree that the impacts that should be screened in are: changes in physical processes; increases in Suspended Sediment Concentrations (SSC) and sediment deposition but only for the Proposed Development export cable corridor during all phases; risk of accidental pollution during construction; and in-combination effects during all phases.	No	Noted.
			Changes in prey availability that may arise during all phases of development, as a result of colonisation of hard structures and the aggregation of fish and shellfish, should be considered for the potential to impact features of some SACs (marine mammals) and SPAs (seabirds).	No	Noted and impacts to prey species of marine mammals were considered in the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) in paragraph 5.4.3.278 *et seq*., and prey species of seabirds in paragraph 5.5.2.312.
			EMF effects should be considered. MSS acknowledge that it may not be possible to carry out a full quantitative assessment of EMF emitted from export and inter-array cables on behaviour of prey species.	No	This impact was considered in section 5.2.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b), however, given the localised nature of EMF effects and that there is no spatial overlap between the Proposed Development and the Berwickshire and North Northumberland Coast SAC, there is considered to be no Source-Pathway-Receptor link and no LSE on Annex I habitats. EMF effects on fish, as prey species of marine mammals and seabirds, is considered in paragraphs 278 *et seq*. and paragraph 312, of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) respectively.
	Diadromous fish	MS-LOT/MSS/NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	An arbitrary cut off (100 km) should not be used to screen out SACs for diadromous fish distant from the development site. All SACs should be screened in where there is a potential impact mechanism, regardless of the distance. Agree with the six sites screened in but advise that there may be others which should be screened in.	No	Noted and the justification for sites included in the initial screening of sites for Annex II diadromous fish has been revised; see paragraph 4.2.2.108 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).

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		MS-LOT Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	The SACs identified and selected in the HRA Screening Report as being screened in are agreed, with the exception of the Tweed Estuary SAC, which can be screened out.	No	Noted, sites screened-in are aligned with this response as they relate to the current proposals as set out in section 4.2 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
		MS-LOT/NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Atlantic salmon must be assessed within the HRA process and not just within the EIA.	No	Assessments of diadromous fish, including Atlantic salmon are provided in section 6 of this Part of the RIAA.
		MS-LOT/MSS Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Impacts on other qualifying diadromous species such as river and sea lamprey, can be screened out of the HRA and should instead be considered through the EIA Report. In this regard, Atlantic salmon is not a qualifying interest of the Tweed Estuary SAC.	No	These comments are noted, however a lack of evidence relating to the possible connectivity of the Proposed Development with lamprey means the Applicant has considered lamprey species in both the HRA and EIA.
		MSS Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Lack of overlap between development site and SACs is insufficient justification to exclude impact pathways associated with temporary habitat loss/disturbance and long-term habitat loss.	No	Noted and additional justifications were included in section 5.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
			Further justification is required to exclude increased SSC as a potential impact mechanism.		Noted and additional justifications were included in section 5.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
		NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Key impacts to be considered for diadromous fish (Atlantic salmon): • Underwater noise (sound pressure) – during the pre-construction phase particularly in relation to any UXO clearance. Construction phase (e.g. vessel movement, foundation installation especially piling, drilling etc.) Operation and maintenance phases where there is any noisy maintenance works and potentially operational noise depending on wind farm type (fixed or floating) and decommissioning activities. • Underwater noise (particle motion) - as above. • EMF – consideration is required of both the offshore export cable and cables within the wind farm site. This should also consider any differences of inter-array cables between fixed and floating wind turbine generators.	No	Noted and these impacts have been screened in for diadromous fish (see section 3.2.2). It should be noted that floating foundations do not form part of the design envelope for the Proposed Development (see section 4 in Part One of this RIAA).
	Diadromous fish	MSS/NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Consideration required of whether the physical presence of the structures may affect predator-prey relationships and result in potential impacts to diadromous fish during construction and operation.	No	Noted and effects of the presence of physical structures is considered in section 5.3.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
	Diadromous fish	Dee District Salmon Fishery Board (DDSFB) Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Updates provided on the recent assessments of salmon stocks in the Dee.	No	Noted and information is considered in the baseline description in paragraph 195 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) and in full in section 6.2.5 of this Part of the RIAA.
			Concern regarding cumulative impacts with other offshore wind farms on the east coast.	No	In-combination effects have been screened in for diadromous fish species (see section 5.3.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) and section 3.2.2 of this Part of the RIAA).
			The risk of increased predation, if the fish aggregate around the wind turbines, should be considered.	No	Noted and effects of the presence of physical structures is considered in section 5.3.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
	Diadromous fish	DDSFB and Fisheries Management Scotland	Broadly agree with the assessments made in section 5.3, and support the assessment that underwater noise, EMFs, accidental pollution and in-combination effects cannot be discounted as likely significant effects for the Dee SAC.	No	Potential LSEs have been identified for diadromous fish features with connectivity to the Proposed Development with respect to underwater noise, EMFs, and in-combination effects (see section 3.2.2 of this Part of the RIAA). Potential LSE with respect to accidental pollution has been

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					discounted on the basis that accidental pollution will be subject to other regulatory control through both legislation and the requirements for contingency plans. This approach to accidental pollution is consistent with advice from NatureScot (2021) and MSS (2021).
		Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Do not consider that temporary, habitat loss or disturbance can be screened out at this stage for Dee SAC.	No	Further justification to support screening this impact out was presented in section 5.3.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
			Concern that the wind farm may act as 'artificial island' that migratory fish chose to avoid due to visual disturbance. This visual disturbance relates to highly dynamic image of wind turbine blades (known as 'shadow flicker'), as represented in the surface window.	No	MSS advised MS-LOT, in the EIA Scoping Opinion for the Initial Berwick Bank Wind Farm Proposal, that there is insufficient information for visual impacts of wind turbine blades to be scoped in as a separate topic, and the mechanisms and implications of impact are speculative and unclear. On this basis, this impact was not screened in for consideration within this Part of the RIAA.
	Diadromous fish	Forth District Salmon Fisheries Board (FDSFB) Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	The risk of increased predation, if the fish aggregate around the wind turbines, should be considered.	No	Noted and effects of the presence of physical structures is considered, and screened out, in section 5.3.3 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
	Diadromous fish	River Tweed Commission (RTC) Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Reference to changes to the run-timing of adult salmon returning to the Tweed SAC.	No	Noted and information considered in the baseline description in paragraph 190 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) and is detailed in full in section 6.2.5 of this Part of the RIAA.
	Marine mammals	MSLOT Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Agree that direct effects from EMF, and operational noise can be screened out.	No	Noted and these impact pathways were screened out in section 5.4 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
			Advise that vessel collision risk and accidental pollution can be screened out.	No	Noted and these impact pathways were screened out in section of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
			The in combination effects identified in the HRA Screening Report are agreed and screened in.	No	Noted.
			Underwater noise from vessels and changes to prey availability should be screened in for all three marine mammal species associated with the four European Sites located in Scottish waters for all phases.	No	Noted and these impact pathways were screened in, in section 5.4 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
			Consideration of the impacts from pre-construction activities including unexploded ordnance clearance, some geophysical activities and the in combination effects of these must be considered in the HRA.	No	Noted and these impact pathways were screened in, in section 5.4 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
	Marine mammals	MSS, NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Agree with the four SACs in Scottish waters that have been screened in.	No	Noted. The full list of sites screened in, is presented in section 3.2.3 of this Part of the RIAA.
			Agree that underwater noise from pile driving and in-combination effects should be screened in. Agree that changes in water clarity, operational noise and EMF can be screened out.	No	Noted and a summary of the screening conclusions is presented in section 3.2.3 of this Part of the RIAA.
			Highlight inconsistencies in the site numbering for transboundary sites.	No	Noted and the numbering of the transboundary sites was updated in the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b).
			Updates to the bottlenose dolphin abundance estimates and latest seal usage maps.	No	As per the response to HRA Stage One LSE Screening (Received as Part of Scoping Opinion for the 2020 Berwick Bank proposal (SSE Renewables, 2020), the population of bottlenose dolphins for Moray Firth SAC taken forward to the assessment in this Part of the RIAA is 224 individuals (paragraph 806). In line with stakeholder advice, the seal density values are based on Carter *et al.* (2020) and abundance estimates for the breeding populations were informed using Joint Nature Conservation

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
					Committee (JNCC) maximum population estimates (JNCC Standard Data Forms; see section7.6).
	Marine mammals	NatureScot Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	Clarifications over seal haul-out sites. Confirmation that, given the distance between the Fast Castle haul-out site and the landfall locations, it is unlikely that construction works at landfall or activities associated with cable installation are likely to affect any individual hauled out using this site.	No	Text in paragraph 249 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) relating to haul-out sites was updated.
	Marine mammals	Natural England Screening response on the 2020 Berwick Bank proposal LSE Screening Report.	The appropriate SACs and potential impacts on them have been taken forward for consideration of LSE.	No	Noted.
30 June 2020	Diadromous fish	MS-LOT, MSS, SNH Teleconference (Pre-scoping meeting)	MSS raised queries regarding which SACs will be included for Atlantic salmon and highlighted that consideration also needs to be given to rivers across the Proposed Development boundary, including the River Tweed SAC. SNH stated that it is unclear which salmon are going back to which natal rivers, so whilst it is possible to state which SACs are closest geographically, evidence cannot be provided as to whether salmon are going to particular protected sites. Therefore, SNH expect the assessment at LSE and EIA stages to be qualitative rather than quantitative.	No	Further clarity (and supporting evidence) is provided in section 4.2 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b) regarding European site identification for migratory fish features for inclusion in the HRA. Ultimately in this screening, LSE could not be discounted for a number of sites, including the River Tweed SAC (Table 5.5). As discussed in section 4.2 of the HRA Stage One LSE Screening Report for the revised Proposed Development (SSE Renewables, 2021b), European SACs are not selected on the basis of being closest geographically, rather, the selection was informed by the best available evidence on migratory behaviour.
15 July 2020	Diadromous fish	MS-LOT, MSS, SNH Letter response to proposed benthic survey specification	Several rivers which discharge in the vicinity, including the South Esk, Tay, Teith and Tweed, support major populations of diadromous fish, such as salmon, sea trout, eel and sea lamprey, which may migrate through or otherwise use the Proposed Development area. It is probable that aspects of construction and operation will have the potential to impact on diadromous fish.	No	Noted and diadromous fish are considered in section 6 of this Part of the RIAA.
Formal Response to HRA Stage One LSE Screening (Received as Part of Scoping Opinion) (MS-LOT, 2022))					
04 February 2022	General	NatureScot	Limited narrative has been provided to adequately justify some of the decisions made within the LSE matrix tables.	No	Further detail on specific concerns is covered in the comments below.
			The HRA screening report concludes no LSE for some potential impacts on the basis of a fairly limited consideration.	No	Noted. Further detail on specific concerns is covered in the comments below.
	Annex I habitats	NatureScot	Content with the single site screened in for consideration of LSE – Berwickshire and North Northumberland Coast SAC and habitat features identified.	No	Noted and a summary of the screening conclusions for Annex I habitats is presented in section 3.2.1 of this Part of the RIAA.
			Content with the impacts outlined and agree with the justification and conclusions provided to include Berwickshire and North Northumberland Coast SAC.	No	Noted and a summary of the screening conclusions for Annex I habitats is presented in section 3.2.1 of this Part of the RIAA.
	Diadromous fish	NatureScot	Agree that SACs screened in for Atlantic salmon are likely to be “suitably precautionary” for two lamprey species.	No	Noted and a summary of the screening conclusions for Annex II diadromous fish is presented in section 3.2.2 of this Part of the RIAA.
			Content with list of European sites taken forward for determination of LSE for Atlantic salmon, river and sea lamprey and the impact pathways and LSE conclusions made (other than for increases in SSC and sediment deposition which should also be screened-in).	Yes	SSC and sediment deposition is now considered as an impact pathway in the RIAA for Annex II fish during construction and decommissioning (see section 3.2.2 and section6.3 of this Part of the RIAA).
			Despite knowledge gaps in relation to the movement of Atlantic salmon, it might be reasonable to expect that Atlantic salmon smolts originating from the Moray Firth would be unlikely to travel extensively in a southerly direction and are content therefore with the list of European sites to be taken forward for determination of LSE for Atlantic salmon, river and sea lamprey.	No	Noted and full species accounts are presented in section 6.2.5 of this Part of the RIAA.

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
			NatureScot support inclusion in the HRA of freshwater pearl mussel, for which Atlantic salmon are a host species.	No	Noted and a summary of the screening conclusions for Annex II diadromous fish, and supporting species, is presented in section 3.2.2 of this Part of the RIAA.
			As there are likely to be high numbers of young Atlantic salmon migrating through the area each year and on the basis of the limited information provided concerning expected concentrations of sediment, behavioural responses to increases in suspended sediment and sediment deposition should be screened in during the construction and decommissioning phase.	Yes	SSC and sediment deposition is now considered as an impact pathway in the RIAA for Annex II fish during construction and decommissioning (see section 3.2.2 and section6.3 of this Part of the RIAA).
			Recent research on EMF effects from underwater cables concluded that we are still not that knowledgeable on the effects of EMF on fish and benthic species. This is likely to be addressed further through a strategic project via ScotMER in the longer term.	No	Noted and EMF is considered in section 6.4.1 of this Part of the RIAA.
			Underwater noise impacts should consider both sound pressure and particle motion. NatureScot content with approach to assessment outlined.	No	Noted and underwater noise impacts are considered in section 6.3.1 of this Part of the RIAA.
			Research by Harding *et al.* (2016) should be considered which found that soft-start and ramp-up procedures associated with piling activity may be ineffective as mitigation to protect Atlantic salmon from noisy activities.	No	Soft start is used to minimise risk of injury. The levels of noise in this study were very low, below the level at which behavioural effects are expected. Although there are uncertainties about the acoustics in this paper. In close proximity to the pile driving (i.e. tens to hundreds of metres) noise levels (both sound pressure and particle motion) will be much higher than those referred to in this paper, such that it would be expected that avoidance reactions would be observed in these very close ranges. The paper provided does not support an assumption that soft starts will not be effective.
			Research on Atlantic salmon behaviour at sea (provided in appendix E) indicates that ceasing relevant noisy activities (such as piling) during the hours of darkness could help to mitigate potential impacts from noise.	No	Noted and designed in measures relevant to underwater noise are outlined in Table 6.3 of this Part of the RIAA. No additional mitigation is considered necessary.
			Depending on the findings of the assessment, consideration should be given to limiting or ceasing relevant noisy activities during daylight hours including during periods when high numbers of young Atlantic salmon could be migrating through these waters.	No	Noted and designed in measures relevant to underwater noise are outlined in Table 6.3 of this Part of the RIAA. No additional mitigation is considered necessary.
			The Applicant should regard the advice on the timing of fish migration provided in appendix E of the Scoping Opinion.	No	Noted and timing of migration is discussed in section 6.2.5 of this Part of the RIAA.
			The narrative on the rationale for likely significant effects in combination with other plans or projects as provided in paragraphs 211 – 213 in section 5.3.4 is unclear.	No	Noted, this is revisited in this Part of the RIAA (see section3.3).
	Marine mammals	NatureScot	NatureScot support the use of telemetry data to inform potential connectivity with Firth of Tay and Eden Estuary SAC for harbour seal and agree that the site should be Screened-in.	No	Noted and a summary of the screening conclusions for Annex II diadromous fish is presented in section 3.2.2 of this Part of the RIAA.
			As grey seals in Scotland tend to stay within 20 km of the breeding colony during the breeding season, NatureScot don't consider it necessary to use a 100 km screening buffer for this species.	No	Noted. Although also note that reducing the size of the screening buffer does not change the list of sites included for grey seal.
			NatureScot agree with the list of SACs and their qualifying features screened in.	No	Noted and a summary of the screening conclusions for Annex II marine mammals is presented in section 3.2.3 of this Part of the RIAA.
			Advice from Natural England should be sought with respect to the Southern North Sea SAC.	No	Natural England were consulted on the HRA Stage One LSE Screening for the Proposed Development but returned no comments relating to marine mammals, beyond what was previously stated in the Screening Response

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
					on the 2020 Berwick Bank proposal LSE Screening Report (SSE Renewables, 2020) as outlined above in this table.
			Conservation objectives for the seal SACs are currently being revised in line with a programme for all European sites to have their conservation objectives updated.	No	Noted and latest conservation objectives are detailed in section 7.6 of this Part of the RIAA.
			The site overview for the Firth of Tay and Eden Estuary SAC for harbour seal is out of date. The latest estimate is 41 individuals (SCOS, 2020) indicating a more than 90% decline in the population.	No	Noted, this has been updated in this Part of the RIAA (see section 7.6.3).
			NatureScot highlight that the Firth of Tay and Eden Estuary SAC for harbour seal site is currently 'unfavourable, declining'.	No	Noted, this has been updated in this Part of the RIAA (see section 7.6.3).
			The bottlenose dolphin population figure in the site overview for the Moray Firth SAC is outdated. The population size for bottlenose dolphin of 224 (95% CI = 214 – 234), using data from 2015-2019 based on the population estimates presented in Arso Civil *et al*. (2021) should be referenced.	No	Noted, this has been updated in this Part of the RIAA (see section 7.6.5).
			With respect to underwater noise from unexploded ordnance (UXO), without robust supporting evidence to show the consistent performance of the preferred low order/deflagration method, NatureScot advise, as per the recent joint SNCB/DEFRA position statement, that the risk assessment considers a worse case of high order detonation in terms of impact and mitigation.	No	This Part of the RIAA considers the maximum design scenario and impacts as assessed in the marine mammal chapter in the Offshore EIA Report, (i.e. although application of low order techniques is the preferred option for UXO clearance, there is a small risk of unintended consequences should low order clearance accidentally result in high order detonation of UXO and therefore the assessment of potential impacts due to the underwater noise during UXO clearance and subsequent mitigation is based on the maximum design scenario of high order detonation and is presented in Table 7.10).
			Underwater noise from vessels should be screened in for grey seal, harbour seal and bottlenose dolphin for all activities across the lifespan of the Project.	Yes	Underwater noise from vessels is screened in for grey seal, harbour seal and bottlenose dolphin as requested (see section 3.2.3 of this Part of the RIAA).
			Changes in prey availability should be considered. However, impacts should not focus underwater noise, rather than also including the direct impact of habitat loss/prey disturbance from the installation of foundations, cables, scour protection and the colonisation of hard structures.	No	Noted and all potential impact pathways with the potential to affect prey have been considered (see section 7.3.2 of this Part of the RIAA).
			NatureScot disagree that - 'effects on fish populations from…habitat disturbance are likely to be temporary, localised, short-term and therefore not significant', given the current uncertainties and potentially significant effects on spawning.	No	Effects on diadromous fish are considered fully in section 6 of this Part of the RIAA.
			NatureScot recommend consideration is given to the effects of EMF on changes in prey availability.	No	Noted and all potential impact pathways with the potential to affect prey have been considered (see section 7.3.2 of this Part of the RIAA).
			NatureScot agree with the decision to screen out direct effects of EMF on marine mammals.	No	Noted. EMF is screened out for marine mammals (see section 3.2.3 of this Part of the RIAA).
			NatureScot advise that EMF and colonisation of hard structures within soft sediment habitats are likely to have a greater effect on changes in prey availability than underwater noise during operation and maintenance.	No	Noted and all potential impact pathways with the potential to affect prey have been considered (see section 7.3.2 of this Part of the RIAA**)**.
	Marine mammals	NatureScot	Underwater noise impacts for bottlenose dolphin from vessel activity need to be assessed across all phases, particularly with respect to the export cable route and landfall.	Yes	Noted and this Part of the RIAA considers the impact of underwater noise from vessels on bottlenose dolphin across all phases of the project (see section 7.3.1).
			NatureScot will need to agree the approach to cumulative effect assessment for marine mammal interests for HRA, EIA and EPS licensing requirements.	No	The approach to the cumulative/in-combination assessment for marine mammal interests for HRA, EIA and EPS licencing requirements has been presented and agreed with stakeholders during the Road Map Meeting 3
			For grey seal, we advise that there is potential connectivity with the cable route and both the Isle of May SAC as well as Berwickshire and North Northumberland Coast SAC.		Noted. Both SACs have considered in this Part of the RIAA.

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
	General (coastal processes)	Natural England	NE assume that impacts to coastal processes on English SPAs and SACs have been screened out due to the distance of the development from those sites. Natural England advises that the Coastal Processes chapter of the relevant document will need to demonstrate that the development will not have indirect effects that could extend as far as English SPAs and SACs.	No	Noted and the Coastal Processes chapter in the Offshore EIA Report has been used to determine and document the extent of plumes and deposition arising from the disturbance of sediments. This has been checked against the screening buffers used for the identification to European sites and features to be considered in this Part of the RIAA.
	General	Natural England	NE note a general paucity of justification for instances where it is considered there is no LSE and suggest there may be merit in providing greater evidence to support no LSE in any future iterations of the report.	No	Noted. Assessments of LSE have been revisited in the drafting of the RIAA and reviewed in light of the assessments made in the Offshore EIA Report.
	In-combination effects	Natural England	NE note that in-combination effects are often excluded on the basis that the contribution of the Berwick Bank OWF project will be minimal, or will only result in a minimal increase in baseline levels. We consider that this approach will require the Environmental Statement to clearly quantify the baseline and the predicted increase in pressures (spatially as well as temporally) where relevant, (e.g. with respect to vessel movements and disturbance to birds and marine mammals).	No	Noted.
	Introduction/Background	MS-LOT	MS-LOT notes that the Developer submitted a Habitats Regulations Appraisal ("HRA") screening report ("HRA Screening Report") separate from the Scoping Report on 28 October 2021 in relation to the Proposed Development. The Scottish Ministers' response to the HRA Screening Report is however contained within the relevant receptor chapters of this Scoping Opinion.	No	Noted and specific responses are detailed below.
			MS-LOT advise that the representations from Natural England ("NE"), RSPB Scotland and NatureScot, together with the advice from MSS on the HRA Screening Report must be fully reviewed and addressed by the Developer.	No	Noted and specific responses are detailed below.
			MS-LOT highlight the representation from Natural England with regard to the need for greater evidence to support the conclusion of no likely significant effect ("LSE") on English Special Protection Areas ("SPA") and Special Areas of Conservation ("SAC") and also consider any indirect effects to coastal processes on English SPA and SACs. The Scottish Ministers advise the Developer to engage with Natural England on these points.	No	Noted. As confirmed in the Applicant's letter to Natural England dated 1st June 2022, the assumptions applied at Screening have been revisited in view of the outputs of the physical processes modelling undertaken for the Proposed Development. This modelling finds that there would be no changes in tidal currents or sediment transport that extend to the Anglo-Scots border of the 20 km study area. It is therefore concluded that the Proposed Development would not disrupt beach and offshore bank morphological processes or destabilise coastal features (or result in likely significant effects) with English SPA and SACs. These findings are reported and evidenced in section 1.37.
	General	MS-LOT	The Scottish Ministers note the need to carry out an assessment under the 1994 Habitats Regulations and the 2017 Offshore Habitats Regulations. This assessment must be coordinated with the EIA in accordance with EIA Regulations. In addition, the Scottish Ministers reiterate the advice regarding consideration of the derogation process under regulation 49 of the 1994 Habitats Regulations and regulation 29 of the 2017 Offshore Habitats Regulations.	No	Noted and agreed.
	Benthic	MS-LOT	MS-LOT agree that that the Berwickshire and Northumberland Coast SAC is screened in for the impacts identified. This is a view supported by the NatureScot December representation and the MSS December advice.	No	Agreement from MS-LOT noted.
	Fish and Shellfish Ecology	MS-LOT	MS-LOT advises that the reference to the River Teith SAC should be amended to include Atlantic salmon as a feature.	Yes	The Atlantic salmon feature of the River Teith SAC has been considered in this Part of the RIAA (see Table 3.1). Impacts to diadromous species is assessed in section 6.

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
			Additionally, MS-LOT advise that suspended sediment concentrations and sediment deposition must also be screened in during the construction and decommissioning phases for each of the sites and qualifying features identified in Tables 5.4 to 5.9. Lastly, MS-LOT advise that all the points raised in respect of indirect impacts upon freshwater pearl mussels and underwater noise impacts must be fully addressed from the NatureScot December representation.		
	Marine Mammals	MS-LOT	Seals: MS-LOT advise the potential connectivity with the export cable corridor route and both the Isle of May SAC and Berwickshire and North Northumberland Coast SAC. In addition, the Scottish Ministers highlight NatureScot's December representation recommending to use of the Firth of Forth area for the Isle of May SAC and the Firth of Forth plus the Farne Islands for Berwickshire and North Northumberland Coast SAC.	No	Potential connectivity with Proposed Development export cable corridor and Isle of May SAC as well as Berwickshire and North Northumberland Coast SAC is considered in section 7.6. An email received from NatureScot on 17 March 2022 provided clarification on their scoping representation of December 2021 and confirmed that the assessment of impacts for grey seal should be based on a maximum population estimates from JNCC standard data forms for breeding populations and this has been incorporated into the assessment.
			Cumulative effects: MS-LOT agree with the cumulative effects identified in the Scoping Report but advise that further discussion and agreement as part of the Developer's Road Map process is required. Noting that an agreed approach to cumulative effect assessment for marine mammals for HRA, EIA and European Protected Species licensing is also still required. MS-LOT refer to NatureScot's December representation and MSS December advice in this regard and advise that they must be fully considered.	No	The approach to the cumulative/in-combination assessment for marine mammal interests for HRA, EIA and EPS licencing requirements has been presented and agreed with stakeholders during the Road Map Meeting 3.
			MS-LOT refer to the NatureScot December representation and Natural England representation together with the MSS December advice and advise that the Developer must fully review and address these. MS-LOT agree that all of the SACs and their qualifying features as detailed in Table 4.3 of the HRA Screening Report, which are located in Scottish waters, should be screened in.	No	Noted and a summary of the screening conclusions for Annex II marine mammals is presented in section 3.2.3 of this Part of the RIAA.
			MS-LOT highlight NatureScot's December representation with regard to the revision of the conservation objectives for the seal SACs. In addition, the Scottish Ministers highlight NatureScot's December representation and the MSS December advice with regard to updating the baseline information provided in the HRA Screening Report. MS-LOT advise that this must include consideration of the discussions as part of the Developer's Road Map process and the extended correspondence amongst the Developer, NatureScot and MSS on bottlenose dolphins. The Scottish Ministers advise that the Southern North Sea SAC is Screened-in but advise the Developer to engage with Natural England on this point.		Noted. The latest conservation objectives have been considered within this RIAA in section 7. In line with recommendation, the population of bottlenose dolphins for Moray Firth SAC taken forward to the assessment in RIAA is 224 individuals (see section 7.6.5). Natural England were consulted on the HRA Stage One LSE Screening for the Proposed Development but returned no comments relating to marine mammals, beyond what was previously stated in the Screening Response on the 2020 Berwick Bank proposal LSE Screening Report (SSE Renewables, 2020) as outlined above in this table.

Date	Receptor Group/Topic	Consultee and Type of Consultation	Issue(s) Raised	Change Required to Screening Outcomes Y/N?	Response to Issue Raised and/or Where Addressed
			MS-LOT advise that the risk assessment for underwater noise from UXO clearance, must consider the worst case scenario as detailed previously. In addition, the Scottish Ministers agree with NatureScot's December representation regarding underwater noise from vessels and the requirement for further consideration of changes in prey availability including direct impact of habitat loss or prey disturbance, impact of the colonisation of hard structures, effects on fish populations from habitat disturbance and EMF effects on changes in prey availability. The Scottish Ministers advise that the points raised by NatureScot must be fully addressed.	Yes	This RIAA considers the maximum design scenario and impacts as assessed in volume 2, chapter 10 of the Offshore EIA report (i.e. although application of low order techniques is the preferred option for UXO clearance, there is a small risk of unintended consequences should low order clearance accidentally result in high order detonation of UXO and therefore the assessment of potential impacts due to the underwater noise during UXO clearance and subsequent mitigation is based on the maximum design scenario of high order detonation and is presented Table 7.10.) Disturbance to marine mammals from elevated underwater noise due to vessel use, changes in fish and shellfish communities affecting prey availability (direct impact of habitat loss or prey disturbance, impact of the colonisation of hard structures, effects on fish populations from habitat disturbance and EMF effects on changes in prey availability) have been all considered for all phases of the development in line with NatureScot advice.
			MS-LOT agree with the approach that has been outlined in Tables 5.10 to 5.15 of the HRA Screening Report, however, they advise that Table 5.14 needs to include underwater noise impacts for bottlenose dolphin from vessel activity. Additionally, this must be assessed across all phases of the Proposed Development and in particular, with respect to the export cable route and landfall location. In addition, the Scottish Ministers advise that further discussion is required on the methods to be used to undertake quantitative assessments of impacts to the SAC populations that are to be included in the HRA.	Yes	Noted. Injury and disturbance to bottlenose dolphin from elevated underwater noise due to vessel use in relation to the Proposed Development export cable corridor and landfall has been considered in section 7.
Benthic Ecology	MSS		MSS agree that likely significant effects on the Berwickshire and North Northumberland Coast SAC from increases in suspended sediment and sediment deposition should be screened in for all phases. The likely significant effect could be determined by modelling of sediment plumes when the precise location of the export cable is determined. MSS agree with those impacts scoped out of the HRA.	No	Noted and a summary of the screening conclusions for Annex II marine mammals is presented in section 3.2.3 of this Part of the RIAA.
Marine Mammals	MSS		MSS support the decision to include the Firth of Tay and Eden Estuary SAC, with its declining population of harbour seals, in the assessment.	No	Noted. Firth of Tay and Eden Estuary SAC and harbour seal as a designated feature has been included in the assessment (see section 7.6.3).
			MSS note that some of the baseline information in section 5.4.2 and 5.4.3 is outdated and has been superseded by advice given to the applicant in the Road Map process for the EIA Scoping, particularly regarding bottlenose dolphins: • The appropriate population size to use for bottlenose dolphins on the east coast of Scotland, using a weighted 5-year mean based on estimates in Arso Civil *et al*. 2021, has been described in the EIA Scoping advice above. • The most appropriate approaches to estimating density for bottlenose dolphins have also been described in more detail above.		Noted. Coastal East Scotland bottlenose dolphin population is based on advice received from MSS with 224 individuals and densities of 0.197 and 0.294 animals/km^2 are used in the assessment (see paragraph 806).
			MSS states that further discussion will be required on the methods to be used to undertake quantitative assessments of impacts to the SAC populations that are to be included in the HRA.		The HRA has been informed by the quantitative assessment of effects and population modelling (iPCoD) done as part of the Offshore EIA Report. The HRA has considered the effects on species as features of SACs against the relevant conservation objectives of these SACs.

3 SUMMARY OF HRA SCREENING CONCLUSIONS FOR SPECIAL AREAS OF CONSERVATION

10 This section summarises all LSEs identified from the HRA Stage One Screening (arising alone and/or in-combination) for SACs and defines the scope of the Stage Two assessments within this Part of the RIAA. An account is provided of any updates made to the screening outcomes as reported in the HRA Stage One Screening Report, which was shared with consultees in October 2021 (SSE Renewables, 2021b).

3.2 SCREENING OUTCOMES FOR THE PROPOSED DEVELOPMENT ALONE

11 The HRA Stage One Screening Report (SSE Renewables, 2021b) identified that 11 SACs are likely to be significantly affected by the Proposed Development alone.

3.2.1 SCREENING OUTCOMES FOR ANNEX I HABITATS

12 One European site designated for Annex I habitats (Berwickshire and North Northumberland Coast SAC) was advanced to HRA Stage Two Appropriate Assessment.

13 In response to the HRA Stage One Screening Report (SSE Renewables, 2021b) NatureScot was content with the single site screened in to the HRA Stage Two HRA Appropriate Assessment – Berwickshire and North Northumberland Coast SAC and with habitat features identified (see Table 3.1 and Figure 3.1). A summary of the site features at risk of potential LSE, along with corresponding impact pathways for each phase of the Project is provided in Table 3.1.

14 The following updates have been made to the screening outcomes reported in October 2021 (SSE Renewables, 2021b):

- A minor error was published in the HRA Stage One Screening Report (SSE Renewables, 2021b). In the summary table 7.1 of that report, accidental pollution was erroneously reported as a potential LSE for the reef feature of this site. Following advice from NatureScot (2021) and MSS (2021), accidental pollution associated with construction and operation and maintenance activities is not considered as an impact pathway and no LSE is anticipated. This is on the basis that accidental pollution will be subject to other regulatory control through both legislation and the requirements for contingency plans. No LSEs are therefore reported for the reef feature of this site (see Table 3.1); and
- Due to the selection of the Skateraw landfall location (and slight modification (reduction) of the Proposed Development export cable corridor), the minimum distance between the Berwickshire and North Northumberland Coast SAC and the Proposed Development export cable corridor is now 4.1 km (previously 3.0 km). As the site is now further away from the Proposed Development export cable corridor the potential for effects, such as those arising from increased SSC and sediment deposition is reduced. This change is, however, considered to have no material bearing on the screening outcomes reported previously.

15 The changes to the design since the HRA Screening exercise (SSE Renewables, 2021b) detailed in section 4.10 of Part One of the RIAA would result in beneficial outcomes for habitat receptors, or this receptor group is otherwise not sensitive to the activities. Therefore, these changes are considered to have no material bearing on the screening outcomes for Annex I habitats reported previously.

3.2.2 SCREENING OUTCOMES FOR ANNEX II DIADROMOUS FISH

16 The following six European sites designated for Annex II diadromous fish were advanced to HRA Stage Two Appropriate Assessment and are shown in Figure 3.2:

- Tweed Estuary SAC;
- River Tweed SAC;
- River South Esk SAC;
- River Tay SAC;
- River Dee SAC; and
- River Teith SAC.

17 A summary of the site features for which LSE was identified, along with corresponding impact pathways for each phase of the Project, is provided in Table 3.1.

18 The following update has been made to the screening outcomes for diadromous fish sites reported in October 2021 (SSE Renewables, 2021b):

- Following advice from Scottish Ministers and NatureScot in their response to HRA Stage One Screening Report (MS-LOT, 2022), the impact pathway 'increase in suspended sediment concentration (SSC) and sediment deposition' has been taken forward to HRA Stage Two Appropriate Assessment during the construction and decommissioning phases for each of the above listed European sites designated for Atlantic salmon NatureScot advised that: "*as there are likely to be high numbers of young Atlantic salmon migrating through the area each year, and on the basis of the limited information provided concerning expected concentrations of sediment, behavioural responses to increases in suspended sediment and sediment deposition should be screened in during the construction and decommissioning phase.*"

19 The changes to the design since the HRA Screening exercise (SSE Renewables, 2021b) detailed in section 4.10 of Part One of the RIAA would result in beneficial outcomes for Annex II diadromous fish, or this receptor group is otherwise not sensitive to the activities. Therefore, these changes are considered to have no material bearing on the screening outcomes for Annex II diadromous fish reported previously.

3.2.3 SCREENING OUTCOMES FOR ANNEX II MARINE MAMMALSG

Pinnipeds

20 Three European sites designated for pinnipeds were advanced to HRA Stage Two Appropriate Assessment and are shown in Figure 3.3:

- Berwickshire and North Northumberland Coast SAC (grey seal);
- Isle of May (grey seal); and
- Firth of Tay and Eden Estuary SAC (harbour seal).

21 A summary of the site features for which LSE was identified, along with corresponding impact pathways for each phase of the Project, is provided in Table 3.1. In response to the HRA Stage One Screening Report (SSE Renewables, 2021b), NatureScot agreed with the list of SACs and their qualifying features screened in (MS-LOT, 2022).

22 Since the HRA Stage One Screening Report outcomes were reported in October 2021 (SSE Renewables, 2021b), routine geophysical surveys during the operation and maintenance phase of the Proposed Development have been added to the project design (see section 4.10 of Part One of the RIAA). As a result, injury and disturbance to pinnipeds from elevated underwater noise during site investigation surveys during the operation and maintenance phase (in addition to consideration of this impact during the construction phase) has been considered as a potential impact during the HRA Stage Two Appropriate

Assessment. No other updates relating to pinnipeds have been made to the HRA Stage One Screening Report outcomes reported in October 2021.

Cetaceans

23 Two European sites designated for cetaceans were advanced to HRA Stage Two Appropriate Assessment and are shown in Figure 3.3:

- Southern North Sea SAC (harbour porpoise); and
- Moray Firth SAC (bottlenose dolphin).

24 A summary of the site features for which LSE was identified, along with corresponding impact pathways for each phase of the Project, is provided in Table 3.1. In response to the HRA Stage One Screening Report (SSE Renewables, 2021b), NatureScot agreed with the list of SACs and their qualifying features screened in (MS-LOT, 2022).

25 The following updates have been made to the screening outcomes reported in October 2021 (SSE Renewables, 2021b):

- The LSE Screening concluded that the impact pathway 'underwater noise from vessels and other vessel activities' during all phases of the Proposed Development could be screened out for harbour porpoise at Southern North Sea SAC and bottlenose dolphin at Moray Firth SAC. NatureScot advised in their response to the screening outcomes (SSE Renewables, 2021b) that: "Underwater noise from vessels should be screened in for grey seal, harbour seal and bottlenose dolphin for all activities across the lifespan of the project." Therefore, this impact pathway has been screened in for bottlenose dolphin, grey seal and harbour seal but, due to the intervening distance between the Proposed Development and the Southern North Sea SAC, this impact pathway has not been screened in for harbour porpoise.
- Since the HRA Stage One Screening Report outcomes were reported in October 2021 (SSE Renewables, 2021b), routine geophysical surveys during the operation and maintenance phase of the Proposed Development have been added to the project design (see section4.10 of Part One of the RIAA). As a result, injury and disturbance to cetaceans from elevated underwater noise during site investigation surveys during the operation and maintenance phase (in addition to consideration of this impact during the construction phase) has been considered as a potential impact during the HRA Stage Two Appropriate Assessment.

26 No other updates relating to cetaceans have been made to the HRA Stage One Screening Report outcomes reported in October 2021 (SSE Renewables, 2021b). The changes to the design since the HRA Screening exercise (SSE Renewables, 2021b) detailed in section 4.10 of Part One of the RIAA would have no material bearing on the screening outcomes for cetaceans reported previously.

3.3 SCREENING OUTCOMES FOR LIKELY SIGNIFICANT EFFECTS IN-COMBINATION

27 It is acknowledged that the potential remains for a trivial effect alone (insufficient to result in a conclusion of LSE) to contribute to a LSE in-combination with other plans and projects. Hereafter, LSE that would only result through effects acting in-combination are referred to as Likely Significant Effects In-Combination (LSEI). This section summarises the outcome for the consideration of LSEI for each receptor group.

28 In the HRA Stage One Screening Report, the LSEI assessment focused on identifying sites/features for which no LSE alone was concluded, but where there is LSE in-combination with other plans and projects (e.g. due to wide foraging ranges resulting in a species interacting with a large number of projects). It is not necessary at the LSE in-combination stage to consider sites/features for which an LSE 'alone' has already been identified, as in-combination effects will be considered at the Stage Two Appropriate Assessment.

3.3.1 LSE IN-COMBINATION FOR ANNEX I HABITATS

29 No European sites designated for Annex I habitats overlap with the Proposed Development; however, a search area of 20 km was applied in order to identify relevant sites designated for Annex I habitats which may be within the zone of influence (ZoI) of effects associated with the Proposed Development. As one mean tidal excursion in the vicinity of the Proposed Development equates to approximately 6.5 km, as derived from the Atlas of UK Marine Renewable Energy Resources (ABPmer, 2008), a search area of 20 km is considered sufficiently precautionary to capture effects arising from increased SSC and sediment deposition.

30 For Annex I habitats, LSE alone was identified for the only site within 20 km, Berwickshire and North Northumberland Coast SAC for increases in SSC and sediment deposition (Proposed Development export cable corridor works only) and changes in physical processes during the operation and maintenance phase (Proposed Development export cable corridor works only), therefore effects in-combination will be considered at HRA Stage Two Appropriate Assessment.

31 No impact pathways were identified between the Proposed Development and any additional sites designated for Annex I habitats, therefore there is no potential for in-combination effects at any sites apart from Berwickshire and Northumberland Coast SAC.

32 For impacts discounted for LSE alone, there is either no pathway to effect, or the Proposed Development would result in only negligible or inconsequential effects that would not contribute (even collectively with other projects or plans) in a material way to in-combination effects.

3.3.2 LSE IN-COMBINATION FOR ANNEX II DIADROMOUS FISH

33 A precautionary approach to the selection of relevant sites for Annex II diadromous fish was adopted in the HRA Stage One LSE Screening Report (SSE Renewables, 2021b). With respect to Atlantic salmon, all SACs located south of Fraserburgh and the Moray Firth were identified as relevant in particular due to the potential for disruption to migration (i.e. barriers to migration) to/from natal rivers. Recent evidence suggests that smolts migrating from rivers in the Moray Firth head north and directly across the North Sea rapidly, rather than moving in a coastal direction upon leaving their natal rivers (Newton *et al.*, 2017; Gardiner *et al.*, 2018a). The latest evidence indicates that adult salmon migration to natal rial rivers in the Moray Firth is most likely from the north (TCE, 2019). Therefore, on this basis, there is no potential for connectivity between the Proposed Development and Atlantic salmon from any additional SACs beyond those identified as relevant in the HRA Stage One Screening Report.

34 With respect to lamprey species, and as acknowledged by NatureScot and MSS in their screening response on the 2020 Berwick Bank Wind Farm Proposal LSE Screening Report, there is little information on their spatial distribution out with estuaries. Therefore, on a precautionary basis, the area of search for Atlantic salmon sites, as described above, was considered a suitable proxy for identification of sea lamprey and river lamprey sites. This search area extended to 100 km from the Proposed Development boundary.

35 No impact pathways were identified between the Proposed Development and any additional sites designated for Annex II diadromous fish, therefore there is no potential for in-combination effects at any sites apart from those which are screened in for HRA Stage Two Appropriate Assessment (i.e. Tweed Estuary SAC, River Tweed SAC, River South Esk SAC, River Tay SAC, River Dee SAC, River Teith SAC).

3.3.3 LSE IN-COMBINATION FOR MARINE MAMMALS

36 A precautionary approach to selection of relevant sites for Annex II marine mammals was adopted in the HRA Stage One LSE Screening Report (SSE Renewables, 2021b). As marine mammals are highly mobile animals with the potential to forage over wide areas, all European sites for marine mammal features with a range that overlaps with the Proposed Development were considered. For Annex II cetaceans (harbour porpoise and bottlenose dolphin) the search area extended to the relevant Management Unit (MU) for each species, as defined by the Inter Agency Marine Mammal Working Group (IAMMWG, 2015). For harbour seal, a precautionary search area of 100 km was applied, based on telemetry data. For grey seal, a search area of 100 km was also applied, based on the latest advice regarding the typical foraging range of the species from haul out sites.

37 The HRA Stage One LSE Screening Report (SSE Renewables, 2021b) identified LSE alone for all UK sites within species' range, therefore in-combination effects for these sites will be assessed at HRA Stage Two Appropriate Assessment.

38 With respect to the 19 transboundary sites identified within the search areas outlined above, all relevant effect pathways are considered extremely weak, given the intervening distances between the Proposed Development and the transboundary sites considered (>290 km). As a result, only negligible (if even detectable) effects would be apparent and could not contribute, in any material way, to an in-combination effect, and as such, LSEI associated with planned projects or other activities in the vicinity of the Proposed Development are also not anticipated for marine mammal features of any transboundary site.

3.4 SUMMARY TABLE OF LIKELY SIGNIFICANT EFFECTS IDENTIFIED AND CONSIDERED IN THE HRA STAGE TWO APPROPRIATE ASSESSMENT

39 A summary of the site features for which LSE has been identified, along with corresponding impact pathways for each phase of the Project, is provided in Table 3.1. The full outcome of the LSE screening, including sites and impacts that have been screened out and justification for screening these out, is presented in the HRA Stage One Screening Report (SSE Renewables, 2021b).

Table 3.1: A Summary of all European Sites for which LSE Could not be Discounted at HRA Stage One Screening and for which Appropriate Assessment is Required

No.	European Site	Distance to (km)		Relevant Qualifying Interest Feature(s)	Project Phase	Impact
		Proposed Development Array Area	Proposed Development Export Cable Corridor			
Annex I Habitats						
1	Berwickshire and North Northumberland Coast SAC	34.7	4.1	Mudflats and sandflats not covered by seawater at low tide	Construction/Decommissioning	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
					Operation and maintenance	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
						Alteration of seabed habitats arising from effects of physical processes (Proposed Development export cable corridor works only)
				Large shallow inlets and bays	Construction/Decommissioning	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
					Operation and maintenance	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
						Alteration of seabed habitats arising from effects of physical processes (Proposed Development export cable corridor works only)
				Reefs	Construction/Decommissioning	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
					Operation and maintenance	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
						Alteration of seabed habitats arising from effects of physical processes (Proposed Development export cable corridor works only)
				Submerged or partially submerged sea caves	Construction/Decommissioning	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
					Operation and maintenance	Increased SSC and associated sediment deposition (Proposed Development export cable corridor only)
						Alteration of seabed habitats arising from effects of physical processes (Proposed Development export cable corridor works only)
Annex II Diadromous Fish						
2	Tweed Estuary SAC	46.5	29.0	Sea lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				River lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration

No.	European Site	Distance to (km)		Relevant Qualifying Interest Feature(s)	Project Phase	Impact
		Proposed Development Array Area	Proposed Development Export Cable Corridor			
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
3	River Tweed SAC	51.6	34.1	Atlantic salmon	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				Sea lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				River lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
4	River South Esk SAC	51.4	76.5	Atlantic salmon	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				Freshwater pearl mussel	Construction/Decommissioning	Underwater noise
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
5	River Tay SAC	87.2	102.7	Atlantic salmon	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures

No.	European Site	Distance to (km)		Relevant Qualifying Interest Feature(s)	Project Phase	Impact
		Proposed Development Array Area	Proposed Development Export Cable Corridor			
				Sea lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				River lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
6	River Dee SAC	79.8	106.6	Atlantic salmon	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				Freshwater pearl mussel	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
7	River Teith SAC	148.1	113.8	Atlantic salmon	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				Sea lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling
						Colonisation of hard structures
				River lamprey	Construction/Decommissioning	Injury and/or disturbance to fish from underwater noise and vibration
						Increased SSC and associated sediment deposition
					Operation and maintenance	EMF from subsea electrical cabling

No.	European Site	Distance to (km)		Relevant Qualifying Interest Feature(s)	Project Phase	Impact
		Proposed Development Array Area	Proposed Development Export Cable Corridor			
						Colonisation of hard structures
Marine Mammals						
(1)	Berwickshire and North Northumberland Coast SAC	34.7	4.0	Grey seal	Construction/Decommissioning	Injury and disturbance to marine mammals from elevated underwater noise during piling
						Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance
						Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
					Operation and maintenance	Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
8	Isle of May SAC	40	21	Grey seal	Construction/Decommissioning	Injury and disturbance to marine mammals from elevated underwater noise during piling
						Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance
						Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
					Operation and maintenance	Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
9	Firth of Tay and Eden Estuary SAC	47	45	Harbour seal	Construction/Decommissioning	Injury and disturbance to marine mammals from elevated underwater noise during piling
						Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance
						Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities

No.	European Site	Distance to (km)		Relevant Qualifying Interest Feature(s)	Project Phase	Impact
		Proposed Development Array Area	Proposed Development Export Cable Corridor			
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
					Operation and maintenance	Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
10	Southern North Sea SAC	146	151	Harbour porpoise	Construction/Decommissioning	Injury and disturbance to marine mammals from elevated underwater noise during piling
						Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
					Operation and maintenance	Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
11	Moray Firth SAC	167	193	Bottlenose dolphin	Construction/Decommissioning	Injury and disturbance to marine mammals from elevated underwater noise during piling
						Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance
						Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys
					Operation and maintenance	Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities
						Changes in fish and shellfish communities affecting prey availability
						Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys

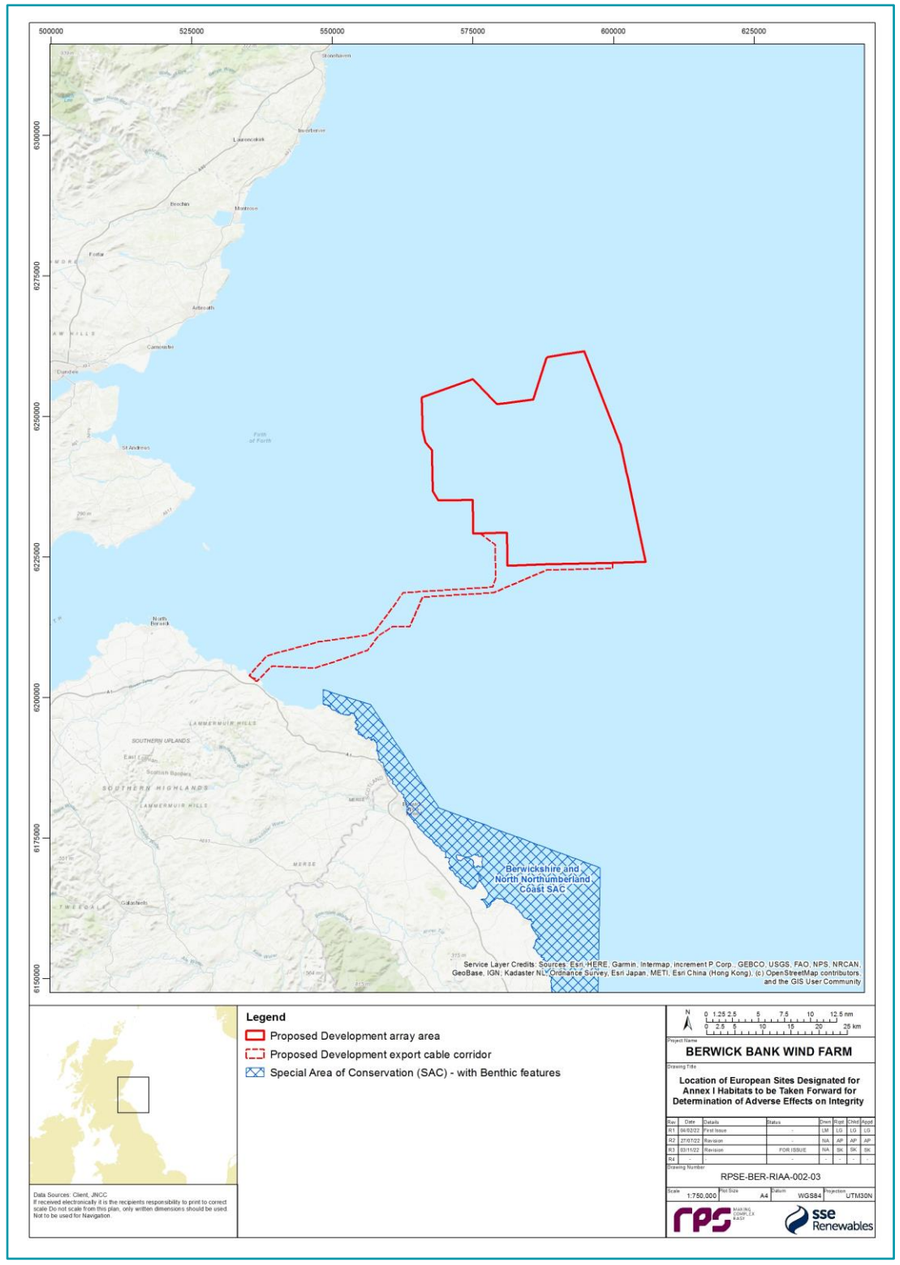

Figure 3.1: Location of European Sites Designated for Annex I Habitats to be Taken Forward for Determination of Adverse Effects on Integrity

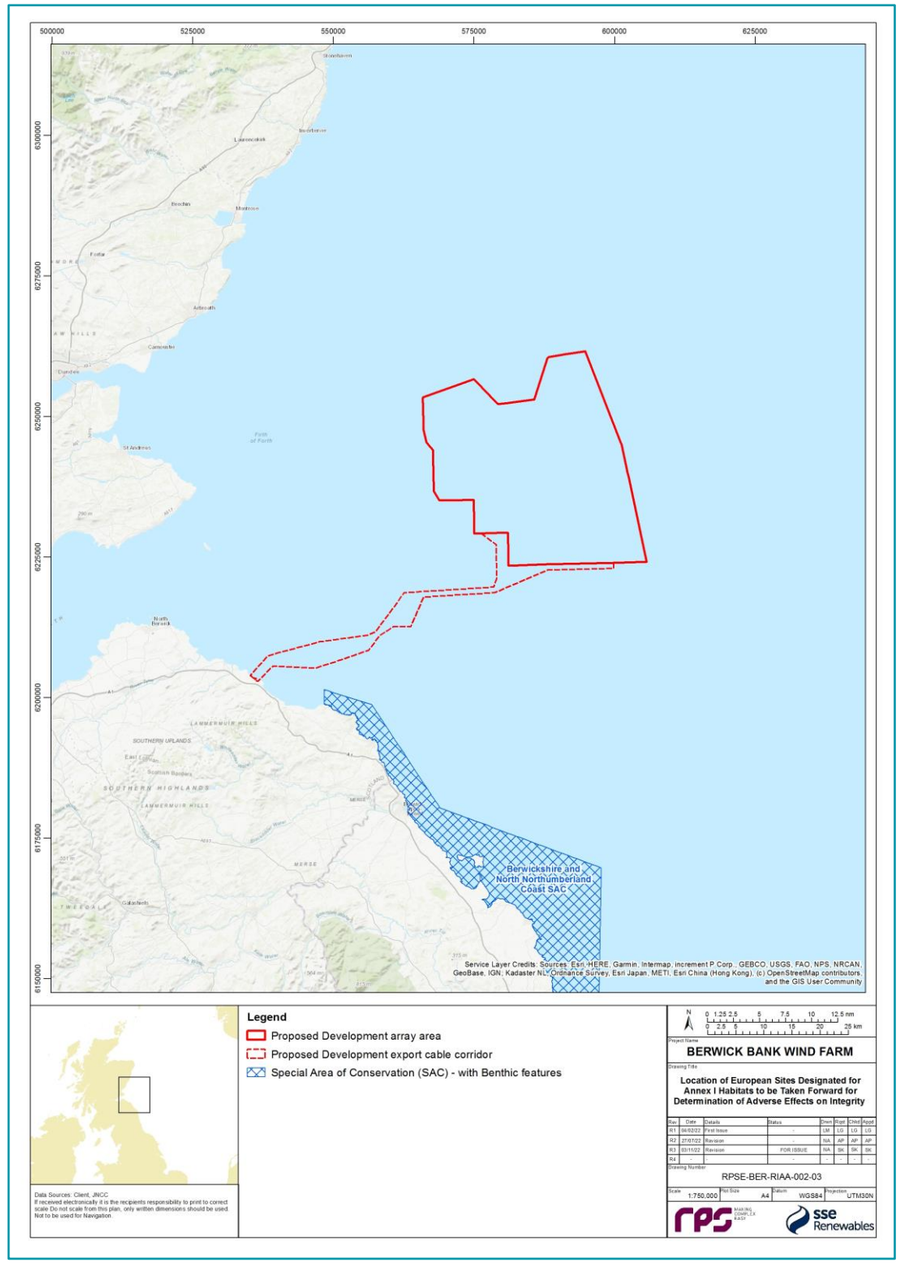

Figure 3.2: European Sites Designated for Annex II Diadromous Fish Species Taken Forward for Determination of Adverse Effects on Integrity

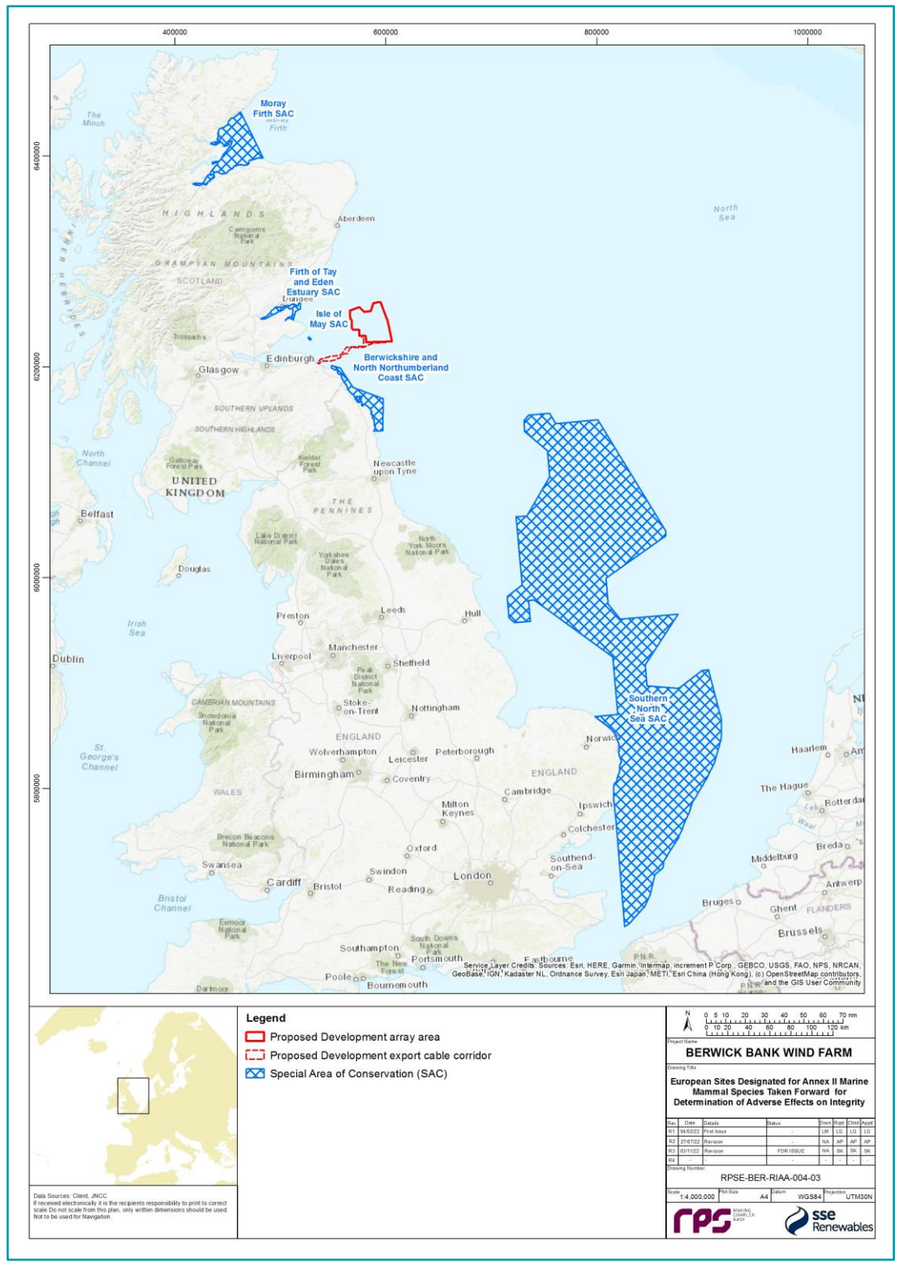

Figure 3.3: European Sites Designated for Annex II Marine Mammal Species Taken Forward for Determination of Adverse Effects on Integrity

4 INFORMATION TO INFORM THE APPROPRIATE ASSESSMENTS

40 As described in chapter 2 of Part One of the RIAA, a European site is progressed to the Appropriate Assessment stage (Stage Two of the HRA process) where it is not possible to exclude a LSE on one or more of its qualifying interest features in view of the site's conservation objectives. European sites, features and potential impacts requiring an Appropriate Assessment for the Proposed Development are therefore those for which LSE could not be ruled out during the Screening exercise and following consultation (see Table 2.1).

41 Information to help inform the Appropriate Assessment for SACs is provided in the following sections of this Part of the RIAA and is split into relevant receptor groups:

- Section 5: Annex I habitats;
- Section 6: Annex II diadromous fish; and
- Section 7: Annex II Marine mammals.

42 The information provided includes a description of the SACs under consideration, their qualifying interest features, and an assessment of potential effects on site integrity in light of the conservation objectives of each site.

4.1 MAXIMUM DESIGN SCENARIOS

43 Assessments for all European sites considered in this Part of the RIAA (i.e. SACs) are based on a realistic maximum design scenario derived from the design envelope for the Proposed Development. The maximum design scenario for each of the potential impacts for each receptor group are tabulated separately in each of the receptor chapters according to the effect-pathway under consideration. An overview of the maximum design scenarios considered for the assessment of potential impacts on receptor groups considered in this Part of the RIAA has been provided in Table 4.1.

44 The maximum design scenarios are consistent with those used for assessment in relevant chapters of the Offshore EIA Report.

4.2 DESIGNED IN MEASURES

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

46 Designed in measures of relevance to the assessment of potential impacts are tabulated separately in each of the receptor sections, according to the effect-pathway under consideration. An overview of the designed in measures of relevance for all receptor groups is provided in Table 4.2.

47 Measures intended specifically to avoid or reduce effects on European sites were not considered during the HRA Stage One Screening but are included within the HRA Stage Two Appropriate Assessment for determination of Adverse Effects on Integrity. The RIAA will indicate whether adverse impacts on European sites are likely and if so, whether those effects can be avoided through the introduction of mitigation measures that avoid or reduce the impact. These measures are referred to as Secondary Mitigation and may be taken from topic chapters within the Offshore EIA Report or, where necessary, may have been

developed specifically to comply with HRA requirements. Where the latter is the case, this is made clear throughout.

4.3 BASELINE INFORMATION

48 Baseline information on the European sites (i.e. SACs for this Part of the RIAA) identified for further assessment within HRA Stage Two Appropriate Assessment has been gathered through a comprehensive desktop study of existing studies and datasets. The key data sources are summarised in each of the receptor group sections and presented in detail within topic chapters in the Offshore EIA Report. Any additional sources of information used in the HRA Stage Two Appropriate Assessment are also summarised.

49 For brevity, information on the SACs is summarised within the main body of this Part of the RIAA, however, detailed reference information (such as attributes and targets for the conservation objectives, citations, condition status and existing pressures) is presented in appendix A and referenced in the HRA Stage Two Appropriate Assessment as appropriate.

4.4 CONSERVATION OBJECTIVES AND CONSERVATION ADVICE

50 The statutory nature conservation bodies (SNCBs) have produced conservation advice for European sites under their statutory remit. This conservation advice provides supplementary information on sites and features, and although the content provided is similar, the format of the advice provided varies between the different SNCBs.

51 Due to the location and scale of the Proposed Development, European sites with the potential to be impacted fall variously under the remit of NatureScot, Natural England and the JNCC. The Berwickshire and North Northumberland Coast SAC conservation advice has been jointly developed by NatureScot and Natural England but is hosted on NE's Designated Site System as an interactive Conservation Advice Package (CAP). The Southern North Sea SAC CAP has been jointly developed by Natural England and the JNCC but is hosted on JNCC's website in the form of a 'Conservation Objectives and Advice on Operations' document. The Tweed Estuary SAC is under Natural England's remit and therefore conservation advice is hosted on Natural England's Designated Site System.

52 For European sites under the statutory remit of NatureScot, CAP documents have been produced for all terrestrial SACs (note that many of the sites screened in for Annex II fish species are considered terrestrial), while Conservation and Management Advice documents (CMAs) cover marine SACs and marine SPAs. These documents contain revised and updated conservation objectives for the features of each site, site-specific clarifications and advice in order for the conservation objectives to be achieved, and advice on management required to achieve the conservation objectives.

53 Conservation objectives set the framework for establishing appropriate conservation measures for each feature of the site and provide a framework against which plans or projects can be assessed. The conservation objectives set out the essential elements needed to ensure that the favourable conservation status of a qualifying habitat or species is maintained or restored at a site. If all the conservation objectives are met, then the integrity of the site will be maintained.

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

55 In this Part of the RIAA, the Applicant has referenced the most up-to-date conservation objectives and conservation advice available, which for Scottish sites under the remit of NatureScot includes the 'new style' conservation objectives provided by NatureScot in CAPs/CMAs and the 'European Sites Casework Guidance' (currently being updated - July 2021[1]). New CAPs include revised conservation objectives, which are better targeted for each feature and include supplementary advice for each headline objective. They also include either 'maintain' or 'restore' objectives. In addition to the new feature-specific objectives, it is noted that there are overarching objectives for the whole site, with Objective 2 related to site integrity.

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

57 Where Supplementary Advice to the Conservation Objectives, or site-specific conservation advice describes minimum targets for qualifying features in more detail, this detail is provided in appendix A and/or referenced in the course of the HRA Stage Two Appropriate Assessment.

58 Where Ramsar interests coincide with qualifying features within an SAC, the advice for overlapping designations is considered to be, sufficient to support the management of the Ramsar interests. Therefore, the conservation objectives are referenced for both designations.

4.5 APPROACH TO THE IN-COMBINATION ASSESSMENTS

59 The approach taken for the assessment of in-combination impacts has been informed by the cumulative effects assessment (CEA) carried out for relevant topics in the Offshore EIA Report. The CEA methodology is described in detail in volume I, chapter 6 of the Offshore EIA Report and summarised below.

60 The cumulative impacts of the Proposed Development in conjunction with other proposed plans or projects have been considered within each topic chapter of the Offshore EIA Report. Due to the range of receptors being assessed, the projects which are relevant to the in-combination assessments will be different for each receptor.

61 The Marine Scotland Consenting and Licensing Guidance: For Offshore Wind, Wave and Tidal Energy Applications (Scottish Government, 2018) states that 'Engagement with MS-LOT is required to identify which plans/projects/ongoing activities should be included in the in-combination element of the cumulative effects assessment.' The offshore wind projects in the Firth of Forth and Tay region have been considered, alongside other developments, including those which:

- became operational since baseline characterisation;
- are under construction;

[1] See https://www.nature.scot/doc/maintain-or-restore-objectives-guidance-hr#Using+%E2%80%98New+style%E2%80%99+Conservation+Objectives+in+the+Conservation+Advice+Packages

- those with consent and submitted but not yet determined;
- those projects with a Scoping Report; and
- plans and projects which are “reasonably foreseeable” (i.e. developments that are being planned, including, for example, offshore renewable energy projects which have a Crown Estate Agreement for Lease (AfL), offshore renewable energy projects that have been scoped).

62 The in-combination assessment has considered all other relevant plans, projects and activities where detail to inform the assessment is publicly available three months prior to the Proposed Development application.

63 The in-combination assessment presents relevant in-combination impacts of projects according to a tiered approach. This approach provides a framework for placing relative weight upon the potential for each project/plan to be included in the in-combination assessment to ultimately be realised, based upon the project/plan’s current stage of maturity and certainty in the projects’ parameters. The approach utilised within the in-combination assessment comprises the following tiers:

- tier 1 - Proposed Development (Berwick Bank Wind Farm offshore) with Berwick Bank Wind Farm onshore;
- tier 2 – All plans/projects assessed under Tier 1, plus projects which became operational since baseline characterisation, those under construction, and those with consent and submitted but not yet determined;
- tier 3 – All plans/projects assessed under Tier 2, plus those projects with a Scoping Report; and
- tier 4 – All plans/projects assessed under Tier 3, which are reasonably foreseeable, plus those projects likely to come forward where an AfL has been granted.

64 An overview of the projects or activities which will be considered for in-combination with the Proposed Development include:

- Berwick Bank Wind Farm onshore elements and Cambois connection;
- other offshore wind farms and associated cabling and infrastructure;
- oil and gas infrastructure/development (cables and pipelines);
- other forms of cabling (i.e. telecommunications and interlinks);
- beach replenishment schemes;
- navigation and shipping; and
- aggregate extraction and disposal of dredging spoil.

The Applicant is aware that on 4 July 2022, Inch Cape Offshore Limited applied to Scottish Ministers to vary its offshore consent to construct and operate Inch Cape Offshore Wind Farm[2]. The proposed variation(s) are at a very early stage in the development process. It was concluded in the supporting EIA and HRA screening report[3] that there are no new or materially different impacts arising from the variation compared to the initial proposal (ICOL revised design as consented). Given that this is the most current information available (as of October 2022), the Applicant has continued to assess the ICOL revised design (as consented).

[2] Inch Cape Offshore Windfarm (Revised Design), Firth of Forth – Proposed Variation – Screening Request and Report | Marine Scotland Information

[3] Screening – Inch Cape Offshore Windfarm (Revised Design), Firth of Forth – Proposed Variation | Marine Scotland Information

Table 4.1: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Receptor Groups Considered in the RIAA

Potential Impact	Receptor Group	Phase[4] C	Phase[4] O	Phase[4] D	Maximum Design Scenario	Justification
Increased suspended sediment concentrations and associated sediment deposition (Proposed Development export cable corridor only)	Annex I habitats (benthic habitats)	✓	✓	✓	**Construction Phase** Seabed preparation: • boulder and sand wave clearance; • sand waves may be cleared to a width of 25 m, average height 5 m and clearance along circa 20% of offshore export cables corridor length (174.4 km); and • modelling and assessment assumed a dredge and disposal technique is used to redistribute material in the within the Proposed Development application boundary. Cable installation: • offshore export cables length up to 872 km; • installation using jet trenching which mobilises material from a depth of up to 3 m deep in a trench of up to 2 m wide; • modelling assumes that the Proposed Development export cable corridor extends over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column); and • offshore export cable installation at the landfall via trenchless techniques. **Operation and Maintenance Phase** • cable repair/reburial activities; and • offshore export cables: up to 4,000 m of cable for repair locations and up to 4,000 m of cable for reburial locations over 35 year lifetime. **Decommissioning Phase** • decommissioning of offshore export cables; • offshore export cable length up to 872 km; and • decommissioning using jet dredging which mobilises material from a up to 3 m deep and 2 m wide trench.	Greatest volume of sediment released into the water column. *Seabed preparation* Site clearance activities may be undertaken using a range of techniques, the suction hopper dredging has the potential to cause the greatest increase in suspended sediment and largest plume extent as material is released near the water surface and has therefore been considered as the maximum design scenario. *Cable installation* Cable routes include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route therefore the assessment provides the upper bound in terms of suspended sediment and dispersion potential. Ploughing (and to a certain extent jetting) moves material rather than bringing it fully into suspension therefore the assumption that the seabed is fluidised presents the maximum design scenario. Offshore export cable trenching modelling assumes sediment release along the Proposed Development export cable corridor to the nearshore point at which a continuous rock outcrop is encountered. *Decommissioning* Maximum design scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left *in situ* this will result in reduced levels of suspended sediment and associated deposition during decommissioning.
Alteration of seabed habitats arising from effects of physical processes	Annex I habitats (benthic habitats)	✗	✓	✗	**Operation and Maintenance Phase** Wind turbines • 179 wind turbines with 20 m diameter suction caisson jacket foundations with a total footprint (including scour protection) of 12,240 m^2 per foundation, with scour protection 2 m in height; and	Provides the largest obstruction to flow in the water column. This is aligned with caisson foundations which represent a greater area of influence than piled jacket foundations.

[4] C = Construction, O = Operation and maintenance, D = Decommissioning

Potential Impact	Receptor Group	Phase[4] C	Phase[4] O	Phase[4] D	Maximum Design Scenario	Justification
					• additionally, 179 structures with four legs per foundation (i.e. 716 legs in total) with 5 m diameter spaced 60 m apart at the seabed were included through the water column to model associated influence on wave climate and tidal currents. OSPs/Offshore converter substation platforms • eight OSPs/Offshore converter substation platforms each with 6 jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 6,206 m^2 footprint per unit (including scour protection). Six legs of 4 m diameter spaced 40 m apart at the seabed; and • two OSPs/Offshore converter substation platforms each with 8 jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 12,559 m^2 footprint per unit (including scour protection). Eight legs of 5 m diameter spaced 80 m apart at the seabed. Cable protection • Cable protection (armouring) along 15% of the array, OSP/Offshore converter substation platform interconnector and offshore Proposed Development export cable corridor, of up to 3 m in height and 20 m width; and • Up to 78 inter-array cable crossings 3.5 m in height, 21 m wide and 30 m in length and up to 16 offshore export cable crossings 3.5 m in height, 21 m wide and 40 m in length.	
Increased suspended sediment concentrations and associated sediment deposition	Annex II diadromous fish	✓	✖	✓	**Construction Phase** Wind turbines and OSPs/Offshore converter substation platforms installed on piled jacket foundations: • drilling of foundations associated with 179 wind turbine structures, with 2 x 5.5 m piles per leg and 4 legs per foundation; • drilling undertaken for 20% of total 80 m depth (estimated at 16 m) with a rate of 0.5 m/h; • modelling undertaken for drilling events at locations across the area encompassing a range of dispersion characteristics with 2 concurrent drilling events; and • drilling of foundations associated with up to 5 OSPs/Offshore converter substation platforms for up to 4 piles of 3.5 m diameter associated with each of the 8 legs, with 4 per foundation requiring drilling to 20% depth (i.e. 12 m) and drilling at 2 OSPs/Offshore converter substation platforms for 4 piles of 4 m diameter are associated with each of the 8 legs, with 4 per foundation requiring drilling to 20% depth (i.e. 12 m). Installation of inter-array and offshore export cables (maximum trench width of 2 m and maximum trench depth of 3 m): • inter-array cables length up to 1,225 km; • buried offshore export cable length up to 872 km; • OSP/Offshore converter substation platform interconnector cable length up to 94 km; • sand wave clearance over 30% of inter-array and OSP/Offshore converter substation platform interconnector cables (395.7 km) and 20% of offshore export cables (174.4 km); • boulder clearance over 20% of inter-array, OSP/Offshore converter substation platform interconnector cables (263.8 km) and offshore export cables (174.4 km); • installation using jet trenching which mobilises material from a depth of up to 3 m deep 2 m wide trench; and • modelling assumes that the offshore cable routes extend over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column).	Greatest volume of sediment released into the water column. *Seabed preparation* Site clearance activities may be undertaken using a range of techniques, the suction hopper dredging has the potential to cause the greatest increase in suspended sediment and largest plume extent as material is released near the water surface and has therefore been considered as the maximum design scenario. *Foundation installation* Drilling may be required at 10% of site locations therefore more locations are associated with the 307 wind turbine array, however each drilling event would release less material. (20% depth of a single 60 m pile per leg.) The overall total release is less than the 179 wind turbine array. Piles relating to OSPs/Offshore converter substation platforms have a greater number of legs and are smaller in diameter and require less drilling depth than the 179 wind turbines to be assessed and therefore the modelled scenarios will provide an upper envelope of SSC for each event. *Cable installation* Cable routes include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route therefore the assessment provides the upper bound in terms of suspended sediment and dispersion potential.

Potential Impact	Receptor Group	Phase[4] C	Phase[4] O	Phase[4] D	Maximum Design Scenario	Justification
					Decommissioning Phase • piled substructures will be cut at an agreed depth below the level of the seabed for partial removal, suction caisson foundations will be removed; • decommissioning of inter-array and offshore export cables: – inter-array cables length up to 1,225 km; – offshore export cable length up to 872 km; and – OSP/Offshore converter substation platform interconnector cable length up to 94 km. • decommissioning using jet dredging which mobilises material from up to 3 m deep, 2 m wide trench; and • modelling assumes that the offshore cable routes extend over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column.	Ploughing (and to a certain extent jetting) moves material rather than bringing it fully into suspension therefore the assumption that the seabed is fluidised presents the maximum design scenario. The inter-array modelling was carried out for a section of an indicative cable route which would have the widest impact, (i.e. where the tidal currents are strongest and material brought into suspension will be carried the furthest). Interconnector cable trenching characteristics are the same as those for inter-array cable trenching therefore magnitude of impacts are quantified within the indicative section of trenching modelled. Offshore export cable trenching modelling assumes sediment release along the Proposed Development export cable corridor to the nearshore point at which a continuous rock outcrop is encountered. *Decommissioning* Maximum design scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left in situ this will result in reduced levels of suspended sediment and associated deposition during decommissioning.
Injury and/or disturbance to fish from underwater noise and vibration	Annex II diadromous fish	✓	×	×	**(Pre-)Construction phase** • clearance of up to 14 UXOs within the inter-array area or Proposed Development export cable corridor. • absolute maximum assessed of 300 kg UXO; • low order clearance of all UXOs using low order techniques (subsonic combustion) with a single donor charge of up to 80 g Net Explosive Quantity (NEQ) for each clearance event; • up to 500 g NEQ clearance shot for neutralisation of residual explosive material; • small risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO; • up to 2 detonations within 24 hours; and • clearance during daylight hours only. **Construction Phase** • wind turbines: – up to 179 piled jacket foundations, with up to 4 legs per foundation and up to 2 x 5.5 m diameter piles per leg (1,432 piles). – maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – two concurrent piling events with 2 vessels for wind turbine foundations and/or OSPs/Offshore converter substation platforms; – minimum 900 m and maximum 49.3 km distance between concurrent piling events; – up to 10 hours absolute maximum piling per pile (9 hours realistic maximum);	Maximum number and maximum size of UXOs encountered in the Proposed Development based on UXO Hazard Assessment undertaken for Seagreen. Maximum number of UXOs will lead to greatest potential impact. Donor charge is maximum required to initiate low order detonation. Assumption of a clearance shot of up to 500 g at all locations will lead to the greatest potential impact, however it should be noted that this may not always be required. Maximum design scenario is for the maximum number of piles, the maximum possible duration of piling and the greatest hammer energy (leading to the greatest propagation of noise into the water column).

Potential Impact	Receptor Group	Phase[4] C	Phase[4] O	Phase[4] D	Maximum Design Scenario	Justification
					– total duration of piling for wind turbines only = 14,320 hours (absolute max) to 12,888 hours (realistic max); and – maximum piles installed within 24 hours (concurrent piling) = 5. • OSPs/Offshore converter substation platforms: – up to 8 jacket foundations with up to 6 legs per foundation and 4 x 3.0 m diameter piles per leg (192 piles) and up to 2 jacket foundations with up to 8 legs per foundation and 4 x 4.0 m diameter piles per leg (64 piles); – maximum hammer energy up to 4,000 kJ; – no concurrent piling of OSPs/Offshore converter substation platforms; – up to 8 hours absolute maximum piling per pile; – total duration of piling for OSPs/Offshore converter substation platforms only = 2,048 hours; and – maximum piles installed within 24 hours (single piling) = 3. • number of days when piling may occur within piling phase (OSPs/Offshore converter substation platforms and wind turbines): 372 days.	
Electromagnetic Fields (EMF) from subsea electrical cabling	Annex II diadromous fish	×	✓	×	**Operation and Maintenance Phase** Presence of inter-array and offshore export cables: • up to 1,225 km of 66 kV inter-array cables; – up to 872 km of 275 kV; – minimum burial depth 0.5 m; – up to 15% of inter-array cables and offshore export cable route may require cable protection; and – cables will also require cable protection at asset crossings (up to 78 crossings for inter-array cables and up to 16 crossings for offshore export cables). Operation and maintenance phase of up to 35 years.	Maximum length of cables across the array area and offshore export cable route and minimum burial depth (the greater the burial depth, the more the EMF is attenuated). The maximum design scenario for EMF is based on the greatest cable length as this provides the greatest potential for EMF effects on fish and shellfish IEFs.
Colonisation of foundations, scour protection and cable protection	Annex II diadromous fish	×	✓	×	**Operation and Maintenance Phase** Long term habitat creation of up to 10,198,971 m^2 due to: • presence of up to 307 wind turbines and 10 OSPs/Offshore converter substation platforms on jacket foundations; • presence of scour protection associated with wind turbines and OSPs/Offshore converter substation platforms; • presence of cable protection associated with up to 1,225 km of inter-array cables, up to 94 km of interconnector cables and up to 872 km of offshore export cables. Assumes up to 15% of inter-array, OSP/Offshore converter substation platform interconnector and offshore export cables may require cable protection; • presence of cable protection for cable crossings, 78 cable crossings for array and OSP/Offshore converter substation platform interconnector cables and 16 crossings for the offshore export cables; and • operation phase of up to 35 years.	Maximum number of wind turbines and OSP/Offshore convertor station platform foundations and associated scour protection, maximum length of cables and cable protection resulting in greatest surface area for colonisation. The estimate of habitat creation from the presence of foundations has been calculated as if the foundations were a solid structure. This is, therefore, a conservative estimate of habitat creation on the basis that the jacket foundations will have a lattice design rather than a solid surface, as has been assumed.
Injury and disturbance to marine mammals from elevated underwater noise during piling (fixed foundations)	Annex II marine mammals	✓	×	×	**Construction Phase** • Wind turbines: – up to 179 piled jacket foundations, with up to 4 legs per foundation and up to 2 x 5.5 m diameter piles per leg (1,432 piles); – maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – up to 2 concurrent piling of wind turbine foundations with 2 vessels;	The largest hammer energy and the maximum spacing between concurrent piling vessels could lead to the largest area of ensonification at any one time. Minimum spacing between concurrent piling represents the highest risk of injury to animals. Note that the absolute maximum hammer energy is the maximum achieved at any one location whilst the 'realistic

Potential Impact	Receptor Group	Phase[4] C	Phase[4] O	Phase[4] D	Maximum Design Scenario	Justification
					– minimum 950 m and maximum 49.43 km distance between concurrent piling events; – Up to 10 hours absolute maximum piling per pile (nine hours realistic maximum); – total duration of piling = 12,888 hours (realistic maximum) to 14,320 hours (absolute maximum); and – maximum piles installed within 24 hours (concurrent piling) = 5. • Offshore Substation Platforms (OSP/Offshore convertor station platforms): – up to 8 jacket foundations with up to 6 legs per foundation and 4 x 3.0 m diameter piles per leg (192 piles) and up to 2 jacket foundations with up to 8 legs per foundation and 4 x 4.0 m diameter piles per leg (64 piles); – maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – up to 8 hours absolute maximum (7 hours realistic maximum) piling per pile; – total duration of piling = 1,792 hours (realistic maximum) to 2,048 hours (absolute maximum); and – maximum piles installed within 24 hours (based on single piling) = 3. The maximum scenario for concurrent piling is maximum of 2 piling events at any one time. Number of days when piling may occur within piling phase (OSP/Offshore convertor station platforms and wind turbines) = 372 days. Total piling phase of 52 months over a construction phase of 96 months.	maximum' is taken as the average of the maximum energy likely to be achieved across all 179 locations (and is estimated as 75% of the maximum). The longest duration of piling at any location results in the greatest number of days when piling could occur. The maximum number of piles installed within 24 hours will result in the greatest impact over 24 hours. Maximum number of piles for wind turbines installed within 24 hours is based on the realistic maximum duration of piling and assuming up to 2 concurrent piling vessels for wind turbines, with an assumption that there will be a maximum of 2 piling events at any one time. Note that maximum design scenario assumes concurrent piling for wind turbine foundations as the maximum design scenario but it may occur as a combination of wind turbines and OSPs/Offshore convertor station platforms. Figures have been rounded to nearest whole number. The maximum number of days when piling occurs will result in the greatest potential impact. Total number of days when piling may occur is based on the total number of piles divided by the number of piles that can be installed within 24 hours for wind turbines and OSP/Offshore convertor station platforms. Duration of piling at wind turbines assumes two concurrent vessels. OSPs/Offshore convertor station platforms only assume a single vessel for pile installation. In total, a maximum of two piling vessels will be piling at any one time.
Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	Annex II marine mammals	✓	✓	×	**Pre-Construction phase** Geophysical site investigation activities include: • Multi-beam echo-sounder (MBES) (200 kHz to 400 kHz; 180-240 dB re 1 1µPa). • Sidescan Sonar (SSS) (200 kHz to 900 kHz; 190-245 dB re 1 1µPa). • Single Beam Echosounder (SBES) (200 kHz to 400 kHz; 180-240 dB re 1 1µPa). • Sub-Bottom Profiler (SBP) (0.5 kHz to 12 kHz chirp, 4 kHz pinger, 100 kHz pinger; 200-240 chirp dB re 1 1µPa, 200-235 pinger (both) dB re 1 1µPa.). • Ultra High Resolution Seismic (UHRS) (19.5 kHz to 33.5 kHz; 170-200 dB re 1 1µPa). • magnetometer. Geotechnical site investigation activities include: • boreholes. • Cone penetration tests (CPTs). • vibrocores. Site investigation surveys will involve the use of up to two geophysical/geotechnical survey vessels and take place over a period of up to three months with up to 70 return trips. **Operation and maintenance phase**	Maximum range of geophysical and geotechnical activities likely to be undertaken using equipment typically employed for these types of surveys will result in the greatest potential impact.

Potential Impact	Receptor Group	Phase[4] C	O	D	Maximum Design Scenario	Justification
					Routine geophysical surveys of wind turbine foundations, estimated to occur every six months for first two years and annually thereafter (approximately 37 surveys over the 35 year life cycle of the Proposed Development). It is assumed that approximately 10% of the inter-array cable length will require inspections each year (more if issues are found). Offshore export cables surveyed annually.	
Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	Annex II marine mammals	✓	×	×	**Pre-Construction phase** • clearance of 14 UXOs within the Proposed Development array area or Proposed Development offshore export cable route. • maximum UXO size of up to 300 kg. • surveys will involve the use of up to seven vessels on site at any one time with up to 30 vessel movements in total. • intention for low order clearance of all UXOs using low order techniques (subsonic combustion) with a single donor charge of up to 80 g net explosive quantity (NEQ) for each clearance event. • up to 500 g NEQ clearance shot for neutralisation of residual explosive material at each location. • small risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO (as per paragraph 873, approximately 10% of the total number of UXOs could result in high order detonation). • Up to 2 detonations within 24 hours. • Clearance during daylight hours only.	Maximum number and maximum size of UXOs encountered in the project area based on UXO Hazard Assessment undertaken for Seagreen will result in the greatest potential impact. Donor charge is maximum required to initiate low order detonation. Assumption of a clearance shot of up to 500 g at all locations although noting that this may not always be required.
Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities	Annex II marine mammals	✓	✓	✓	**Construction phase** Vessels used for a range of construction activities associated with site preparation, inter-array cables and offshore export cables, including boulder clearance, sand wave clearance, drilling and trenching; maximum vessels on site at any one time including: • up to 9 pre-installation boulder clearance vessels with up to 316 return trips throughout the construction phase. • up to 3 sand wave clearance vessels with up to 104 return trips over a throughout the construction phase. Vessels associated with site preparation, foundation installation, OSP/Offshore Converter Station platform installation, inter-array cables, offshore export cables, and landfall works, with up to 11,484 vessel round trips over the construction phase; maximum vessels on site at any one time including: • up to 9 main installation vessels making up to 297 return trips; • up to 14 cargo barges making up to 194 return trips; • up to 9 support vessels making up to 714 return trips; • up to 22 tug/anchor handlers making up to 794 return trips; • up to 6 cable installation vessels making up to 36 return trips; • up to 22 guard vessels making up to 1,488 return trips; • up to 8 survey vessels making up to 464 return trips; • up to 14 crew transfer vessels (CTVs) making up to 3,342 return trips; • up to 10 scour/cable protection installation vessels making up to 3,390 return trips; and • up to 20 resupply vessels making up to 245 return trips. Other activities:	Maximum numbers of vessels on site at any one and largest numbers of round trips during each phase of the Proposed Development and broad range of vessel types representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact. Range of other activities including maximum timescales (where available) during which activities are conducted.

Potential Impact	Receptor Group	Phase[4] C	Phase[4] O	Phase[4] D	Maximum Design Scenario	Justification
					• up to 10% of piles are anticipated to require drilling at wind turbine foundations (144 piles) with a maximum drilling duration of 96 days; • up to 32 piles will require drilling at OSPs/Offshore convertor station platform foundations with a maximum drilling duration of up to 39 days; and • Burial of 1,225 km of inter-array cables and 828 km of offshore export cable via jet trenching; along with cable laying and jack up rigs. Maximum offshore construction duration of up to 96 months. **Operation and Maintenance Phase** Vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth, replacement of access ladders, and geophysical surveys; maximum vessels on site at any one time including: • up to 4 CTVs making up to 832 return trips per year; • up to 1 jack up vessel making up to 2 return trips per year; • up to 2 support vessels making up to 26 return trips per year; • up to 1 cable repair vessel making up to 5 return trips per operational lifetime; • up to two service operations vessels (SOV, daughter craft) making up to four movements within Proposed Development array area per day; • up to 1 cable survey vessel making 1 return trip per year; and • up to 1 excavator/backhoe dredger making up to 5 return trips over operational lifetime. **Decommissioning Phase** Vessels used for a range of decommissioning activities such as removal of foundations, cables and cable protection. Noise from vessels assumed to be as per vessel activity described for construction phase above.	
Changes in fish and shellfish communities affecting prey availability	Annex II marine mammals	✓	✓	✓	**Construction Phase** Up to 113,974,700 m^2 of temporary subtidal habitat loss/disturbance due to: • use of jack-up vessels during foundation installation, with up to 4 jack-up events per wind turbine and 4 jack-up events per OSP/Offshore convertor station platform; • installation of up to 1,225 km of inter-array cables, up to 94 km of interconnector cable, up to 872 km offshore export cables with seabed disturbance width of: up to 25 m for sand wave clearance, up to 25 m for boulder clearance and up to 15 m for cable burial; • sand wave clearance for up to 20% of the Proposed Development export cable corridor length, up to 30% of inter-array cables and OSPs/Offshore convertor station platform interconnector cables; • boulder clearance for up to 20% of offshore export cable length, inter-array cables and OSPs/Offshore convertor station platform interconnector cables; • anchor placement; • offshore export cables installation at the landfall via trenchless burial techniques; • up to eight exit punches out, each 20 m x 5 m, for removal of up to 8 cables from the landfall; and • clearance of up to 14 UXO.	Maximum design scenarios described for fish will result in the greatest potential impact.

Potential Impact	Receptor Group	Phase[4] C	O	D	Maximum Design Scenario	Justification
					Other impacts on fish and shellfish communities include: • increased SSCs and associated deposition from construction activities, such as drilling of 179 foundations, installation of up to 1,225 km of inter-array and up to 872 km of offshore export cables; • injury and/or disturbance to fish and shellfish from underwater noise and vibration as a result of the clearance of up to 14 UXOs and installation of 179 offshore wind turbines and up to 10 OSPs/Offshore convertor station platforms; and • up to 7,798,856 m^2 of long term habitat loss due to presence of wind turbine and OSPs/Offshore convertor station platforms foundations as well as cable protection for cable crossing. Maximum duration of the offshore construction phase is up to 96 months up to 372 days piling. **Operation and Maintenance Phase** • Up to 989,000 m^2 temporary subtidal habitat loss/disturbance due to: major component replacements for wind turbines and OSPs/Offshore convertor station platforms; inter-array, interconnector and offshore export cable repair/reburial events. • increased SSCs and associated sediment deposition from cable repair/reburial events. • up to 7,798,856 m^2 of long term subtidal habitat loss due to presence of: wind turbines on suction caisson foundations and 10 OSPs/Offshore convertor station platforms on jacket foundations with associated scour protection; cable protection associated with inter-array, interconnector and offshore export cables; cable protection for cable crossings. • EMF from subsea electrical cabling due to presence of inter-array and offshore export cables. • colonisation of foundations, scour protection and cable protection leading to long term habitat creation of up to 10,198,971 m^2. • EMF from presence of up to 1,225 km of 66 kV inter-array cables and up to 872 km of 275 kV HVAC offshore export cables. **Decommissioning Phase** • up to 34,571,200 m^2 temporary subtidal habitat loss/disturbance due to: use of jack up vessels during decommissioning of wind turbine and OSPs/Offshore convertor station platforms foundations; complete removal of inter-array, interconnector and offshore export cables; anchor placement during cable decommissioning; • increased SSCs and associated sediment deposition from: cutting and removal of piled jacket foundations and decommissioning of inter-array, interconnector and offshore export cables; and • up to 7,562,609 m^2 permanent subtidal habitat loss due to complete removal of cable protection and scour protection for inter-array, OSPs/Offshore convertor station platforms interconnector and offshore export cables.	

Table 4.2: Designed in Measures of Relevance to the Assessment of Potential Impacts on European Sites

	Designed in Measure	Relevance to European Site Interest Features: Annex I Habitats	Annex II Diadromous Fish	Annex II Marine Mammals
Measure	Development of, and adherence to, a Decommissioning Plan			
Subject	The aim of this plan is to adhere to the existing UK and international legislation and guidance relating to decommissioning. Overall, this will ensure the legacy of the Proposed Development will reduce the amount of long-term disturbance to the environment as far as reasonably practicable.	✓	✓	✓
Measure	Implementation of piling soft start and ramp up measures. During piling operations, soft starts will be used. This will involve the implementation of lower hammer energies (i.e. approximately 15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.		✓	✓
Subject	This measure will minimise the risk of injury to fish species in the immediate vicinity of piling operations, allowing individuals to flee the area before noise levels reach a level at which injury may occur.			
Measure	Detonation of UXO using low order techniques.			
Subject	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to minimise noise levels and thereby injury and disturbance to fish and shellfish receptors.		✓	
Measure	Detonation of UXO using low order techniques.			
Subject	Low order techniques will be adopted where practicable. Given the small risk that a low order could unintentionally arise in high order detonation, the MMMP will also include secondary mitigation to reduce the risk of injury from UXO clearance. Measures such as visual and acoustic monitoring will be applied.			✓
Measure	Development of, and adherence to, an appropriate Code of Construction Practice (CoCP).			
Subject	These measures have been identified during the design of the offshore and intertidal elements of the Project as part of the EIA process. They include strategies, control measures and monitoring procedures for managing the potential environmental impacts of constructing the Project and limiting disturbance from construction activities as far as reasonably practicable.	✓	✓	✓
Measure	EMF Preparation and implementation of a Cable Plan (CAP), including a cable burial risk assessment (CBRA) to inform cable burial depth			
Subject	A CAP will be prepared prior to the construction phase and will include a detailed cable laying plan, including geotechnical data, cable laying techniques and a CBRA which will include details on target and minimum burial depths. While the sediments in which cables are buried burial of cables will not reduce the strength of EMF, the burial of cables it does increase the distance between cables and fish and shellfish IEFs, with greater attenuation of EMFs with greater distance from the cable, thereby potentially reducing the effect of EMFs on those IEFs.		✓	
Measure	An outline Marine Mammal Mitigation Protocol (MMMP) (volume 4, appendix 23 of the Offshore EIA Report) will be consulted on with NatureScot and/or MSS, approved by MS-LOT and implemented prior to construction, as described in volume 3, appendix 6.3. For the purpose of developing the MMMP, a mitigation zone will be defined based on the maximum predicted injury range from the dual metric noise modelling for any of the modelled scenarios (4,000 kJ for concurrent piling of wind turbines and, 4,000 kJ for single piling at wind turbine/OSP-Offshore convertor station platform) and across all marine mammal species. The MMMP will set out the designed in measures to apply in advance of and during piling activity.			✓
Subject	The implementation of an approved MMMP will mitigate for the risk of physical or permanent auditory injury to marine mammals within a 'mitigation zone'. The potential to mitigate for injury was considered with respect to the largest potential injury zone across all species (2,319 m based on predictions of injury for minke whale using the 4% reducing to 0.5% conversion factor). The use of an approved MMMP will also minimise the potential for collision risk, or potential injury to, marine mammals. Measures such as visual and acoustic monitoring will be applied.			
Measure	Implementation of piling soft start and ramp up measures. During piling operations, soft starts will be used. This will involve the implementation of lower hammer energies (i.e. approximately 15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.			
Subject	This measure will minimise the risk of injury to marine mammal and fish species in the immediate vicinity of piling operations, allowing individuals to flee the area before noise levels reach a level at which injury may occur. It is considered that compliance with these guidelines will, in most cases, reduce the risk of injury to marine mammals to negligible levels. More details about piling soft start and ramp up procedure are presented in MMMP (volume 4, appendix 23).			✓
Measure	A MMMP will also include geophysical surveys to ensure that appropriate measures are followed in line with JNCC guidance (JNCC, 2017).			
Subject	The measures outlined in JNCC guidelines (JNCC, 2017) are designed to reduce the risk of injury to marine mammals during geophysical survey activities.			✓

5 APPRAISAL OF POTENTIAL ADVERSE EFFECTS ON INTEGRITY: ANNEX I HABITATS

5.1 INTRODUCTION

65 The Screening exercise (at Stage One of the HRA process) as updated (see section 3) in response to consultation on the Berwick Bank Wind Farm Offshore HRA Screening Report (SSE Renewables, 2021b) (hereafter, the HRA Screening Report) identified LSEs (as defined in Part One of this RIAA) on the following European sites designated for Annex I habitat features (as summarised in Table 3.1 and illustrated in Figure 3.1):

- Berwickshire and North Northumberland Coast SAC.

66 This section explains the approach taken to assess the potential impacts of the Proposed Development on European sites designated for Annex I habitat features and presents the Stage Two assessments for the above site. Broadly, the potential effects on this site are as follows and are addressed explicitly in sections 5.2 to 5.4:

67 During the construction and decommissioning phases:

- **Increased suspended sediment concentrations and associated sediment deposition (offshore export cable only):** potential for adverse effects from sediment disturbance arising from offshore export cable installation, and seabed preparation works ahead of offshore export cable installation which may result in increases in SSCs and associated sediment deposition (i.e. smothering effects).

68 During the operation and maintenance phase:

- **Increased suspended sediment concentrations and associated sediment deposition (offshore export cable only):** potential for adverse effects from sediment disturbance arising from offshore export cable maintenance (i.e. cable reburial or replacement works) which may result in increases in SSCs and associated sediment deposition (i.e. smothering effects); and
- **Alteration of seabed habitats arising from effects of physical processes:** potential for the presence of foundation structures, associated scour protection and cable protection to introduce localised changes to the tidal flow and wave climate, resulting in potential changes to the sediment transport pathways and associated effects on Annex I habitats.

69 The Stage Two assessments (considering effects both alone and in-combination) for this site are presented in sections 5.2 to 5.4. Integrity matrices summarising the assessments for the site are provided in Table 9.1 in section 9. A summary of all Appropriate Assessments undertaken within this report is provided in the concluding section of this report (see section 8).

5.2 ASSESSMENT INFORMATION

5.2.1 MAXIMUM DESIGN SCENARIOS

70 The maximum design scenario relevant to Annex I habitat features are set out in Table 5.2, Table 5.4 and Table 5.5. An overview of the maximum design scenario for all receptor groups is provided in Table 4.1 in section 4 of this Part of the RIAA.

5.2.2 DESIGNED IN MEASURES

71 Designed in measures relevant to Annex I habitat features are set out in Table 5.3. An overview of the designed in measures for all receptor groups is provided in Table 4.2 in section 4 of this Part of the RIAA.

5.2.3 BASELINE INFORMATION

72 The key data sources are presented within volume 2, chapter 8 of the Offshore EIA Report and summarised below. In addition, the following information has informed the assessments:

- volume 3, appendix 8.1: Benthic Subtidal and Intertidal Ecology Technical Report;
- volume 2, chapter 7: Physical Processes; and
- volume 3, appendix 7.1: Physical Processes Technical Report.

73 Detailed European site information is presented in appendix A.

5.2.4 CONSERVATION OBJECTIVES

74 The Conservation objectives for the site designated for Annex I habitat features identified for Stage Two assessment are provided in section 5.5. Where Supplementary Advice to the conservation objectives, or site-specific conservation advice describes minimum targets for qualifying features in more detail, this detail is provided in appendix A and/or referenced within the relevant Stage Two Appropriate Assessments.

5.2.5 ANNEX I HABITAT ACCOUNTS

75 The following sections provide overview accounts of the Annex I habitat features of the Berwickshire and North Northumberland Coast SAC.

Mudflats and sandflats not covered by seawater at low tide

76 Intertidal mudflats and sandflats are submerged at high tide and exposed at low tide. They form a major component of the Annex I habitat - estuaries and large shallow inlets and bays - in the UK. The physical structure of the intertidal flats ranges from mobile, coarse-sand beaches on wave exposed coasts, to stable, fine-sediment mudflats in estuaries and other marine inlets.

77 Within the Berwickshire and North Northumberland Coast SAC, stretches of the English coastline support this Annex I habitat with a very extensive range of intertidal mudflats and sandflats, ranging from wave exposed beaches to sheltered muddy flats with rich infaunal communities. These have been selected as

biologically diverse and extensive examples of clean sandflats[5] on the east coast. Those in the Lindisfarne and Budle Bay area (to the south of the Proposed Development export cable corridor) and on the adjacent open coast flats north of Holy Island, are the most extensive in north-east England. The largest intertidal beds comprise narrow-leaved eelgrass *Zostera angustifolia* and dwarf eelgrass *Zostera noltii*, a diverse infauna, and some large beds of mussels *Mytilus edulis*. Some of the bays along the open coast have mobile sediments, with populations of sand-eels *Ammodytes sp*., small crustaceans and polychaete worms. These communities are important in supporting predator communities such as macrofauna, juvenile fish and overwintering and migrating wading birds. More sheltered sediments have very stable lower shore communities of burrowing heart-urchins *Echinocardium cordatum* and bivalve molluscs (English Nature and SNH, 2000).

Large shallow inlets and bays

78 Large shallow inlets and bays are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. These habitats include two of the Annex I habitats of the Berwickshire and North Northumberland Coast SAC (mudflats and sandflats not covered by sea water at low tide and reefs). Large shallow inlets and bays are large indentations of the coast, generally more sheltered from wave action than the open coast. They are relatively shallow (with water less than 30 m over most of the area), and in contrast to the Annex I habitat estuaries, generally have much lower freshwater influence.

79 Within the Berwickshire and North Northumberland Coast SAC, there are several characteristic, sediment-dominated embayments in north-east England. These areas are relatively exposed, uniform in nature and are characterised by crustacean/polychaete and bivalve/polychaete biotopes (English Nature and SNH, 2000).

Reefs

80 Reefs are rocky marine habitats or biological concretions that rise from the seabed. They are generally subtidal but may extend as an unbroken transition into the intertidal zone, where they are exposed at low tide. There are two main types of reefs, rocky reefs where animal and plant communities develop on rock or stable boulders and cobbles, and biogenic reefs where the reef structure is created by the animals themselves (JNCC, 2022[6]).

81 Within the Berwickshire and North Northumberland Coast SAC, moderately wave exposed rocky reef habitats occur throughout the site. Rocky reef communities are characterised by attached algae and invertebrates, usually associated with a range of mobile species such as fish and crustaceans. Factors which affect the biological composition and diversity of reef communities include the level of wave exposure, the degree of immersion by the tide and water movement. Water movement is particularly important for animal and plant communities on the reefs as it provides suspended food for filter feeders and limits the settlement of silt, which may lead to the clogging of gills and feeding organs of marine animals associated with reefs.

82 The subtidal rocky reefs and their rich marine communities, together with the wide variety of associated littoral reefs of this SAC, are the most diverse known on the North Sea coast. Their very varied nature is due to the wide range of physical conditions in the area, from wave-exposed locations on the open coast, through more sheltered reefs within bays, to those exposed to strong tidal streams in sounds and off headlands. As a consequence, reef habitats along the Berwickshire and North Northumberland Coast have a high diversity of communities and species (English Nature and SNH, 2000).

83 Along the Berwickshire and North Northumberland Coast, rock platforms extend offshore as a series of reefs and rocky plains. These platforms extend several kilometres out to sea as a series of underwater terraces. Although this part of the coast is exposed to the full fetch of the North Sea from the east or north-east, the wave action is rapidly attenuated on the more extensive wave cut, rocky platforms enabling a wide range of animal and plant communities to live in close proximity.

84 Sub-features of the Berwickshire and North Northumberland Coast SAC 'Reef' feature have been identified: rocky shore communities; kelp forest communities; and sublittoral faunal turf communities (English Nature and SNH, 2000). These sub-features are described further in paragraphs 85 to 91.

85 **Rocky shore communities** – the intertidal rocky reefs within the SAC support a diverse range of habitats. The majority of rocky shores within the SAC are gently sloping bedrock or boulder shores. The large extent of these shores results in reduced mid and upper shore areas, with dissipated wave action allowing the fucoids, typical of more wave sheltered shores, to maintain a firm attachment. Where sediments are adjacent to sheltered or moderately exposed rocky shores, sand deposited on the shore is often bound by the filaments of the red algae *Audouinella spp*. The more exposed shores, such as the coastline from Fast Castle Head to Eyemouth in south-east Scotland, tend to be animal dominated.

86 The shores associated with headlands such as St Abb's in south-east Scotland are mainly steep and subject to strong wave surge conditions. Here, the high splash zone is dominated by lichens. The upper and middle areas of these shores are typically covered by barnacles *Semibalanus balanoides* and mussels, or limpets *Patella vulgata*, amongst which grow short plants of the red algae *Mastocarpus stellatus* and *Ceramium spp*. On the lower parts of these shores, *S. balanoides* is replaced by *Balanus crenatus* with a greater density of red algae (English Nature and SNH, 2000).

87 Biotopes present within the Scottish section of the SAC closest to the Proposed Development (Fast Castle Head – Eyemouth) include: Rock with mussels and barnacles (MytB, Ala.Myt) and Rock with fucoids and barnacles (BPat.Sem, FvesB, Ldig.Ldig).

88 **Kelp forest communities** - much of the open coast within the SAC is fringed by dense kelp forest communities. Kelp species such as *Laminaria hyperborean*, which largely occur subtidally but may also occur in the sublittoral fringe, support a rich understorey of red algal turf and short epifaunal turf. Beyond this fringing area, reefs in over 10 m water depth, are characterised by urchin grazed kelp habitats, small crabs, squat lobsters and anemones such as *Urticina felina*. Turbidity of the water determines the depth at which kelp grow in the nearshore by limiting light penetration through the water for photosynthesis. St Abbs, in the south-east Scotland section of the SAC, is renowned for its good water clarity, where estimates of underwater visibility range from 2 to 20 m depending on weather and sea conditions. Kelp forests flourish to at least 8 m below chart datum, which a good indicator of a generally low water turbidity for the south-east of Scotland and north-east of England (SNH, English Nature 2000).

89 Biotopes present within the Scottish section of the SAC closest to the Proposed Development (Fast Castle Head – Eyemouth) include: Kelp forest with red algae (Lhyp.Ft). and Tide swept kelp with dense red algae (LhypR.Ft, LhypFa).

90 **Subtidal faunal turf communities** – where kelp and other algae communities are unable to establish due to lack of light, faunal turf communities tend to dominate the reefs, forming a species rich and structurally

[5] Clean sands occur particularly on open coast beaches and in bays UK where wave action or strong tidal currents prevent the deposition of finer silt (Intertidal mudflats and sandflats (Mudflats and sandflats not covered by seawater at low tide) - Special Areas of Conservation (jncc.gov.uk)

[6] Berwickshire and North Northumberland Coast - Special Areas of Conservation (jncc.gov.uk) and Reefs (Reefs) - Special Areas of Conservation (jncc.gov.uk)

and functionally important component of the reef ecosystem. This living turf comprises diverse assemblages of attached animals growing on subtidal substrate, ranging from, encrusting sea mats and sponges, to tall erect soft corals and sea fans. These communities also support prominent mobile species such as crustaceans, echinoderms, molluscs and fish. By definition, faunal turfs are dominated by animals although foliose and crustose red algae are present in the upper regions of this zone where it overlaps with the shallower infralittoral zone (SNH, English Nature 2000).

91 Biotopes present within the Scottish section of the SAC closest to the Proposed Development (Fast Castle Head – Eyemouth) include: Tide swept circalittoral rock with dense *Alcyonium digitatum* (AlcC); Tide swept circalittoral rock with dense *A. digitatum* and hydroid turf (AlcSec); Circalittoral rock with sparse *A. digitatum* and faunal turf (FaAlC); and Circalittoral rock with brittle stars and hydroids (Oph) (English Nature and SNH, 2000).

Submerged or partially submerged sea caves

92 Sea caves occur throughout the Berwickshire and North Northumberland Coast SAC in association with the Annex I reefs, in both the intertidal and the subtidal zones. Depending on the depth of the cave and its morphology, the site supports a range of distinct biological communities. These sub-features of the Berwickshire and North Northumberland Coast SAC 'submerged or partially submerged sea caves' feature are classified as either intertidal (partially submerged at some stage in the tidal cycle) or subtidal (submerged at all times). Each of these types of sea cave support a highly diverse assemblage of sea cave biotopes with characteristic zonation patterns.

93 **Intertidal sea cave communities** - Caves in the intertidal zone are frequently subject to conditions of strong wave surge and scour by coarse sediment. They are typically colonised by encrusting animal species but may also support shade-tolerant algae near their entrances and roofs. Intertidal sea caves are found throughout the SAC. An example in the SAC within south-east Scotland is the steep rocky shores between Fast Castle Head and the volcanic outcrop at St. Abb's head, where erosion of soft rock intrusions within volcanic layers has created a series of narrow gullies, many leading to caves.

94 **Subtidal sea cave communities** - Caves that occur in the subtidal area are continually submerged in water and are not exposed to the air at low tide. Subtidal sea caves, tunnels and arches are present in the volcanic rock around St Abb's head. Environmental conditions in these caves are not as harsh or extreme as in the intertidal sea caves and tend therefore to support a wider range of species. Subtidal sea caves are subject to less water movement from the surrounding sea than intertidal caves, and silt may accumulate on the cave floor. The sponges *Dercitus bucklandi* and *Thymosia guernei*, soft corals, solitary sea-squirts, bryozoans and sessile larvae of jellyfish are characteristic of deeper cave systems. Caves such as these provide an important source of shelter for crustaceans such as crabs and lobsters *Homarus gammarus*, and for a variety of reef-dwelling fish, such as the leopard-spotted goby *Thorogobius ephippiatus* (English Nature and SNH, 2000).

5.2.6 APPROACH TO THE IN-COMBINATION ASSESSMENTS

95 The nature of effects that have been assessed for each Annex I habitat, and the scale over which those effects may occur, are based on assessment criteria applied during the HRA Stage One Screening exercise as presented in Section 3.3. These effects are detailed within the Proposed Development alone assessment (see section 5.5) and have not been re-iterated here.

96 The overarching approach to the assessment of in-combination effects is set out in section 4.5 and is not reiterated here.

Relevant plans and projects

97 The plans and projects set out in Table 5.1have been considered within the in-combination assessment for European sites designated for Annex I habitat features.

98 The plans and projects included in this in-combination assessment for European sites designated for Annex I habitat features have been derived in part, from the Cumulative Effects Assessment (CEA) longlist presented in volume 3, appendix 6.4 of the Offshore EIA Report.

Table 5.1: List of Other Developments with Potential for In-combination Effects on Annex I Habitat Features

Developments	Status (i.e. Application, Consented, Under Construction, Operational)	Distance from Array Area (km)	Distance from Offshore Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development [e.g. Project Construction Phase Overlaps with Proposed Development Construction Phase]
Tier 1							
No Tier 1 projects identified within the benthic subtidal and intertidal ecology CEA study area. Due to the use of trenchless techniques in the intertidal zone there is no pathway for in-combination effects with the onshore infrastructure.							
Tier 2							
Offshore Wind Projects and Associated Cables							
Inch Cape Offshore Wind Farm – 15680	Consented	19.0	39.0	Up to 1,000 MW (up to 72 wind turbines)	2023-2025	2026 onwards	The construction and operational and maintenance phases of the Inch Cape Offshore Wind Farm overlaps with the construction and operation and maintenance phases of the Proposed Development.
Neart na Gaoithe Offshore Wind Farm – 66600019	Under construction	16.0	15.0	Up to 450 MW (up to 75 wind turbines)	2022-2023	2024 onwards	The operational phase of the Neart na Gaoithe Offshore Wind Farm overlap with the construction and operation and maintenance phases of the Proposed Development.
Seagreen 1 – 10762	Under construction	5.0	35.0	Up to 114 wind turbines with no capacity limit	2022-2023	2024 onwards	The operational phase of Seagreen 1 overlaps with the construction and operation and maintenance phases of the Proposed Development.
Seagreen 1A Project	Consented	5.0	36.0	Up to 36 wind turbines with no capacity limit	2023-2025	Q3 2025 onwards	The construction and operational phases of the Seagreen 1A Project overlaps with the construction and operation and maintenance phases of the Proposed Development.
Seagreen 1A Export Cable Corridor	Consented	6.0	28.0	A 110 km offshore export cable from Seagreen 1A Project to the landfall at Cockenzie	April 2023 – June 2024	July 2024 onwards	The operational phase of the Seagreen 1A Export Cable Corridor overlaps with the operation and maintenance phase of the Proposed Development.
Oil and Gas Activities							
No Oil and Gas Projects identified within the benthic subtidal and intertidal ecology cumulative effects study area.							
Aggregate Extraction							
No Aggregate Extraction Projects identified within the benthic subtidal and intertidal ecology cumulative effects study area.							
Disposal Sites							
Eyemouth – FO0080	Operational	35.0	17.0	Dredged material disposal site	N/A	Ongoing	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Coastal Protection/Infrastructure							
No Coastal Protection Projects identified within the benthic subtidal and intertidal ecology cumulative effects study area.							
Subsea Cables (Telecommunications and Interlinks) and Pipelines							
Eastern Link 1	Planning application submitted	28	2	Scotland England Green Link 1 - interconnector between Torness in Scotland and County Durham in England	2024 - 2027	2027 onwards	The construction and operational and maintenance phase of the Eastern Link 1 Project overlaps with the construction and operation and maintenance phases of the Proposed Development.
Eastern Link 2	Planning application submitted	14	21	Scotland England Green Link 2 - interconnector between Peterhead in Scotland and North Yorkshire in England	2025 - 2029	2029 onwards	The construction and operational and maintenance phase of the Eastern Link 2 overlaps with the construction and operation and maintenance phases of the Proposed Development.
Ministry of Defence sites							
No Ministry of Defence projects identified within the benthic subtidal and intertidal ecology cumulative effects study area.							

Developments	Status (i.e. Application, Consented, Under Construction, Operational)	Distance from Array Area (km)	Distance from Offshore Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development [e.g. Project Construction Phase Overlaps with Proposed Development Construction Phase]
Tier 3							
Subsea Cables (Telecommunications and Interlinks) and Pipelines							
Cambois connection	Pre-planning Application	n/a	n/a	Alternative offshore export cable	Q1 2028 – Q4 2031	Q4 2031	The construction and operation and maintenance phases of the Cambois connection overlap with the construction and operation and maintenance phases of the Proposed Development.
Shipping and Navigation							
Eyemouth - Pontoon	Application	34.1	15	Floating Pontoon to serve Neart na Gaoithe maintenance facility	2022	2022 onwards	Project operational phase overlaps with Proposed Development construction and operation and maintenance phases.
Tier 4							
ScotWind	Lease offer	Unknown	Unknown	17 offshore wind projects with combined capacity of 24.8 GW	Unknown	Unknown	Screened out. There is currently insufficient data to make a fair and robust assessment of any overlap and therefore cumulative effects associated with the ScotWind proposals have been screened out.

5.3 CONSTRUCTION AND DECOMMISSIONING

5.3.1 INCREASED SUSPENDED SEDIMENT CONCENTRATIONS AND ASSOCIATED SEDIMENT DEPOSITION

99 Temporary increases in SSC and associated sediment deposition are predicted to occur during the construction and decommissioning phases of the Proposed Development as a result of the installation/removal of foundations, seabed preparation (i.e. sand wave and boulder clearance)and as a result of the installation of array, OSP/Offshore convertor station platform interconnector, and offshore export cables. Seabed preparation activities (e.g. sand wave and boulder clearance) will occur in advance of installation of offshore cables and dredged material will be disposed of within the Proposed Development array area and Proposed Development export cable corridor (see section 4 in Part One of the RIAA for further details regarding seabed preparation activities).

100 These activities may result in temporary changes to water clarity, smothering and siltation rates (see paragraph 115 *et seq.* for further detail*)*.

101 The assessment of LSE during the HRA Stage 1 Screening process identified that during construction and decommissioning phases, LSE could not be ruled out for the potential impact of increased SSC and associated sediment deposition. This relates to the following designated site and relevant Annex I habitat features:

- Berwickshire and North Northumberland Coast SAC:
  - mudflats and sandflats not covered by seawater at low tide;
  - large shallow inlets and bays;
  - reefs; and
  - submerged or partially submerged sea caves.

102 The HRA Stage 1 Screening determined that this applies to the Proposed Development export cable corridor only which is, at its closest point, located 4.1 km from the SAC. The Proposed Development array area is at its closest point 34.69 km from this SAC which is beyond the ZoI predicted for increased SSC and associated sediment deposition (predicted precautionarily to be 20 km during LSE screening and refined to 10 km following modelling undertaken to inform this assessment, see paragraph 110 for further detail regarding deposition).

103 The impact is predicted to be of local spatial extent, short term duration, intermittent and medium reversibility.

104 The following sections explain how this potential impact on Annex I habitat features of the Berwickshire and North Northumberland Coast SAC has been quantified and assessed.

Maximum design scenario relevant to the assessment of adverse effects on integrity

105 The maximum design scenario considered for the assessment of potential impacts on Annex I habitat features from increased SSC and associated sediment deposition during construction and decommissioning is presented in Table 5.2.

Table 5.2: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex I Habitat Features from Increased SSC and Associated Sediment Deposition during Construction and Decommissioning

Potential Impact	Maximum Design Scenario	Justification
Increased SSC and Associated Sediment Deposition during Construction and Decommissioning	**Construction Phase** Seabed preparation: • boulder and sand wave clearance; • sand waves may be cleared to a width of 25 m, average height 5 m and clearance along circa 20% of offshore export cables corridor length (174.4 km); and • modelling and assessment assumed a dredge and disposal technique is used to redistribute material within the Proposed Development application boundary. Cable installation: • offshore export cables length up to 872 km; • buried offshore export cables length up to 828.4 km; • installation using jet trenching which mobilises material from a depth of up to 3 m deep in a trench of up to 2 m width; • modelling assumes that the Proposed Development export cable corridor extends over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column); and • Offshore export cable installation at the landfall via trenchless techniques. **Decommissioning Phase** • decommissioning of offshore export cables: • offshore export cable length up to 872 km; and • decommissioning using jet trenching which mobilises material from an up to 3 m deep and 2 m wide trench.	Greatest volume of sediment released into the water column. Seabed preparation - site clearance activities may be undertaken using a range of techniques, the suction hopper dredging has the potential to cause the greatest increase in suspended sediment and largest plume extent as material is released near the water surface and has therefore been considered as the maximum design scenario. Cable installation - cable routes include a variety of seabed material and in some areas 3 m depth may not be achieved or may be of a coarser nature which settles in the vicinity of the cable route therefore the assessment provides the upper bound in terms of suspended sediment and dispersion potential. Ploughing (and to a certain extent jetting) moves material rather than bringing it fully into suspension therefore the assumption that the seabed is fluidised presents the maximum design scenario. Physical Processes modelling of the Offshore export cable trenching assumes sediment release along the Proposed Development export cable corridor to the nearshore point at which a continuous rock outcrop is encountered Decommissioning – maximum design scenario assumes complete removal of all infrastructure, including cables and cable protection where it is possible and appropriate to do so. If any infrastructure is left in situ this will result in a reduced levels of suspended sediment and associated deposition during decommissioning.

Designed in measures relevant to the assessment of adverse effects on integrity

106 Designed in measures (and the associated commitments) which are of relevance to the assessment of potential impacts on Annex I habitat features from increased SSC and associated sediment deposition during construction and decommissioning are presented in Table 5.3.

Table 5.3: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex I Habitat Features from Increased SSC and Associated Sediment Deposition

Effect/Impact Pathway	Detail of Measure	Justification
Increased SSC and sediment deposition	Development of, and adherence to, a Decommissioning Plan	The aim of this plan is to adhere to the existing UK and international legislation and guidance relating to decommissioning. Overall, this will ensure the legacy of the Proposed Development will reduce the amount of long-term disturbance to the environment as far as reasonably practicable.

Information to inform Appropriate Assessment

107 The Appropriate Assessments for European sites for Annex I habitats are presented in section 5.5. Information common to inform the Appropriate Assessments in presented in this section.

108 The installation of the Proposed Development offshore export cables, and any seabed preparation works required prior to the installation of the offshore export cables, will disturb seabed sediments. This is predicted to lead to elevated levels of suspended sediments, above background levels, and sediment deposition as the material resettles back to the seabed, which may smother benthic habitats and species. Site specific benthic grab surveys showed that the sediments within the offshore section of the Proposed Development export cable corridor are characterised by muddy sand sediments which grade into slightly gravelly muddy sand, and rocky habitats with increasing proximity to the landfall. The sample stations with the highest percentage composition of mud are generally found along the inshore section of the Proposed Development export cable corridor.

109 Full details of the physical processes modelling undertaken to determine the fate of disturbed sediments along the Proposed Development export cable corridor, which has been used to inform this assessment, are presented in volume 3, appendix 7.1 of the Offshore EIA Report. This includes the individual scenarios considered and assumptions within these, and full modelling outputs for suspended sediments and associated sediment deposition. For the purposes of this assessment, the following activities have been considered:

- seabed feature clearance prior to offshore export cables installation; and
- installation of offshore export cables.

110 Sand wave clearance for the installation of offshore export cables will involve disturbance of seabed material within a corridor of up to 25 m in width for 20% of offshore export cables where it may be necessary. Modelling of suspended sediments associated with site preparation activities showed that during the dredging phase the suspended sediment plume is very small with concentrations <100 mg/l. Suspended sediment concentration is predicted to reach its peak in the disposal phase with concentrations reaching 2,500 mg/l at the release site, but the plume is predicted to be at its most extensive when the deposited material is redistributed on successive tides. Under these circumstances, concentrations of 100 mg/l to 250 mg/l are predicted with average values <100 mg/l extending up to 10 km, corresponding with a tidal excursion. Sedimentation of deposited material is focussed within 100 m of the site of release with a maximum depth 0.5 m to 0.75 m whilst the finer sediment fractions are distributed in the vicinity at much smaller depths circa 5 mm to 10 mm over a maximum distance of 10 km from the site of activity. Sedimentation one day following cessation of operation is similar to during sand wave clearance operations with a small extension to the area over which sedimentation has occurred but with no increase in maximum sedimentation depth. The dispersal of the deposited material would continue on successive tides and be incorporated into the baseline sediment transport regime.

111 For the installation of offshore export cables, the modelling outputs predicted average SSCs of up to 500 mg/l at the source whilst more generally the suspended sediment plume is predicted to be one tenth of this value, typically <50 mg/l and extending north and south on the tide. Suspended sediment concentrations are predicted to reduce to background levels on slack tides. Average sedimentation is predicted to be small and typically <1 mm during the works and up to 30 mm one day after cessation of operations. Sedimentation at the coastline is typically <3 mm.

112 Impacts of increased SSC and associated sediment deposition during construction and decommissioning are predicted to be negligible within the Berwickshire and North Northumberland Coast SAC given most sediment deposition will be localised, focussed within the Proposed Development export cable corridor and any fine sediment fractions such as silt and clay (hereafter referred to as fines) reaching the coast within the SAC are predicted to be <3 mm in thickness. The maximum distance the fines could travel within the Berwickshire and North Northumberland Coast SAC from the Proposed Development export cable corridor based on the modelled 10 km ZoI, is St Abb's Head, Scotland.

113 Increases in SSC and sediment deposition during the construction and decommissioning phases are predicted to be of local spatial extent, short term duration, intermittent, reversible, and of overall negligible magnitude.

114 The Marine Evidence-based Sensitivity Assessment (MarESA) and the Feature Activity Sensitivity Tool (FeAST) have been drawn upon to support the assessment of sensitivity of the Annex I habitats within the Berwickshire and North Northumberland Coast SAC as detailed in the following sections.

Mudflats and sandflats not covered by seawater at low tide

115 On the basis of the mapped distribution of designated habitat features of the Berwickshire and North Northumberland Coast SAC, the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature are concentrated in the English part of the SAC, and small patches of the feature in the Scottish part of the SAC are approximately 12 km from the Proposed Development export cable corridor. This feature is therefore located beyond the limit of the predicted maximum extent (10 km) of increased SSC and deposition arising from the installation of offshore export cables and associated sand wave clearance activities. Considering the project specific physical processes modelling outputs, there is no pathway to effect on the Annex I habitat mudflats and sandflats not covered by seawater at low tide feature as a result of increased SSC and sediment deposition.

Large shallow inlets and bays

116 As discussed in section 5.2.5, large shallow inlets and bays are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats.

117 Large shallow inlets and bays do not have any specific biotopes associated with it, although the feature consists of the following sub-features: intertidal sand and muddy sand; subtidal coarse sediment; subtidal sand; subtidal mud, subtidal mixed sediment, and saltmarsh habitat. On the basis of the mapped distribution of designated habitat features of the Berwickshire and North Northumberland Coast SAC, the qualifying Annex I large shallow inlets and bays feature are concentrated in the English part of the SAC, approximately 38 km from the Proposed Development export cable corridor. This feature is therefore located beyond the limit of the predicted maximum extent (10 km) of increased SSC and deposition arising from the installation of offshore export cables and associated sand wave clearance activities. Considering the project specific physical processes modelling outputs, there is no pathway to effect on the Annex I large shallow inlets and bays feature as a result of increased SSC and sediment deposition.

Reefs

118 According to the mapped distribution of designated habitat features of the Berwickshire and North Northumberland Coast SAC, the qualifying Annex I reef feature are distributed extensively throughout the SAC, including in the Scottish section of the SAC, and are within the ZoI of increased SSC from the Proposed Development offshore export cable works. As discussed in section 5.2.5, subtidal reefs within the Berwickshire and North Northumberland Coast SAC include the sub-features kelp forest communities and subtidal faunal turf communities. These sub-features of the reef habitat are moderately sensitive to smothering. Siltation can clog or block the feeding/respiratory organs of animals, which can lead to the death of individual organisms and potentially damage the community. Increased water turbidity influences the ability of kelp and other algal species to photosynthesise. Activities which result in a reduction in water clarity may have a detrimental effect on their physiological functioning which in turn may affect the growth and survival of kelp forest. Deposition of silt can also cover available substrate which interferes with the process of spore attachment. Young sporelings, or holdfasts which contain a diverse range of microniches for colonisation, are also sensitive to being covered by silt, which can inhibit their growth and development. Extensive physical damage may therefore lead to loss of habitat (English Nature and SNH, 2000). The MarESA also identifies that the biotopes which represent the subtidal reef feature habitats are of medium sensitivity to smothering and siltation rate change and water quality changes due to the inability of organisms to feed until the sediment is dispersed.

119 Most intertidal communities tend to be more resilient to physical change than subtidal communities because of their adaptation to the natural physical processes to which they are subjected. These harsh conditions generally result in a rapid recolonisation and re-growth of communities.

120 Species such as *Fucus serratus* within the biotope *Fucus serratus* and red seaweeds on moderately exposed lower eulittoral rock (LR.MLR.BF.Fser.R), may experience adverse effects from the loss of light associated with reduced water clarity and smothering (d'Avack and Tyler-Walter, 2015). Similarly, in areas of reduced water clarity, *Laminaria* species may experience significant decrease in growth from the shading of suspended matter and/or phytoplankton (Lyngby and Mortensen, 1996; Spilmont *et al*., 2009). Biotopes such as *Fucus vesiculosus* on mid eulittoral mixed substrata (LR.LLR.F.Fves.X) have a medium sensitivity to changes in water clarity and smothering as these effects reduce the ability of *F.vesiculosus* to photosynthesise reducing its growth potential however they are likely to rapidly regain photosynthetic capabilities following the return of light levels to the baseline conditions (Perry, d'Avack and Budd, 2015). This level of recovery extends to short periods of smothering; however, spores and juvenile individuals will be more likely to experience mortality (Perry, d'Avack and Budd, 2015). The smothering of algal turf will reduce grazing by littorinids which characterise the Coralline crusts and *Corallina officinalis* in shallow eulittoral rockpools (LR.FLR.Rkp.Cor.Cor) biotope, however sediments are likely to be removed rapidly as a result of wave action (Tillin and Budd, 2018).

121 Reefs are deemed to be of medium vulnerability, medium recoverability and overall, the sensitivity is considered to be medium.

Submerged or partially submerged sea caves

122 According to the mapped distribution of designated habitat features of the Berwickshire and North Northumberland Coast SAC, the qualifying Annex I submerged or partially submerged sea caves feature are distributed throughout the SAC, including in the Scottish section of the SAC, and are within the ZoI of increased SSC from the Proposed Development offshore export cable works. The sensitivity of the communities associated with submerged or partially submerged sea caves ranges from not sensitive to medium according to the MarESA. Whilst the upper, vertical walls of caves are unlikely to be subject to any smothering or affected by increased SSC, the inner reaches of caves with shallow slopes or horizontal ledges have the potential to be. The effect could result in reductions in suspension feeding by characteristic species whilst some species, such as encrusting sponges, prefer these conditions and will not experience adverse effects in these conditions over short periods. The wave exposed conditions experienced by biotopes typical of sea caves are also likely to result in any settled sediment being removed quickly.

123 Submerged or partially submerged sea caves are deemed to be of medium vulnerability, medium recoverability and overall, medium sensitivity.

5.4 OPERATION AND MAINTENANCE

5.4.1 INCREASED SUSPENDED SEDIMENT CONCENTRATIONS AND ASSOCIATED SEDIMENT DEPOSITION

124 Maintenance activities associated with the offshore export cables (e.g. cable repair and/or reburial) may lead to increases in SSCs and associated sediment deposition over the operational lifetime of the Proposed Development. These changes may result in temporary changes to water clarity, smothering and siltation rate changes.

125 The assessment of LSE during the HRA Stage 1 Screening process identified that during operation and maintenance, LSE could not be ruled out for the potential impact of increased SSC and associated sediment deposition. This relates to the following designated site and relevant Annex I habitat features:

- Berwickshire and North Northumberland Coast SAC:
  - mudflats and sandflats not covered by seawater at low tide;
  - large shallow inlets and bays;
  - reefs; and
  - submerged or partially submerged sea caves.

126 The HRA Stage 1 Screening determined that this applies to the Proposed Development export cable corridor only, which is at its closest point 4.1 km from the SAC. The Proposed Development array is at its closest point 34.69 km from this SAC which is beyond the ZoI predicted for increased SSC and associated sediment deposition (predicted precautionarily to be 20 km during LSE screening and refined to 10 km following modelling undertaken to inform this assessment; see paragraph 110).

127 The impact is predicted to be of local spatial extent, short term duration, intermittent and have medium reversibility.

128 Paragraphs 129 to 139 explain how the impacts of the Proposed Development on Annex I habitat features during operation and maintenance have been quantified and assessed.

Maximum Design Scenario Relevant to the Assessment of Adverse Effects on Integrity

129 The maximum design scenario considered for the assessment of potential impacts on Annex I habitat features from increases in SSC and sediment deposition during operation and maintenance are set out in Table 5.4.

Table 5.4: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex I Habitat Features from Increases in SSC and Sediment Deposition during Operation and Maintenance

Potential Impact	Maximum Design Scenario	Justification
Increased SSC and Associated Sediment Deposition during Operation and Maintenance	Up to four offshore export cable repair events over 35-year lifetime each affecting up to 1 km of cable (i.e. 4 km of repair events over lifetime). Up to four offshore export cable reburial events over 35-year lifetime each affecting up to 1 km of cable (i.e. 4 km of reburial events over lifetime). Width of disturbance per offshore export cable repair/reburial event of 15 m.	Maximum design scenario for sediment disturbance and therefore increases in SSC and sediment deposition during operation and maintenance phase.

Designed in measures relevant to the assessment of adverse effects on integrity

130 There are no designed in measures which are of relevance to the assessment of potential impacts on Annex I habitat features from increases in SSC and sediment deposition during the operation and maintenance phase.

Information to inform Appropriate Assessment

131 The Appropriate Assessments for European sites for Annex I habitats are presented in section 5.5. Information common to inform the Appropriate Assessments in presented in this section.

132 Maintenance activities within the Proposed Development benthic subtidal and intertidal Proposed Development export cable corridor may lead to increases in SSCs and associated sediment deposition over the operational lifetime of the Proposed Development. The maximum design scenario for offshore export cables is for cable repair of up to 4,000 m and reburial of up to 4,000 m of offshore export cables over the Proposed Developments lifetime (35 years), using similar methods as those for cable installation activities.

133 The length of cable affected during each repair or reburial event would be approximately 1 km, which is approximately 0.4% of the length of cable assessed for the construction phase. Repair/reburial events would be undertaken intermittently over the Proposed Developments lifetime. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired however the impacts of the operation and maintenance activities (i.e. cable repair and reburial) are predicted to be no greater than those detailed for construction (which considered the entire length of offshore export cable) and, in reality, substantially smaller due to the reduced scale.

134 Impacts of increased SSC and associated sediment deposition during the operation and maintenance phase, are predicted to be negligible within the Berwickshire and North Northumberland Coast SAC given most sediment deposition will be localised, focussed within the Proposed Development export cable corridor and any fines reaching the coast within the SAC are predicted to be < 3 mm in thickness. The maximum distance that the modelling outlined in paragraph 110 predicted fines could travel from the Proposed Development export cable corridor, was 10 km.

135 Increases in SSC and sediment deposition during the operation and maintenance phase are predicted to be of local spatial extent, short term duration, intermittent, reversible, and of overall negligible magnitude.

Mudflats and sandflats not covered by seawater at low tide

136 As outlined in paragraph 115, the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature of the Berwickshire and North Northumberland Coast SAC are concentrated in the English part of the SAC, approximately 12 km from the Proposed Development export cable corridor. This feature is therefore located out with the predicted ZoI of increased SSC and sediment deposition arising from cable repair activities. There is, therefore, considered to be no pathway to effect on the Annex I habitat mudflats and sandflats not covered by seawater at low tide feature as a result of increased SSC and sediment deposition.

Large shallow inlets and bays

137 As outlined in paragraph 117, the qualifying Annex I habitat large shallow inlets and bays feature of the Berwickshire and North Northumberland Coast SAC are concentrated in the English part of the SAC, approximately 38 km from the Proposed Development export cable corridor. This feature is therefore located out with the predicted ZoI of increased SSC and sediment deposition arising from cable repair activities. There is, therefore, considered to be no pathway to effect on the Annex I habitat mudflats and sandflats not covered by seawater at low tide feature as a result of increased SSC and sediment deposition.

Reefs

138 The sensitivity of reefs to increased SSC and sediment deposition is as described previously for the construction phase assessment in section 5.3.1 which assessed them to be of medium vulnerability, medium recoverability and therefore overall, medium sensitivity.

Submerged or partially submerged sea caves

139 The sensitivity of submerged or partially submerged sea caves to increased SSC and sediment deposition is as described previously for the construction phase assessment in section 5.3.1 which assessed them to be of medium vulnerability, medium recoverability and therefore overall, medium sensitivity.

5.4.2 ALTERATION OF SEABED HABITATS ARISING FROM EFFECTS OF PHYSICAL PROCESSES

140 Alteration of seabed habitats may arise from the effects of changes to physical processes, including scour effects and changes in the sediment transport and wave regimes resulting in potential effects on benthic receptors and Annex I habitats.

141 The presence of foundation structures, associated scour protection and cable protection may introduce localised changes to the tidal flow and wave climate, resulting in potential changes to the sediment transport pathways and long-term effects on benthic ecology for the lifetime of the Proposed Development.

Volume 3, appendix 7.1 of the Offshore EIA Report provides a full description of the modelling used to inform this assessment.

142 The assessment of LSE during the HRA Stage 1 Screening process identified that during the operation and maintenance phase, LSE could not be ruled out for the potential impact of alteration of seabed habitats arising from effects of physical processes. This relates to the following designated site and relevant Annex I habitat features:

- Berwickshire and North Northumberland Coast SAC:
  - mudflats and sandflats not covered by seawater at low tide;
  - large shallow inlets and bays;
  - reefs; and
  - submerged or partially submerged sea caves.

143 The impact is predicted to be of long-term duration and continuous, but of local spatial extent, with high reversibility.

144 The following sections explain how the impacts of the Proposed Development on Annex I habitat features have been quantified and assessed.

Maximum design scenario relevant to the assessment of adverse effects on integrity

145 The maximum design scenario considered for the assessment of potential impacts on Annex I habitat features from changes in physical processes are set out in Table 5.5.

Table 5.5: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex I Habitat Features from Changes in Physical Processes

Potential Impact	Maximum Design Scenario	Justification
Alteration of seabed habitats arising from effects of physical processes	Wind turbines: • 179 wind turbines with 20 m diameter suction caisson jacket foundations with a total footprint (including scour protection) of 12,240 m^2 per foundation, with scour protection 2 m in height; and • 179 structures with four legs per foundation (i.e. 716 legs in total) with 5 m diameter spaced 60 m apart at the seabed were included through the water column to model associated influence on wave climate and tidal currents. OSPs/Offshore convertor station platforms: • eight OSPs/Offshore convertor station platforms each with 6 jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 6,206 m^2 footprint per unit (including scour protection). Six legs of 4 m diameter spaced 40 m apart at the seabed; and • two OSP/Offshore convertor station platforms each with eight jacket legs comprising suction caissons of 15 m in diameter with associated scour protection of 60 m diameter and a height of 2 m giving rise to 12,559 m^2 footprint per unit (including scour protection). Eight legs of 5 m diameter spaced 80 m apart at the seabed. Cable protection • Cable protection along 15% of the inter-array cabling, OSP/Offshore convertor station platform interconnector cables and offshore Proposed Development export cable corridor, of up to 3 m in height and 20 m width; and • Up to 78 inter-array cable crossings 3.5 m in height, 21 m wide and 30 m in length and up to 16 offshore export cable crossings 3.5 m in height, 21 m wide and 40 m in length.	Provides the largest obstruction to flow in the water column. This is aligned with caisson foundations which represent a greater area of influence than piled jacket foundations.

Designed in measures relevant to the assessment of adverse effects on integrity

146 There are no designed in measures which are of relevance to the assessment of potential impacts on Annex I habitat features from changes in physical processes during the operation and maintenance phase.

Information to inform Appropriate Assessments

147 The Appropriate Assessments for European sites for Annex I habitats are presented in section 5.5. Information common to inform the Appropriate Assessments in presented in this section.

148 The presence of the Proposed Development infrastructure will obstruct tidal flow and alter the wave climate within the benthic subtidal and intertidal ecology study area. Tidal flow is predicted to accelerate in the immediate vicinity of each structure as it is redirected around the foundation and there may be a zone of reduced speed in the lee of the structure. During peak current speed the flow is redirected in the immediate vicinity of the structures and cable protection at the south of the site. The variation is a maximum of 1 cm/s which constitutes less than 2% of the peak flows within 200 m of the structure and reduces significantly with increased distance from each structure. These changes would also be largely limited to the immediate vicinity of the foundations and only extend a small distance beyond the southern and western boundaries of the Proposed Development array area. The limited nature of these changes would not influence the hydrodynamic regime. The modelling presented in volume 3, appendix 7.1 of the Offshore EIA Report demonstrates that tidal flows will not be affected in the nearshore.

149 Modelling of the predicted changes to wave climate for a one in one-year storm found the changes will be reductions in the lee of the site and increases where the waves are deflected by the structures. These changes are in the order of 2 cm which represents less than 1% of the baseline significant wave height. For the more severe 1 in 20-year storm event, the changes are predicted to follow the same pattern with decreases in the lee of benthic subtidal and intertidal ecology study area and increases either side. However, the changes are not significantly increased from the more frequent return period scenario and in the order of 2 cm to 4 cm whereas the baseline wave heights are increased for the greater return period events giving rise to a less marked overall impact on wave climate.

150 Sediment transport is driven by a combination of tidal currents and wave conditions, the magnitude of these has been individually quantified as described in paragraphs 148 and 149. For a one in one year storm from 000° during the flood tide the wave climate is in concert with tidal flow reducing the tidal flow on the lee side of the structure further. However, during the ebb flow, the wave climate and tidal flow are in opposition, reducing the magnitude of the littoral current. With the presence of infrastructure, wave climate causes a small reduction in the magnitude of flow whilst there is little difference between the magnitude of littoral current flow and the tidal flows. Changes in magnitude compared to baseline current flow are ±5% (volume 3, appendix 7.1 of the Offshore EIA Report) which would not be sufficient to disrupt beach and offshore bank morphological processes or destabilise coastal features.

151 Residual currents are effectively the driver of sediment transport and therefore any changes to residual currents would have a direct impact on sediment transport which would persist for the lifecycle of the Proposed Development. However, if the presence of the foundation structures does not have a significant influence on either tide or wave conditions (see paragraphs 148 to 150 above for changes in tidal currents and changes to wave climate and littoral current) they cannot therefore have a significant influence on the sediment transport regime. For completeness, the residual current and sediment transport was simulated with the foundations in place. The maximum change in residual current and sediment transport is predicted to be approximately ±15% within close proximity to the structures (less than 300 m elongated in the direction of principal tidal currents). Changes in the residual current and sediment transport reduce with increasing distance from the wind turbines towards baseline levels.

152 Changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are not predicted to extend to the Berwickshire and North Northumberland Coast SAC.

153 The modelling presented in volume 3, appendix 7.1 of the Offshore EIA Report demonstrates that tidal flows will not be affected in the nearshore. For some wave climates (predominately storms approaching from the northerly sectors), there is predicted to be a very small change at the coast, but these are for specific storm directions and would be imperceptible from natural variation. The combination of the two (littoral currents) and thus the impact on sediment transport is also not predicted to give rise to any discernible change in physical processes at the coast and, therefore, within the Berwickshire and North Northumberland Coast SAC.

154 The impact is predicted to be of long-term duration and continuous, but of local spatial extent with high reversibility and overall negligible magnitude.

Mudflats and sandflats not covered by seawater at low tide

155 The FeAST assesses the sensitivity of mudflats and sandflats not covered by seawater at low tide to changes in tidal currents and wave exposure to be low. The MarESA finds that the sensitivity ranges from not sensitive to medium sensitivity. Increases in changes in tidal currents and wave exposure can lead to physical damage and reduction in suspension feeding, as well as potential shifts in sediment and community characteristics over extended periods. Whereas a reduction in flow from tides can result in the clogging of suspension and deposit feeders feeding apparatus. The MarESA finds that for both pressures, biotopes with organisms such as *Z. nolteii* and *M. edulis* are the most sensitive as changes to currents and wave exposure can impact feeding as well as their distribution due to species differing levels of tolerance.

156 Mudflats and sandflats not covered by seawater at low tide are deemed to be of medium vulnerability, medium recoverability and therefore overall, medium sensitivity to this pressure.

Large shallow inlets and bays

157 As discussed in section 5.2.5, large shallow inlets and bays are habitat complexes which comprise an interdependent mosaic of subtidal and intertidal habitats. The habitat - large shallow inlets and bays - does not have any specific biotopes associated with it, although the feature consists of the following sub-features: intertidal sand and muddy sand; subtidal coarse sediment; subtidal sand; subtidal mud, subtidal mixed sediment and saltmarsh habitat. The sensitivity of the component habitats is therefore likely to be similar to the equivalent biotopes. The FeAST determines equivalent biotopes to be not sensitive to tidal current and wave exposure changes.

158 Large shallow inlets and bays are deemed to be of low vulnerability, high recoverability and therefore overall, negligible sensitivity to this pressure.

Reefs

159 As discussed in section 5.2.5, subtidal reefs within the Berwickshire and North Northumberland Coast SAC include the sub-features kelp forest communities and subtidal faunal turf communities.

160 Kelp forest communities fringe the open coast within the SAC and are characterised by kelp species such as *Laminaria hyperborean* which support an understorey of red algal turf and short epifaunal turf. Beyond this fringing area, reefs in over 10 m water depth, are characterised by urchin grazed kelp habitats, small crabs, squat lobsters and anemones such as *Urticina felina*. Subtidal faunal turf communities are present beyond the kelp communities where, due to lack of light, this living turf comprises diverse assemblages of attached animals growing on subtidal substrate including encrusting sea mats and sponges, tall erect soft corals and sea fans. The MarESA identifies that the biotopes which represent these subtidal reef habitats are not sensitive to changes in local water flow from tidal currents or local wave exposure changes.

161 Intertidal reefs within the Berwickshire and North Northumberland Coast SAC includes the sub-feature rocky shore communities. The majority of rocky shores within the SAC are gently sloping bedrock or boulder shores, and within the stretch of coastline from Fast Castle Head to Eyemouth in south-east Scotland, tend to be animal dominated. The MarESA identifies that the biotopes which represent the intertidal reef range from not sensitive (rock with fucoids and barnacles) to being of medium sensitivity (rock with mussels and barnacles) to changes in local water flow from tidal currents but are not sensitive to local wave exposure changes.

162 Reefs are deemed to be of medium vulnerability, medium recoverability and therefore overall medium sensitivity.

Submerged or partially submerged sea caves

163 MarESA assesses the sensitivity of all the biotopes representative of the habitats of submerged or partially submerged sea caves to be not sensitive tidal current and wave exposure changes.

164 Intertidal sea cave communities which occur above the low water mark are subject to varying degrees of tidal inundation and splash from waves. The communities within these caves tend to be dominated by

species which are tolerant of high energy water movement and exposure to the air and therefore not sensitive to tidal current and wave exposure changes.

165 Subtidal sea cave communities which occur in the subtidal are continually submerged in water and are not exposed to the air at low tide. Conditions in these caves, are not as harsh or extreme as in intertidal sea caves and are subject to less water movement from the surrounding sea. Subtidal sea caves are not sensitive to tidal current change and wave exposure change which may be attributed to the sheltered nature of subtidal sea caves.

166 Submerged or partially submerged sea caves are deemed to be of negligible sensitivity.

5.5 INFORMATION TO INFORM ASSESSMENT OF ADVERSE EFFECTS ON INTEGRITY

5.5.1 BERWICKSHIRE AND NORTH NORTHUMBERLAND COAST SAC

European Site information

167 The Berwickshire and North Northumberland Coast SAC extends from Alnmouth in north-east England to north of St Abbs head in Scotland and is located 34.69 km from the Proposed Development array area and 4.14 km from the Proposed Development export cable corridor. The site contains a complex mix of marine habitats, associated species and communities which is unusually diverse for the North Sea. The SAC is designated for the following Annex I habitats: large shallow inlets and bays; mudflats and sandflats not covered by seawater at low tide; reefs; and submerged or partially submerged sea caves.

168 A feature condition assessment was undertaken in 2014 and submerged or partially submerged sea caves were assessed as "favourable maintained[7]". The condition of the SAC's other Annex I features has not been assessed at the time of writing.

169 Further information on this European site is presented in appendix A.

Conservation objectives

170 The conservation objectives for the Berwickshire and North Northumberland Coast SAC have been developed by Natural England and NatureScot and apply to the site and the individual species and/or assemblage of species for which the site has been classified. These high-level objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its Qualifying Features, by maintaining or restoring:

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

171 Supplementary advice on conservation objectives, last updated by Natural England and NatureScot on 13 March 2020, provide the site-specific attributes and targets specific to the Annex I habitat features of the site.

172 The attribute targets show that the current objective is to 'maintain' the attributes for each Annex I feature. These supplementary attributes and targets are considered in the assessments below and are provided for reference in appendix A.

Features and effects for assessment

173 Table 5.6 summarises the LSEs that were identified for the Annex I habitat features of the Berwickshire and North Northumberland Coast SAC and the features and effects which have been considered in the assessment of adverse effects on Integrity for this site. Table 5.6 also takes account of the project specific assessment information presented in sections 7.1 and 5.4 and where modelling has demonstrated no pathway to effect for particular features.

Table 5.6: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the Berwickshire and North Northumberland Coast SAC

Annex I Habitat Feature	Increased SSC and Sediment Deposition	Alteration of Seabed Habitats Arising from Effects of Physical Processes
Mudflats and sandflats not covered by seawater at low tide	× Project specific modelling has demonstrated no pathway to effect for this feature.	✓ Operation and maintenance phase
Large shallow inlets and bays	× Project specific modelling has demonstrated no pathway to effect for this feature.	✓ Operation and maintenance phase
Reefs	✓ Construction and Decommissioning ✓ Operation and maintenance	✓ Operation and maintenance phase
Submerged or partially submerged sea caves	✓ Construction and Decommissioning ✓ Operation and maintenance	✓ Operation and maintenance phase

Construction and decommissioning

<u>Increased SSC and associated sediment deposition</u>

Mudflats and sandflats not covered by seawater at low tide

174 As discussed in section 5.3.1, pre installation sand wave clearance and installation of the offshore export cables will lead to increases in SSC and associated sediment deposition. As outlined in paragraph 115,

[7] https://sitelink.nature.scot/site/8207

however, the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature of the Berwickshire and North Northumberland Coast SAC are located out with the predicted ZoI of increased SSC and sediment deposition. There is, therefore, considered to be no pathway to effect on the Annex I habitat mudflats and sandflats not covered by seawater at low tide feature as a result of increased SSC and sediment deposition. Effects arising from SSC and sediment deposition, as a result of the construction and decommissioning of the Proposed Development will not undermine the conservation objectives for this feature.

175 The extent and distribution of the mudflats and sandflats not covered by seawater at low tide feature will not be reduced, and the population and distribution of qualifying species will not be reduced. The supporting processes on which the Annex I mudflats and sandflats not covered by seawater at low tide feature rely will also not be adversely affected. The structure and function of mudflats and sandflats not covered by seawater at low tide feature will be unaffected. There will be no significant adverse effects on the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the construction or decommissioning phases.

Large shallow inlets and bays

176 The Berwickshire and North Northumberland Coast SAC is located 4.12 km from the Proposed Development export cable corridor, and the qualifying Annex I large shallow inlets and bays feature of the Berwickshire and North Northumberland Coast SAC are located out with the predicted ZoI of increased SSC and sediment deposition. There is, therefore, considered to be no pathway to effect on the Annex I large shallow inlets and bays feature as a result of increased SSC and sediment deposition. Effects arising from SSC and sediment deposition, as a result of the construction and decommissioning of the Proposed Development will not undermine the conservation objectives for this feature.

177 The extent and distribution of the large shallow inlets and bays feature will not be reduced, and the population and distribution of qualifying species will not be reduced. The supporting processes on which the feature rely will also not be adversely affected. The structure and function of the large shallow inlets and bays feature will be unaffected. There will be no significant adverse effects on the qualifying Annex I habitat large shallow inlets and bays feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the construction or decommissioning phases.

Reefs

178 As discussed in section 5.2.5, subtidal reefs within the Berwickshire and North Northumberland Coast SAC include the sub-features kelp forest communities and subtidal faunal turf communities. These sub features of the reef have been assessed as having medium sensitivity to smothering and siltation rate change and water quality changes. Siltation can clog or block feeding/respiratory organs of animals, and increased water turbidity influences the ability of kelp and other algal species to photosynthesise. Intertidal species can also be adversely affected by reduced water clarity and siltation rate changes and have been assessed as having medium sensitivity to the impact.

179 The results of project specific modelling, discussed in paragraphs 110 to 112, shows that sedimentation at the coastline is predicted to be typically <3 mm and SSCs are predicted to reduce to background levels on slack tides. The Berwickshire and North Northumberland Coast SAC site is located 4.12 km from the Proposed Development export cable corridor, therefore the effects resulting from changes to water quality and light smothering and siltation rate change will be reduced due to dispersal.

180 The extent and distribution of the Annex I reefs feature will not be reduced, and the population and distribution of qualifying species will not be reduced. The supporting processes on which the Annex I reef feature rely will also not be adversely affected. The structure and function of the reef habitats will also be unaffected. Given the above, there will be no significant adverse effects on the qualifying Annex I reefs feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the construction or decommissioning phases.

Submerged or partially submerged sea caves

181 The MarESA finds the effects of increased siltation and changes in water quality to have a varying impact on component biotopes of submerged or partially submerged sea caves. The effect can either be a reduction in suspension feeding by characteristic species, or many encrusting sponges for example, prefer these conditions, and will have no problem operating in these conditions over short periods.

182 The results of project specific modelling, discussed in paragraphs 110 to 112, shows that sedimentation at the coastline to be typically <3 mm and SSCs are predicted to reduce to background levels on slack tides. The Berwickshire and North Northumberland Coast SAC is located 4.12 km from the Proposed Development export cable corridor, therefore the effects resulting from changes to water quality and light smothering and siltation rate change will be reduced due to dispersal.

183 The extent and distribution of habitats associated with the Annex I submerged or partially submerged sea caves feature will not be reduced, and the population and distribution of qualifying species will not be reduced. The structure and function of the submerged or partially submerged sea cave habitats will be unaffected. The supporting processes on which the Annex I feature rely will also not be adversely affected. Given the above, therefore will be no significant adverse effects on the qualifying Annex I submerged or partially submerged sea caves feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the construction or decommissioning phases.

Conclusion

184 The assessment has concluded that there is no pathway to effect for increased SSC and sediment deposition on the Annex I mudflats and sandflats not covered by seawater at low tide feature or the Annex I large shallow inlets and bays feature during the construction and decommissioning phases. As such, the conservation objectives will not be undermined for these features. For the Annex I reefs and Annex I submerged or partially submerged sea caves features, there is no direct spatial overlap of the Proposed Development and the site, so the extent and distribution of habitats associated with these features will not be reduced, and neither will be the population and distribution of qualifying species. Given that levels of increased SSC and deposition predicted at the coast are very low, the structure and function of the features will be unaffected and the supporting processes will be maintained.

185 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity on the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

Increased SSC and associated sediment deposition

186 As detailed in section 5.4.1, maintenance activities associated with the offshore export cable may lead to increases in SSCs and associated sediment deposition over the operational lifetime of the Proposed Development. For the offshore export cables the total length of works would be approximately 0.4% of the length assessed for the construction phase with events being undertaken over the Proposed Developments lifetime. The sediment plumes and sedimentation footprints would be dependent on which section of the cable is being repaired. For the purposes of this assessment, the impacts of the operation and maintenance activities (i.e. cable repair and reburial) are predicted to be no greater than those for construction but in reality, given the reduced scale of the works associated with maintenance, will be of a lower magnitude compared to construction.

Mudflats and sandflats not covered by seawater at low tide

187 As outlined in paragraph 115, the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature of the Berwickshire and North Northumberland Coast SAC are located out with the predicted ZoI of increased SSC and sediment deposition. There is, therefore, considered to be no pathway to effect on the Annex I habitat mudflats and sandflats not covered by seawater at low tide feature as a result of increased SSC and sediment deposition during the operation and maintenance phase. Effects arising from SSC and sediment deposition, as a result of the operation and maintenance of the Proposed Development will not undermine the conservation objectives for this feature.

188 The extent and distribution of the mudflats and sandflats not covered by seawater at low tide feature will not be reduced, and the population and distribution of qualifying species will not be reduced. The structure and function of the mudflats and sandflats not covered by seawater at low tide feature will be unaffected. The supporting processes on which the Annex I mudflats and sandflats rely will also not be adversely affected. There will, therefore, be no significant adverse effects on the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the operation and maintenance phase.

Large shallow inlets and bays

189 The Berwickshire and North Northumberland Coast SAC is located 4.12 km from the Proposed Development export cable corridor, and the qualifying Annex I large shallow inlets and bays feature of the Berwickshire and North Northumberland Coast SAC are located out with the predicted ZoI of increased SSC and sediment deposition. There is, therefore, considered to be no pathway to effect on the Annex I large shallow inlets and bays feature as a result of increased SSC and sediment deposition as a result of maintenance activities. Effects arising from SSC and sediment deposition, as a result of the operation and maintenance of the Proposed Development will not undermine the conservation objectives for this feature.

190 The extent and distribution of the habitats associated with the large shallow inlets and bays feature, and the population and distribution of qualifying species will not be reduced. The supporting processes on which the feature rely will also not be adversely affected. The structure and function of habitats associated with the large shallow inlets and bays feature will be unaffected. There will, therefore, be no significant adverse effects on the qualifying Annex I habitat large shallow inlets and bays feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the operation and maintenance phase.

Reefs

191 The impact of increased SSC and associated sediment deposition on reefs will be the same or less than those predicted for construction and decommissioning (see paragraph 179 for a summary and section 5.3.1 for full details). The sensitivity of this Annex I habitat to this impact will also be the same as that described for construction and decommissioning (see paragraphs 118 to 121, and paragraph 178 for a summary).

192 The extent and distribution of the Annex I reefs feature, and the population and distribution of qualifying species will not be reduced as there is no physical overlap between the Proposed Development and the site. The results of project specific modelling, discussed in paragraphs 110 to 112, shows that, the supporting processes on which the Annex I reefs feature rely will also not be adversely affected. The structure and function of reefs will be unaffected. There will, therefore, be no significant adverse effects on the qualifying Annex I reefs feature of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts during the operation and maintenance phase.

Submerged or partially submerged sea caves

193 The impact of increased SSC and associated sediment deposition on submerged or partially submerged sea caves will be the same or less than those predicted for construction and decommissioning (see paragraph 182 for a summary and section 5.3.1 for full details). The sensitivity of this Annex I habitat to this impact will also be the same as that described for construction and decommissioning (see paragraphs 122 to 123, and paragraph 181 for a summary).

194 Significant adverse effects on the qualifying Annex I habitat submerged or partially submerged sea caves of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of increased SSC and associated sediment deposition impacts during operation and maintenance. The extent and distribution of the habitats associated with submerged or partially submerged sea caves, and the population and distribution of qualifying species will not be reduced. The structure and function of habitats associated with submerged or partially submerged sea caves will be unaffected. The supporting processes on which the Annex I feature rely will also not be adversely affected.

Conclusion

195 The assessment has concluded that there is no pathway to effect for increased SSC and sediment deposition on the Annex I mudflats and sandflats not covered by seawater at low tide feature or the Annex I large shallow inlets and bays feature during the operation and maintenance phase, As such, the conservation objectives will not be undermined for these features. For the Annex I reefs and Annex I submerged or partially submerged sea caves features, there is no direct spatial overlap of the Proposed Development and the site, so the extent and distribution of habitats associated with these features will not be reduced, and neither will be the population and distribution of qualifying species. Given that levels of increased SSC and deposition predicted at the coast are very low and will likely be lower than those arising during the construction phase, the structure and function of the features will be unaffected and the supporting processes will be maintained.

196 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts with respect to the operation and maintenance of the Proposed Development acting alone.

Alteration of seabed habitats arising from effects of physical processes

197 As discussed in section 5.4.2, alteration of seabed habitats may arise from the effects of changes to physical processes, including scour effects and changes in the sediment transport and wave regimes resulting in potential effects on benthic receptors. As detailed in section 5.4.2, the modelling presented in volume 3, appendix 7.1 of the offshore EIA Report demonstrates that tidal flows will not be affected in the nearshore. For some wave climates (predominately storms approaching from the northerly sectors), there is predicted to be a very small change at the coast, but these are for specific storm directions and would be imperceptible from natural variation. The combination of the two (littoral currents) and thus the impact on sediment transport is also not predicted to give rise to any discernible change in physical processes at the coast and, therefore, within the Berwickshire and North Northumberland Coast SAC.

Mudflats and sandflats not covered by seawater at low tide

198 Whilst mudflats and sandflats not covered by seawater at low tide have been assessed to have medium sensitivity to this impact, as outlined in paragraphs 148 to 152 modelling has demonstrated that changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are not predicted to extend to the Berwickshire and North Northumberland Coast SAC. Any changes to physical processes are predicted to be localised around the array structures.

199 The extent and distribution of the mudflats and sandflats not covered by seawater at low tide feature will not be reduced as a result of this impact, and the population and distribution of qualifying species will not be reduced. Given that impacts on physical processes are predicted to be largely localised within the Proposed Development array area, the supporting processes on which the Annex I mudflats and sandflats not covered by seawater at low tide feature rely will also not be adversely affected. The structure and function of mudflats and sandflats will be unaffected. There will, therefore, be no significant adverse effects on the qualifying Annex I habitat mudflats and sandflats not covered by seawater at low tide feature of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of alteration of seabed habitats arising from effects of physical processes impacts during operation.

Large shallow inlets and bays

200 Large shallow inlets and bays has been assessed as being of negligible sensitivity to this impact. As outlined in paragraphs 148 to 152 modelling has demonstrated that changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are not predicted to extend to the Berwickshire and North Northumberland Coast SAC.

201 The extent and distribution of habitats associated with the large shallow inlets and bays feature will not be reduced as a result of this impact, and the population and distribution of qualifying species will not be reduced. Given that impacts on physical processes are predicted to be largely localised within the Proposed Development array area, the supporting processes on which the feature rely will also not be adversely affected. The structure and function of the habitats associated with the large shallow inlets and bays feature will be unaffected. There will, therefore, be no significant adverse effects on the qualifying Annex I large shallow inlets and bays feature of the Berwickshire and North Northumberland Coast SAC as a result of alteration of seabed habitats arising from changes in physical processes during the operation and maintenance phase.

Reefs

202 As described in paragraphs 159 to 162, reefs have been assessed to have medium sensitivity to this impact. Modelling has, however, demonstrated that changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are not predicted to extend to the Berwickshire and North Northumberland Coast SAC. Any impacts on physical processes are predicted to be localised around the array structures.

203 The extent and distribution of the reefs feature will not be reduced as a result of this impact, and the population and distribution of qualifying species will not be reduced. Given that impacts on physical processes are predicted to be largely localised within the Proposed Development array area, the supporting processes on which the Annex I reef feature rely will also not be adversely affected. The structure and function of the reefs feature will be unaffected. There will, therefore, be no significant adverse effects on the qualifying Annex I reefs feature of the Berwickshire and North Northumberland Coast SAC as a result of alteration of seabed habitats arising from changes in physical processes during the operation and maintenance phase.

Submerged or partially submerged sea caves

204 As described in paragraphs 163 to 166, submerged or partially submerged sea caves has been assessed as being of negligible sensitivity to this impact. Modelling has also demonstrated that changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are not predicted to extend to Berwickshire and North Northumberland Coast SAC.

205 The extent and distribution of habitats associated with the Annex I submerged or partially submerged sea caves feature will not be reduced as a result of this impact, and the population and distribution of qualifying species will also not be reduced. The structure and function of the habitats associated with the Annex I submerged or partially submerged sea caves feature will be unaffected. Given that impacts on physical processes are predicted to be largely localised within the Proposed Development array area, the supporting processes on which the Annex I feature rely will also not be adversely affected. There will, therefore, be no significant adverse effects on the qualifying Annex I submerged or partially submerged sea caves feature of the Berwickshire and North Northumberland Coast SAC as a result of alteration of seabed habitats arising from changes in physical processes during the operation and maintenance phase.

Conclusion

206 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Berwickshire and North Northumberland Coast SAC, and so for all Annex I habitat features assessed, there is no risk of the extent and distribution conservation objectives being hindered. Similarly, the habitats associated with these features will not be reduced, and neither will be the population and distribution of qualifying species. Given that any changes to tides, waves, littoral currents and sediment transport due to the presence of the infrastructure are predicted to be localised and to not extend to the site, the structure and function of the features will be unaffected and the supporting processes will be maintained.

207 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity of the Berwickshire and North Northumberland Coast SAC from changes in physical processes with respect to the operation and maintenance of the Proposed Development acting alone.

Effects in-combination

208 An assessment of in-combination effects upon the qualifying Annex I habitats of the Berwickshire and North Northumberland Coast SAC arising from each identified impact is provided below.

Assessment of in-combination effects during construction and decommissioning

Increased Suspended Sediment Concentrations and Associated Sediment Deposition

209 There is potential for in-combination effects from increased SSC and associated sediment deposition to Annex I habitats during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction and operation and maintenance phases);
  - Seagreen 1 (operation and maintenance phase only);
  - Seagreen 1A Project (construction and operation and maintenance phases);
  - Seagreen 1A Export Cable Corridor (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase only);
  - Eastern Link 1 (construction and operation and maintenance phases);
  - Eastern Link 2 (construction and operation and maintenance phases); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

210 During the decommissioning phase of the Proposed Development, there is potential for in-combination effects from increased SSC and associated sediment deposition to Annex I habitats with activities associated with the following projects:

- Tier 2:
  - Decommissioning of Inch Cape Offshore Wind Farm);
  - Decommissioning of Neart na Gaoithe Offshore Wind Farm;
  - Decommissioning of Seagreen 1;
  - Decommissioning Seagreen 1A Project;
  - Decommissioning Seagreen 1A Export Cable Corridor; and
  - Use of Eyemouth disposal site.
- Tier 3:
  - Decommissioning of Cambois connection.

Tier 2

211 As described in paragraph 113, increases in SSC and associated sediment deposition arising from the installation of wind turbines and OSP/Offshore convertor station platform foundations, inter-array cables and offshore export cables during the construction phase, have been assessed as being of negligible magnitude on features of the Berwickshire and North Northumberland Coast SAC as a result of the Proposed Development alone. Impacts of increased SSC and associated sediment deposition are predicted to be negligible within the Berwickshire and North Northumberland Coast SAC given most sediment deposition will be localised, focussed within the Proposed Development export cable corridor. Any fines reaching the coast within the SAC are predicted to be <3 mm in thickness and SSCs are predicted to reduce to background levels on slack tides. Furthermore, as outlined in paragraph 115 and paragraph 117 respectively, the qualifying Annex I mudflats and sandflats not covered by seawater at low tide feature and the Annex I large shallow inlets and bats feature of the Berwickshire and North Northumberland Coast SAC are located out with the predicted ZoI of increased SSC and sediment deposition from the Proposed Development alone.

212 Seagreen 1A Project will be installing wind turbines until the end of 2025 which will overlap with the construction phase of the Proposed Development. The Inch Cape Offshore Wind farm will be in the final year of construction, with the programme for the installation of the offshore export cable overlapping with the Proposed Development. Neart na Gaoithe Offshore Wind Farm and the Seagreen 1A Export Cable Corridor will be in operational phase and maintenance activities during the construction phase of the Proposed Development. All of these projects are located further from the Berwickshire and North Northumberland Coast SAC than the Proposed Development export cable corridor. Sediment plumes arising from installation of the Inch Cape Offshore Wind Farm are not predicted to interact with those from the Proposed Development and increases in SSC from maintenance activities at other offshore wind farm projects in Tier 2 would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development.

213 Eastern Link 2 is also further away from the SAC than the Proposed Development and although Eastern Link 1 is closer to the SAC than the Proposed Development, any increases in SSC and associated sediment deposition reaching the SAC will be similarly temporary and negligible as the Proposed Development and therefore not predicted to result in notable in-combination effects.

214 Although the Eyemouth disposal site is close to the Berwickshire and North Northumberland Coast SAC at 0.88 km distance to the east, it is located 16.5 km from the Proposed Development export cable corridor. If offshore cable installation and dredge material disposal coincided, both resultant plumes would be advected on the tidal currents, they would travel in parallel, and not towards one another, and are unlikely to interact in the event that offshore cable installation coincides with the use of the licensed sea disposal site.

215 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

216 During the construction phase of the Proposed Development there is the potential for cumulative impacts with one Tier 3 cable installation. The Cambois connection is a 170 km cable route extending southwards from the Proposed Development array area. Scoping indicates the project will consist of up to four cables installed in 2 m wide trenches up to 3 m in depth. Installation techniques may include jet trenching, cable ploughing and mass flow excavator, as ground conditions dictate. Site preparation will be required, such as boulder and sand wave clearance as part of the approximately two year construction programme. Any increases in SSC and associated sediment deposition reaching the SAC will be similarly temporary and negligible to the Proposed Development and therefore not result in significant in-combination effects. Additionally, the Cambois connection export cable corridor approach to the landfall is south of the SAC compared with the Proposed Development export cable corridor which is north of the SAC therefore any increases in SSC from these projects are unlikely to interact or result in anything other than negligible increases in SSC and sediment deposition within the SAC as a whole.

217 During the decommissioning phase of the Proposed Development all structures above the seabed would be removed. It is proposed to remove all export, inter-array and inter-connector cables and scour protection where possible and appropriate to do so. During decommissioning cables would be removed by similar processes as undertaken during installation therefore increases in SSC would be of a similar form and magnitude. Following decommissioning, changes in suspended sediments concentration and sedimentation would return to baseline levels as it is anticipated that all structures above the seabed level will be completely removed and no further operation to disturb the seabed would be required. Therefore,

the assessment described for the construction phase above is deemed equally applicable for the decommissioning phase.

218 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

Increased Suspended Sediment Concentrations and Associated Sediment Deposition

219 There is potential for in-combination effects from increased SSC and associated sediment deposition to Annex I habitats during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (operation and maintenance phase only);
  - Seagreen 1 (operation and maintenance phase only);
  - Seagreen 1A (operation and maintenance phase only);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase only);
  - Eastern Link 1 (operation and maintenance phase only);
  - Eastern Link 2 (operation and maintenance phase only); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (operation and maintenance phase only).

Tier 2

220 As described in paragraph 135, increases in SSC and associated sediment deposition arising from the maintenance of offshore export cables for the Proposed Development alone has been assessed as being of negligible magnitude on features of the Berwickshire and North Northumberland Coast SAC. During the operation and maintenance phase of the Proposed Development there is the potential for in-combination effects with the maintenance activities at other offshore wind farms, any required maintenance of the Eastern Link 1 and Eastern Link 2 cables, and use of the Eyemouth disposal site. Any increases in SSC and associated sediment deposition as a result of maintenance activities will be temporary, intermittent and highly localised. Any increases reaching the SAC will be similarly temporary and negligible as the Proposed Development and therefore not result in significant in-combination effects.

221 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

222 During the operation and maintenance phase of the Proposed Development there is the potential for in-combination effects with the maintenance activities with all Tier 2 projects and also maintenance of the Cambois connection. Maintenance activities may result in increased SSC; however, these activities would be of limited spatial extent and frequency and lower in magnitude than the construction phase. Any increases reaching the SAC will be similarly temporary and negligible as the Proposed Development and therefore not result in significant in-combination effects.

223 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 3 projects.

Alteration of seabed habitats arising from effects of physical processes

224 There is potential for in-combination effects from alteration of seabed habitats arising from effects on physical processes to Annex I habitats during the operation and maintenance phase of the Proposed Development with the presence of the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (52.0 km from the SAC);
  - Seagreen 1 (64.5 km from the SAC);
  - Seagreen 1A Project (66.6 km from the SAC); and
  - Neart na Gaoithe Offshore Wind Farm(28.5 km from the SAC).

Tier 2

225 As described in paragraph 154, changes in physical processes for the Proposed Development alone has been assessed as being of negligible magnitude on features of the Berwickshire and North Northumberland Coast SAC.

226 Assessment of the Proposed Development was carried out with and without the presence of infrastructure. It can be inferred that during the construction phase there will be gradual changes to tidal currents, wave climate, littoral currents and sediment transport as infrastructure is built. With changes occurring from the baseline environment (no presence of infrastructure) to the operation and maintenance phase (maximum design scenario). This would also be the case for the offshore wind farm developments under construction during this period (i.e. Inch Cape and Seagreen 1A Project). Although, construction of subsea elements such as foundations and cable installation will be largely completed prior to commencing the construction phase of the Proposed Development.

227 The introduction of wind farm infrastructure into areas of predominantly soft sediments has the potential to alter the seabed through changes in the physical processes. This impact is only relevant to the operation and maintenance phase.

228 The modelling and assessment for Neart na Gaoithe included Neart na Gaoithe, Inch Cape, Seagreen 1, and the Seagreen 1A Project in addition to the Proposed Development which is referred to in the documentation as Seagreen Phase 2 and Phase 3. Within the modelling, the Proposed Development was modelled with 725 wind turbines each with an 8 m tower diameter relating to 6 MW devices. The Proposed Development however incorporates a maximum of 307 wind turbines which is significantly less than the scenario modelled and therefore the impacts would, in reality, be less than those reported. The impact of multiple developments on tidal currents was predicted by the study to be low and localised to the near field of each development.

229 The Neart na Gaoithe study also showed that with all offshore wind farms in situ, the cumulative impact on the wave climate is low (<3% average significant wave height) but the effect on wave climate has a larger extent than a single offshore wind farm. The cumulative impact from the combined wind farm developments on sediment transport processes is low, resulting in a 1% to 3% exceedance in the typical critical bed shear stress. Changes are within the immediate vicinity of each of the developments and it is not expected that there would be changes to the far field sediment regimes.

230 Given the other offshore wind farm projects are further from the Berwickshire and North Northumberland Coast SAC than the Proposed Development (see paragraph 224) no significant in-combination effects from this impact are anticipated.

231 Therefore, it can be concluded that there is no risk on an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of alteration of seabed habitats arising from effects of physical processes potential impact can be concluded with respect to the Proposed Development acting in-combination with Tier 2 projects.

Site conclusion

232 In conclusion, with reference to the conservation objectives set for the Annex I habitat features of this site and the information presented in section 5.5, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC.

233 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

6 APPRAISAL OF ADVERSE EFFECTS ON INTEGRITY: DIADROMOUS FISH

6.1 INTRODUCTION

234 The Screening exercise (at Stage One of the HRA process) as updated in response to consultation on the HRA Stage One LSE Screening Report (SSE Renewables, 2021b) (see Section 1.37) identified LSEs on the following European sites designated for Annex II diadromous fish features and freshwater pearl mussel (as summarised in Table 3.1):

- Tweed Estuary SAC;
- River Tweed SAC;
- River South Esk SAC;
- River Tay SAC;
- River Dee SAC; and
- River Teith SAC.

235 This section explains the approach taken to assessing the potential impacts of the Proposed Development on European sites designated for Annex II diadromous fish features and Annex II freshwater pearl mussel and presents the Stage Two assessments for the above sites. Freshwater pearl mussel has been considered within this chapter because part of its life stage is reliant on the diadromous fish species Atlantic salmon. The potential for significant effects to freshwater pearl mussel would be indirect and would occur as a result of direct effects on Atlantic salmon, one of freshwater pearl mussel's host species. Broadly, the potential effects to these sites are as follows and addressed explicitly in the sections below:

236 During construction and decommissioning phase:

- **Injury and/or disturbance from underwater noise and vibration**: direct injury or mortality and or behavioural changes (barriers to migration) due to exposure to underwater noise generated by construction activities (e.g. piling, UXO clearance); and
- Increased **suspended sediment concentrations and associated sediment deposition:** behavioural changes (barriers to migration) due to sediment resuspension during construction and decommissioning (e.g. foundation installation/removal).

237 During operation and maintenance phase:

- **Electromagnetic Fields (EMF) from subsea electrical cabling:** emission of localised EMF due to the presence of subsea electrical cabling may result in behavioural changes, including interference with the navigation of migratory fish; and
- **Colonisation of foundations, scour protection and cable protection**: Potential changes to prey-predator interactions, changes to fish migration patterns due to the fish aggregation effect, and potential spread of marine invasive and non-native species.

238 The Stage Two Appropriate Assessments (considering effects of the Proposed Development both alone and in-combination) for sites designated for diadromous fish and freshwater pearl mussel are presented in section 6.5. Integrity matrices summarising the assessments for the sites are provided in Table 9.2 through to Table 9.7 in section 9. A summary of all Appropriate Assessments undertaken within this report is provided in the concluding section of this report (see section 8).

6.2 ASSESSMENT INFORMATION

6.2.1 MAXIMUM DESIGN SCENARIOS

239 The maximum design scenario relevant to Annex II diadromous fish features and freshwater pearl mussel are set out in Table 6.2, Table 6.10, Table 6.12 and Table 6.15 in this chapter. An overview of the maximum design scenario for all receptor groups is provided in Table 4.1 in chapter 4, for reference.

6.2.2 DESIGNED IN MEASURES

240 Designed in measures relevant to Annex II diadromous fish features are set out in Table 6.3, Table 6.11 and Table 6.13 in this chapter. An overview of the designed in measures for all receptor groups is provided in Table 4.2 in chapter 4, for reference.

6.2.3 BASELINE INFORMATION

241 Baseline information on the Annex II diadromous fish and freshwater pearl mussel features of the European sites identified for appropriate assessment has been gathered through a comprehensive desktop study of existing studies and data sets, as well as site-specific surveys undertaken (as agreed with MS-LOT, MSS and NatureScot) to inform the fish and shellfish baseline characterisation of volume 2, chapter 9 of the Offshore EIA Report: Fish and Shellfish Ecology. Fish and shellfish are spatially and temporally variable, therefore for the purposes of the fish and shellfish ecology characterisation, two study areas have been defined for the EIA (see volume 2, chapter 9 of the Offshore EIA Report for further detail) which are considered to provide an appropriate baseline for the consideration of adverse effects on the European sites screened-in to the HRA:

- The Proposed Development fish and shellfish ecology study area has been defined with reference to the Proposed Development boundary that existed prior to the boundary refinement in June 2022. As the refinements resulted in a reduction of the Proposed Development array area, the fish and shellfish ecology study area is considered to remain representative, as it encompasses the updated Proposed Development boundary, and therefore presents a conservative baseline against which the fish and shellfish appropriate assessment is undertaken. The Proposed Development fish and shellfish ecology study area has not therefore been realigned to the current Proposed Development boundary; and
- The Proposed Development northern North Sea fish and shellfish ecology study area encompasses the Proposed Development fish and shellfish ecology study area and a surrounding area defined by the boundary of the northern North Sea. This is the regional study area and also encompasses waters of the Forth and Tay Scottish Marine Region (SMR).

242 The key data sources are presented in detail within volume 2, chapter 9 of the Offshore EIA Report, and the chapters that supported its findings as summarised below:

- volume 2, chapter 7: Physical Processes;
- volume 2, chapter 8: Benthic Subtidal and Intertidal Ecology;
- volume 3, appendix 9.1: Fish and Shellfish Ecology Technical Report;
- volume 3, appendix 10.1: Subsea Noise Technical Report; and
- volume 3, appendix 10.1: Annex G Particle motion review to subsea noise report.

243 Detailed European site information is presented in appendix A.

6.2.4 CONSERVATION OBJECTIVES

244 The conservation objectives for sites designated for Annex II diadromous fish and freshwater pearl mussel features identified for Stage Two Appropriate Assessment are provided in section 6.5. Where Supplementary Advice to the conservation objectives, or site-specific conservation advice describes minimum targets for qualifying features in more detail, this detail is provided in appendix A and/or referenced within the relevant Stage Two Appropriate Assessments.

6.2.5 SPECIES ACCOUNTS

Atlantic salmon *Salmo salar*

245 Atlantic salmon are anadromous (i.e. spawns in freshwater but completes its life cycle in the sea). They spend two to three years in freshwater, with downstream migration (to open sea) occurring between April and May. Atlantic salmon remain at sea for one to three years. Upstream migration into freshwater occurs year-round, with a peak in late summer/early autumn. A study by Malcolm *et al.* (2015) suggests that most fish across Scotland leave natal rivers between mid-April and the end of May.

246 Following spawning by adult salmon in Scottish east coast rivers, the ova mature into fry and then parr before migrating to sea as smolts. At sea, the smolts grow rapidly and after one to three years they return as adults to spawn, most commonly to their natal river. Many Atlantic salmon die after spawning, but some return to sea as kelts and may return again to rivers to spawn (Mills, 1989). Atlantic salmon are known to migrate in relation to diurnal cues. Evidence provided by Smith and Smith (1997) suggests that Atlantic salmon upstream migration into rivers is related to tidal phase and time of day. Up-estuary movements leading to river entry were found to be predominantly nocturnal and occur during ebb tides, with entry into nontidal reaches of rivers also being nocturnal, however significantly associated with tidal phase (Smith and Smith, 1997). Smolts migrating downstream/offshore have also been found to increase migratory activity nocturnally, with daytime utilised more for prey detection and predator avoidance (Hedger *et al.*, 2008). Dempson *et al.* (2011) also found a small but significant increase in migratory movements nocturnally when compared to daytime, which suggests a slight preference for nocturnal migration.

247 Rod catch data from rivers on the east coast of Scotland can provide insight into the general trends of salmon populations within the vicinity of the Proposed Development fish and shellfish ecology study area. Data provided by Marine Scotland have been interrogated, with a focus on the following rivers relevant to the Proposed Development fish and shellfish ecology study area: Tweed, Forth, Tay, South Esk and Dee. The data shows at a simple level that salmon migrate to/from a number of rivers in the vicinity of the Proposed Development and therefore should be assumed very likely to pass through the Proposed Development boundary, either as smolts or returning adults (RPS, 2022).

248 Migration of Atlantic salmon smolts through the Cromarty Firth and into the Moray Firth was tracked in a study undertaken for Beatrice Offshore Windfarm (BOWL) Ltd. by Glasgow University (BOWL, 2017). The study results indicated an eastwards migration of the tagged fish along the southern coast of the Moray Firth. Results also showed the majority of fish to remain predominantly within the upper 1 m of the water column during migration. Mortality of smolts was considered to be mainly attributable to predation and there was a strong relationship between group survival, early migration and group size.

249 Furthermore, recent evidence from the Moray Firth (Newton *et al.*, 2017; Newton *et al.*, 2019; Gardiner *et al.*, 2018a) suggest that smolts migrating from their rivers in the Moray Firth head directly across the North Sea relatively rapidly. It is thought that this route, rather than moving in a coastal direction upon leaving their natal rivers, allows them to take advantage of east flowing currents which cross the North Sea. This fast progress away from the coast limits exposure to predators close to the coast. It also reduces the potential for interaction with marine renewables developments (including offshore wind). Similar evidence of a rapid easterly migration out into the North Sea has also been shown for the River Dee in Aberdeenshire (Gardiner *et al.*, 2018b). Therefore, it could be assumed that smolts from other east coast rivers (e.g. Tay, Forth and South Esk) would move in a similar fashion.

250 Atlantic salmon in Scotland have been experiencing a decline in recent decades, with rod catch data declining across much of the species' range (Scottish Government, 2020b). Pressures on Atlantic salmon stocks in marine and freshwater environments are numerous and include commercial and recreational exploitation of stocks, disease, impacts related to farmed salmon and climate change (ICES, 2017b). A Marine Scotland report (Marine Scotland, 2017) showed salmon stocks to be at a historically low level.

Sea lamprey Petromyzon marinus

251 The sea lamprey is a primitive, jawless fish resembling an eel. It is the largest of the lampreys found in the UK. It occurs in estuaries and easily accessible rivers and is an anadromous species (i.e. spawning in freshwater but completing its life cycle in the sea) (JNCC, 2021a).

252 In Europe, sea lamprey are distributed from Norway down to the Iberian Peninsula, with the largest populations often observed in the estuaries and large rivers flowing into the Atlantic Ocean in Western Europe, in particular in the Iberian Peninsula, France and the UK (Guo *et al.*, 2016).

253 Like the other species of lamprey, sea lampreys need clean gravel for spawning, and marginal silt or sand for the burrowing juveniles (ammocoetes). Sea lampreys spend most of their adult life at sea, and are parasitic in their marine phase, feeding off a variety of marine and anadromous fishes, including shad, herring, pollack, salmon, mullets, cod, haddock, Greenland sharks and basking sharks (Marine Scotland Directorate, 2019). They are rarely captured in coastal and estuarine waters, suggesting that they are solitary hunters and widely dispersed at sea, and can be found at considerable depths (up to 4,099 m) (Marine Scotland Directorate, 2019). Given that they are parasites in their adult phase, however, their distribution is largely dictated by their host species (Marine Scotland Directorate, 2019). As such it is not expected that they will be particularly attracted to structures associated with offshore wind developments. However, this is not certain, as there is limited information available on the utilisation of the marine environment by sea lamprey. It is a possibility that sea lamprey will be present in the vicinity of the Proposed Development.

254 Sea lamprey spend three to four years in freshwater and downstream migration (to open sea) occurs between July and September. Sea lamprey remain at sea for 18-24 months and upstream migration into freshwater occurs between April and May, with spawning in freshwater from May to June. Sea lampreys have a preference for warm waters in which to spawn (JNCC, 2021a).

River lamprey Lampetra fluviatilis

255 River lamprey are found in coastal waters, estuaries and accessible rivers. Some populations are permanent freshwater residents; however, the species is normally anadromous (i.e. spawning in

freshwater but completing part of its life cycle in the sea) (JNCC, 2021b). Unlike sea lamprey, their growth phase is mainly restricted to estuaries (Marine Scotland Directorate, 2019). After one to two years in estuaries, river lamprey stop feeding in the autumn and move upstream into medium to large rivers, usually migrating into fresh water between October and December (Marine Scotland Directorate, 2019). They live on hard bottoms or attached to larger fish such as cod and herring due to their parasitic feeding behaviour, with spawning taking place in pre-excavated pits in riverbeds. Due to their preference for estuarine and nearshore coastal waters, it is unlikely that river lamprey will be found within the Proposed Development boundary.

256 River lamprey spend five years or more in freshwater, remaining burrowed in river silt beds until adulthood. Downstream migration occurs between July and September, to feed in estuaries. River lamprey can spend around two years in estuaries before migrating upstream. Upstream migration occurs in winter and spring when temperatures are below 10°C.

Freshwater pearl mussel Margaritifera margaritifera

257 The freshwater pearl mussel is an endangered species of freshwater mussel. It is widely distributed in Europe but has suffered widespread decline and is highly vulnerable in every part of its former range. A Scottish national survey undertaken in 2015 found that freshwater pearl mussel had been lost from a number of rivers. More widely, since 1999 a total of 11 rivers in Scotland have seen their freshwater pearl mussel populations become extinct (JNCC, 2019).

258 Freshwater pearl mussel are similar in shape to common marine mussels but grow much larger and live far longer. They can grow as large as 20 cm and live for more than 100 years, making them one of the longest-lived invertebrates (Skinner *et al*., 2003). These mussels live on the beds of clean, fast flowing rivers, where they can be buried partly of wholly in coarse sand or fine gravel. Mussels have a complex life cycle, living on the gills of young Atlantic salmon or sea trout, for their first year, without causing harm to the fish (Skinner *et al*., 2003). While there is no potential for direct impacts on this species from the Proposed Development (as this is an entirely freshwater species), freshwater pearl mussel have been included in the assessment, as a dependant qualifying species, as there is the potential for indirect impacts to occur due to effects on their host species (i.e. Atlantic salmon and sea trout) during their marine phase. Due to effects on Atlantic salmon populations being the only route to impact, where it is concluded that no adverse effects on integrity are to be found on Atlantic salmon, the same can be concluded for freshwater pearl mussel.

6.2.6 APPROACH TO THE IN-COMBINATION ASSESSMENTS

259 The nature of effects that have been assessed for each Annex II diadromous fish species, and the scale over which these effects may occur, are based on assessment criteria applied during the HRA Stage One exercise as presented in section 3.3. These effects are detailed within the alone assessment and have not been re-iterated here.

260 The overarching approach to the assessment of effects in-combination is set out in section 4.5 and is not reiterated here.

Relevant plans and projects

261 The plans and projects set out in Table 6.1 have been considered within the in-combination assessment for European sites designated for Annex II diadromous fish features.

262 The plans and projects included in this in-combination assessment for European sites designated for Annex II diadromous fish features have been derived in part, from the Cumulative Effects Assessment (CEA) longlist presented in and volume 3, chapter appendix 6.4 of the Offshore EIA Report.

Table 6.1: List of Other Developments with Potential for In-Combination Effects on Annex II Diadromous Fish.

Developments	Status [i.e. Application, Consented, Under Construction, Operation]	Distance from Proposed Development Array Area (km)	Distance from Proposed Development Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development [e.g. Project Construction Phase Overlaps with Proposed Development Construction Phase]
Tier 1							
Offshore Wind Projects and Associated Cables							
No Tier 1 projects identified within the fish and shellfish ecology CEA study area.							
Tier 2							
Offshore Wind Projects and Associated Cables							
Inch Cape Offshore Wind Farm – 15680	Consented	19	39	Up to 1,000 MW (up to 72 wind turbines)	2023-2025	2026 onwards	Project construction and operation phases overlap with Proposed Development construction and operation and maintenance phases.
Neart Na Gaoithe Offshore Wind – 66600019	Under construction	16	15	Up to 450 MW (up to 75 wind turbines)	2020-2023	2023 onwards	Project operation phase overlaps with Proposed Development construction and operation and maintenance phases.
Seagreen 1	Under construction	5	35	Up to 114 wind turbines with no capacity limit	2020-2023	2025 onwards	Project construction and operation Phase overlaps with Proposed Development construction and operation and maintenance phases.
Seagreen 1A Project	Consented	5	36	Up to 36 wind turbines with no capacity limit	2023-2025	Q3 2025 onwards	Project construction and operation phases overlap with Proposed Development construction and operation and maintenance phases.
Seagreen 1A Export Cable Corridor	Consented	0.4	16	A 100 km offshore export cable from Seagreen 1A to the landfall at Cockenzie	April 2023 – June 2024	July 2024 onwards	Project operation phase overlaps with Proposed Development construction and operation and maintenance phases.
Oil and Gas Activities							
No oil and gas projects identified within the fish and shellfish ecology CEA study area.							
Aggregate Extraction							
No aggregate extraction projects identified within the fish and shellfish ecology CEA study area.							
Disposal Sites							

Developments	Status [i.e. Application, Consented, Under Construction, Operation]	Distance from Proposed Development Array Area (km)	Distance from Proposed Development Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development [e.g. Project Construction Phase Overlaps with Proposed Development Construction Phase]
Eyemouth – FO0080	Operation	35	17	Dredged material disposal site	N/A	Ongoing	Project operation phase overlaps with Proposed Development construction and operation and maintenance phases
Coastal Protection							
No coastal protection projects identified within the fish and shellfish ecology CEA study area.							
Subsea Cables (Telecommunications and Interlinks)							
Eastern link 1	Planning application submitted	23	2	Scotland England Green Link 1 – interconnector between Torness in Scotland and County Durham in England	2024 – 2027	2027 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Eastern link 2	Planning application submitted	11	21	Scotland England Green Link 2 – interconnector between Peterhead in Scotland and North Yorkshire in England	2025 – 2029	2029 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Infrastructure							
No Infrastructure projects identified within the fish and shellfish ecology CEA study area							
Ministry of Defence sites							
No MoD sites identified within the fish and shellfish ecology CEA study area							
Tier 3							
Subsea Cables (Telecommunications and Interlinks)							
Cambois connection	Pre-Application	0	0	Alternative offshore export cable	Q1 2028 – Q4 2031	Q4 2031	The construction and operation and maintenance phases of the Cambois connection overlap with the construction and operation and maintenance phases of the Proposed Development.
Tier 4							

Developments	Status [i.e. Application, Consented, Under Construction, Operation]	Distance from Proposed Development Array Area (km)	Distance from Proposed Development Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development [e.g. Project Construction Phase Overlaps with Proposed Development Construction Phase]
ScotWind	Lease offer	Unknown	Unknown	17 offshore wind projects with combined capacity of 24.8 GW	Unknown	Unknown	Screened out. There is currently insufficient data to make a fair and robust assessment of any overlap and therefore cumulative effects associated with the ScotWind proposals have been screened out.

6.3 CONSTRUCTION AND DECOMMISSIONING

6.3.1 INJURY AND/OR DISTURBANCE FROM UNDERWATER NOISE AND VIBRATION

263 Increases in underwater noise during construction and decommissioning of the Proposed Development, associated with UXO clearance and piling, have the potential to cause injury and disturbance to Annex II diadromous fish and freshwater pearl mussel.

264 The Screening process concluded there was potential for underwater noise during the construction and decommissioning phase to result in an Adverse Effect on Integrity relating to the following European sites and relevant features:

- Tweed Estuary SAC – sea lamprey and river lamprey;
- River Tweed SAC – Atlantic salmon, sea lamprey and river lamprey;
- River South Esk SAC – Atlantic salmon and freshwater pearl mussel;
- River Tay SAC – Atlantic salmon, sea lamprey and river lamprey;
- River Dee SAC – Atlantic salmon and freshwater pearl mussel; and
- River Teith SAC – Atlantic salmon, sea lamprey and river lamprey.

265 The following sections explain how the potential effects of the Proposed Development on Annex II diadromous fish features during construction and decommissioning have been quantified and assessed.

Maximum design scenario relevant to the assessment of adverse effects on integrity

266 The maximum design scenarios considered for the assessment of potential impacts on Annex II diadromous fish from underwater noise during construction and decommissioning are set out in Table 6.2.

267 Pile driving during the installation of foundations is predicted to lead to a medium-term, intermittent increase in underwater noise levels that may result in injury and/or disturbance to Annex II diadromous fish. The maximum design scenario considers the greatest effect from underwater noise on Annex II diadromous fish, considering the maximum hammer energy and piling duration (see Table 6.2).

268 UXO clearance (including detonation) also has the capability to cause injury and/or disturbance to Annex II diadromous fish. Clearance will be completed prior to the construction phase (pre-construction). Detonation of UXO would represent a short-term (seconds) increase in underwater noise (i.e. sound levels and particle motion) to levels which may result in injury or behavioural effects on fish and shellfish species.

269 There will be no pile driving or UXO clearance during decommissioning, therefore any underwater noise associated with the removal of foundations will be at most similar, but more likely, much less than during construction.

Table 6.2: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from Underwater Noise during Construction

Potential Impact	Maximum Design Scenario	Justification
Injury and/or disturbance from underwater noise and vibration	**(Pre-) Construction Phase** • Clearance of up to 14 UXOs within the inter-array area or Proposed Development export cable corridor; • Absolute maximum assessed of 300 kg UXO; • Low order clearance of all UXOs using low order techniques (subsonic combustion) with a single donor charge of up to 80 g Net Explosive Quantity (NEQ) for each clearance event; • Up to 500 g NEQ clearance shot for neutralisation of residual explosive material; • Small risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO; • Up to two detonations within 24 hours; and • Clearance during daylight hours only. **Construction Phase** • Wind turbines: – up to 179 piled jacket foundations, with up to four legs per foundation and up to 2 x 5.5 m diameter piles per leg (1,432 piles); – Maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – Two concurrent piling events with two vessels for wind turbine foundations and/or OSP/Offshore convertor station platforms; – Minimum 900 m and maximum 49.3 km distance between concurrent piling events; – Up to ten hours absolute maximum piling per pile (nine hours realistic maximum); – Total duration of piling for wind turbines only = 14,320 hours (absolute max) to 12,888 hours (realistic max); and – Maximum piles installed within 24 hours (concurrent piling) = 5. • OSPs/Offshore convertor station platforms: – up to 8 jacket foundations with up to 6 legs per foundation and 4 x 3.0 m diameter piles per leg (192 piles) and up to 2 jacket foundations with up to 8 legs per foundation and 4 x 4.0 m diameter piles per leg (64 piles); – maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – up to 8 hours absolute maximum (7 hours realistic maximum) piling per pile; – total duration of piling = 1,792 hours (realistic maximum) to 2,048 hours (absolute maximum); and – maximum piles installed within 24 hours (single piling) = 3.	Maximum number and maximum size of UXOs encountered in the Proposed Development based on UXO Hazard Assessment undertaken for Seagreen. Maximum number of UXOs will lead to greatest potential impact. Donor charge is maximum required to initiate low order detonation. Assumption of a clearance shot of up to 500 g at all locations will lead to the greatest potential impact, however it should be noted that this may not always be required. Maximum design scenario is for the maximum number of piles, the maximum possible duration of piling and the greatest hammer energy (leading to the greatest propagation of noise into the water column). Note that maximum design scenario assumes concurrent piling for wind turbine foundations as the maximum design scenario but it may occur as a combination of wind turbines and OSPs/Offshore convertor station platforms.

Potential Impact	Maximum Design Scenario	Justification
	The maximum scenario for concurrent piling is maximum of 2 piling events at any one time. Number of days when piling may occur within piling phase (OSPs/Offshore convertor station platforms and wind turbines) = 372 days. Total piling phase of 52 months over a construction phase of 96 months.	

Designed in measures relevant to the assessment of adverse effects on integrity

270 Designed in measures (and the associated commitments) of relevance to the assessments of potential effects on Annex II diadromous fish from underwater noise during construction and decommissioning are set out in Table 6.3.

Table 6.3: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Diadromous Fish from Underwater Noise and Vibration during Construction and Decommissioning

Effect/Impact Pathway	Detail of Measure	Justification
Injury and disturbance from elevated underwater noise during piling	Implementation of piling soft start and ramp up measures. During piling operations, soft starts will be used. This will involve the implementation of lower hammer energies (i.e. approximately 15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	This measure will minimise the risk of injury to fish species in the immediate vicinity of piling operations, allowing individuals to flee the area before noise levels reach a level at which injury may occur.
Injury and/or disturbance from elevated underwater noise during UXO clearance	Low order disposal of unexploded ordnance.	Low order techniques will be adopted wherever practicable (e.g. deflagration and clearance shots) as mitigation to minimise noise levels and thereby injury and disturbance to fish and shellfish receptors.
Injury and/or disturbance from elevated underwater noise during piling and UXO clearance	Development of, and adherence to, an appropriate Code of Construction Practice (CoCP).	These measures have been identified during the design of the offshore and intertidal elements of the Project as part of the EIA process. They include strategies, control measures and monitoring procedures for managing the potential environmental impacts of constructing the Project and limiting disturbance from construction activities as far as reasonably practicable.
	Development of, and adherence to, a Decommissioning Plan.	The aim of this plan is to adhere to the existing UK and international legislation and guidance, with decommissioning industry best practice applied. Overall, this will ensure the legacy of the Project will result in the minimum amount of long-term disturbance to the environment as far as reasonably practicable.

Information to inform Appropriate Assessments

271 The Appropriate Assessments for sites for Annex II diadromous fish are presented in section 6.5. Information common to inform the Appropriate Assessments in presented in this section.

272 The installation of foundations within the Proposed Development fish and shellfish ecology study area may lead to injury and/or disturbance to fish and shellfish species due to underwater noise during pile driving. The maximum design scenario considers the greatest effect from underwater noise on diadromous fish, considering both the greatest hammer energy. This scenario is represented by the installation of up to 179 piled jacket foundations (1,432 piles) for wind turbines, and up to ten jacket foundations (256 piles) for OSP/Offshore convertor station platforms, with each pile installed via impact/percussive piling. Two scenarios were modelled with respect to hammer energy: an average maximum hammer energy of 3,000 kJ and absolute maximum hammer energy of up to 4,000 kJ.

273 For wind turbines, piling was assumed to take place over a period of on average nine hours per pile (maximum duration of up to ten hours per pile) with up to five piles installed in each 24-hour period. Installation of OSP/Offshore convertor station platform foundations will take place over a period of on average seven hours per pile (maximum duration of up to eight hours per pile) with up to three piles installed in each 24-hour period. A maximum duration of 16,368 hours of piling activity, over a maximum 372-day period, may take place during the construction phase, based on the maximum duration of the piling phase.

274 UXO clearance (including detonation) will be completed prior to the construction phase (pre-construction). Until detailed pre-construction surveys are completed within the Proposed Development, the precise number of potential UXO which will need to be cleared is unknown. Drawing on the experience of UXO at other North Sea sites, the maximum number of UXO that may require clearance is up to 14 for the Proposed Development. The maximum design scenario assumes that each of these will be detonated using low order processes, with the assumption that one high order detonation may occur (see Table 6.2). Many of these may be left *in situ* and microsited around. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise (i.e. sound pressure levels and particle motion) which will be elevated to levels which may result in injury or behavioural effects on diadromous fish.

275 To understand the magnitude of noise emissions from piling and UXO clearance during construction activity, underwater noise modelling was undertaken considering the key parameters summarised above. Full details of the modelling undertaken are presented in volume 3, appendix 10.1 off the Offshore EIA Report. Piling activities were modelled for jacket foundations at six locations within the Proposed Development array area taking into account the varying bathymetry and sediment type across the model areas (see volume 3, appendix 10.1 of the Offshore EIA Report). Underwater noise modelling included the use of 'soft start' mitigation to reduce the potential for injury effects (as set out in Table 6.3). The implications of the modelling for diadromous fish and freshwater pearl mussel, injury and behaviour are outlined in the subsequent sections.

276 All other noise sources including cable installation and foundation drilling will result in much lower noise levels and therefore much smaller injury ranges (in most cases no injury is predicted) than those predicted for piling operations.

277 The impact is predicted to be of regional spatial extent, medium term duration, intermittent with high reversibility.

Acoustic assessment criteria

278 Underwater noise can potentially have an adverse impact on fish species ranging from physical injury/mortality to behavioural effects. Recent peer reviewed guidelines have been published by the Acoustical Society of America (ASA) and provide directions and recommendations for setting criteria

(including injury and behavioural criteria) for fish. The Sound Exposure Guidelines for Fishes and Sea Turtles (Popper *et al*., 2014) are considered to be most relevant and best available guidelines for impacts of underwater noise on fish species (see volume 3, appendix 10.1 of the Offshore EIA Report). The Popper *et al*. (2014) guidelines broadly group fish into the following categories based on their anatomy, according to the presence or absence of a swim bladder and on the potential for that swim bladder to improve the hearing sensitivity and range of hearing (Popper *et al*., 2014):

- Group 1: fishes with no swim bladder or other gas chamber (e.g. elasmobranchs, flatfishes and lampreys). These species are less susceptible to barotrauma and are only sensitive to particle motion, not sound pressure. Basking shark, which does not have a swim bladder, falls into this hearing group;
- Group 2: fishes with swim bladders but the swim bladder does not play a role in hearing (e.g. salmonids). These species are susceptible to barotrauma, although hearing only involves particle motion, not sound pressure;
- Group 3: Fishes with swim bladders that are close, but not connected, to the ear (e.g. gadoids and eels). These fishes are sensitive to both particle motion and sound pressure and show a more extended frequency range than groups 1 and 2, extending to about 500 Hz; and
- Group 4: Fishes that have special structures mechanically linking the swim bladder to the ear (e.g. clupeids such as herring, sprat and shads). These fishes are sensitive primarily to sound pressure, although they also detect particle motion. These species have a wider frequency range, extending to several kHz and generally show higher sensitivity to sound pressure than fishes in Groups 1, 2 and 3.

279 Relatively few studies have been conducted on impacts of underwater noise on invertebrates, including crustacean species, and little is known about the effects of anthropogenic underwater noise upon them (Hawkins and Popper, 2016; Morley *et al*., 2013; Williams *et al*., 2015). There are therefore no injury criteria that have been developed for shellfish, however, these are expected to be less sensitive than fish species and therefore injury ranges of fish represent conservative estimates for shellfish.

280 An assessment of the potential for injury/mortality and behavioural effects to be experienced directly by diadromous fish and indirectly by freshwater pearl mussel with reference to the sensitivity criteria above is presented in turn below.

Injury

281 Table 6.4 summarises the fish injury criteria recommended for pile driving based on the Popper *et al*. (2014) guidelines, noting that dual criteria are adopted in these guidelines to account for the uncertainties associated with effects of underwater noise on fish.

282 The Popper *et al*. (2014) guidelines set out criteria for injury due to different sources of noise. Those relevant to the Proposed Development are those for injury due to impulsive (piling and UXO detonation) sources only, as non-impulsive sources would result in a much lower impact.

Table 6.4: Criteria for Onset of Injury to Fish due to Impulsive Piling (Popper *et al.*, 2014)

Group	Type of Animal	Parameter	Mortality and Potential Mortal Injury	Recoverable Injury
1	Fish: no swim bladder (particle motion detection)	SEL, dB re 1 µPa^{2}s	>219	>216
		Peak, dB re 1 µPa	>213	>213
2	Fish: where swim bladder is not involved in hearing (particle motion detection)	SEL, dB re 1 µPa^{2}s	210	203
		Peak, dB re 1 µPa	>207	>207
3 and 4	Fish: where swim bladder is involved in hearing (primarily pressure detection)	SEL, dB re 1 µPa^{2}s	207	203
		Peak, dB re 1 µPa	>207	>207
N/A	Eggs and larvae	SEL, dB re 1 µPa^{2}s	>210	(*Near*) Moderate[a] (*Intermediate*) Low (*Far*) Low
		Peak, dB re 1 µPa	>207	

[a] Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near field (N; i.e. 10s of metres), intermediate (I; i.e. 100s of metres), and far field (F; i.e. 1000s of metres); Popper *et al*. (2014).

283 The full results of the underwater noise modelling are presented in volume 3, appendix 10.1 of the Offshore EIA Report. For the purpose of this assessment, a conversion factor range of 0.5 reducing to 4% was applied as this represents an adequately conservate range for which energy from piling is transferred into sound energy (as explained in volume 3, appendix 10.1, annex A). It should be noted that sensitivity analysis was undertaken on other, more conservative conversion factors, which is presented in volume 3, appendix 10.1 of the Offshore EIA Report. In order to inform this assessment, Table 6.5 and Table 6.6 present the predicted injury ranges associated with the installation of one 5.5 m diameter pile, for peak sound pressure levels (SPL_{pk}) and cumulative sound exposure level (SEL_{cum}) respectively. This modelled scenario resulted in the greatest predicted injury ranges and therefore forms the focus of the assessment for injury.

284 For peak pressure noise levels when piling energy is at its maximum (i.e. 4,000 kJ), mortality and recoverable injury to diadromous fish may occur within approximately 138 m (Group 1 fish species including sea and river lampreys) – 228 m (Group 2 fish species including Atlantic salmon) of the piling activity. The potential for mortality or mortal injury to fish eggs would also occur at distances of up to 228 m (Table 6.5), with a low to moderate risk of recoverable injury to eggs and larvae within the range of hundreds of metres (see Table 6.4 for qualitative criteria). It should be noted that these ranges are the maximum ranges for the maximum hammer energy, and it is unlikely that injury will occur in this range due to the implementation of soft starts during piling operations, which will allow fish to move away from the areas of highest noise levels, before they reach a level that would cause an injury. The initial injury ranges for soft start initiation will be considerably smaller than those maximum ranges presented in Table 6.5 (i.e. of the order of tens of metres, depending on the fish species considered).

285 For cumulative SEL, injury ranges were calculated for piling activities undertaken for the maximum energy scenario and for a realistic hammer energy scenario (i.e. average maximum; Table 6.6). These ranges indicate that with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels (i.e. mortality thresholds were not exceeded and recoverable injury to maximum ranges of 67 m; see Table 6.6). This table also presents ranges of effect for Temporary Threshold Shift (TTS) for all fish groups. As outlined above, TTS is a temporary reduction in hearing sensitivity caused by exposure to intense sound. Normal hearing ability returns following cessation of the noise causing TTS, though the recovery period is variable, during which fish may have decreased fitness due to a reduced ability to communicate, detect predators or prey, and/or assess their environment. Table 6.7 presents the ranges at which TTS in fish may occur as a result of piling for one 5.5 m pile, with TTS predicted to occur to maximum ranges of 4.161 km from piling operations.

286 The injury ranges presented indicate that injury may occur out to ranges of tens to a few hundred metres, based on the maximum design scenario. However, in reality, the risk of fish injury will be considerably lower due to the hammer energies being lower than the absolute maximum modelled, as demonstrated by the lower injury ranges associated with initiation and soft starts in Table 6.5. The expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling (see Table 6.3), mean that it is likely that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

Table 6.5: Summary of Peak Pressure Injury Ranges for Diadromous Fish due to Phase of Impact Piling Resulting in Maximum Peak Sound Pressure Level, for both Wind turbine Foundations and OSP/Offshore Convertor Station Platform Foundations Based on the Peak Pressure Metric

Hearing Group	Response	Threshold (SPL_{pk}, dB re 1 µPa)	Range (m)	
			Wind Turbine – Max Energy and OSP/Offshore Convertor Station Platform	Wind turbine – Realistic Energy
Group 1 Fish: No swim bladder (particle motion detection)	Mortality	213	138	119
	Recoverable injury	213	138	119
Group 2 Fish: Swim bladder not involved in hearing (particle motion detection)	Mortality	207	228	196
	Recoverable injury	207	228	196
Group 3 and 4 Fish: Swim bladder involved in hearing (primarily pressure detection)	Mortality	207	228	196
	Recoverable injury	207	228	196
Fish eggs and larvae	Mortality	207	228	196

Table 6.6: Injury Ranges for Fish due to Impact Pile Driving for the "Realistic" and "Maximum" Pile Driving for Wind turbine Jacket Foundations, and for the Piling of the OSP/Offshore Convertor Station Platform Jackets Based on the Cumulative SEL Metric (N/E denotes where thresholds not exceeded)

Hearing Group	Response	Threshold (SEL, dB re 1 µPa²s)	Range (m)		
			Wind Turbine Max Energy	Wind Turbine Realistic Energy	OSP/Offshore Convertor Station Platform
Group 1 Fish: No swim bladder (particle motion detection) – [*basking shark ranges shown in square brackets*].	Mortality	219	N/E	N/E	N/E
	Recoverable injury	216	N/E	N/E	N/E
	TTS	186	4,161 [2,219]	3,183 [1,609]	3,900 [2,165]
Group 2 Fish: Swim bladder not involved in hearing (particle motion detection)	Mortality	210	19	N/E	19
	Recoverable injury	203	67	53	67
	TTS	186	4,161	3,183	3,943
Group 3 and 4 Fish: Swim bladder involved in hearing (primarily pressure detection)	Mortality	207	33	26	33
	Recoverable injury	203	6	53	67
	TTS	186	4,161	3,183	3,943
Fish eggs and larvae (static)	Mortality	210	495	4	439

287 Noise modelling was also undertaken for concurrent piling for wind turbine foundations. Mortality and recoverable injury ranges were unchanged for the concurrent piling scenario and therefore TTS ranges only are presented in Table 6.7. This indicates that for concurrent piling, TTS ranges may be increased to up to 7.1 km from the piling location for the maximum hammer energy and 5.6 km for realistic hammer energy.

Table 6.7: TTS Injury Ranges for Fish due to Impact Pile Driving at Two Locations Concurrently, for the "Realistic" and "Maximum" Pile Driving for Wind turbine Jacket Foundations Based on the Cumulative SEL Metric

Hearing Group	Response	Threshold (SEL, dB re 1 µPa²s)	Range	
			Wind Turbine Max Energy	Wind Turbine Realistic Energy
Group 1 Fish: No swim bladder (particle motion detection) – [*basking shark ranges shown in square brackets*].	TTS	186	7.1 km [4.3km]	5.6 km [3.3 km]
Group 2 Fish: Swim bladder not involved in hearing (particle motion detection)	TTS	186	7.1 km	5.6 km
Group 3 and 4 Fish: Swim bladder involved in hearing (primarily pressure detection)	TTS	186	7.1 km	5.6 km

288 Underwater noise modelling has also been completed for underwater noise associated with UXO clearance/detonation. Modelling was undertaken for a range of orders of detonation, from a realistic worse case high order detonation to low order detonations (e.g. deflagration and clearance shots) to be used as mitigation to minimise noise levels. Table 6.8 details the injury ranges for fish of all groups in relation to various orders of detonation. The method of low order has been committed to (see Table 6.3) and as such will be the dominant method of UXO clearance, although higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process.

289 The modelling results (Table 6.8) indicate that mortality/mortal injury for all fish (including Group 1, sea lamprey), would occur within a range of 30-45 m from the source following low order detonation. The method of low order has been committed to (see Table 6.3) and as such will be the dominant method of UXO clearance. Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In the event of a high order detonation event (absolute worst-case scenario of a detonation of 300 kg UXO) in this case mortality would occur within 410-680 m of the noise source.

Table 6.8: Injury Ranges for all Fish Groups Relating to Varying Orders of UXO Detonation

Detonation Size (kg)	Mortality		Recoverable Injury	TTS
	Threshold (m)	Range (m)		
0.08 (deflagration)	229 – 234	30 – 45	(*Near*) High (Intermediate) Low (*Far*) Low	(*Near*) High (Intermediate) Moderate-High (*Far*) Low
0.5 (clearance shot)	229 – 234	50 – 80	(*Near*) High (Intermediate) Low (*Far*) Low	(*Near*) High (Intermediate) Moderate-High (*Far*) Low
300 (high order)	229 – 234	410 – 680	(*Near*) High (Intermediate) Low (*Far*) Low	(*Near*) High (Intermediate) Moderate-High (*Far*) Low

Behaviour effects

290 Behavioural effects in response to construction related underwater noise include a wide variety of responses including startle responses (also known as C-turn responses), strong avoidance behaviour, changes in swimming or schooling behaviour or changes of position in the water column. The Popper *et al*. (2014) guidelines provide qualitative behavioural criteria for fish from a range of noise sources. These categorise the risks of effects in relative terms as “high”, “moderate” or “low” at three distances from the source: “near” (i.e. tens of metres), “intermediate” (i.e. hundreds of metres) or “far” (i.e. thousands of metres). The behavioural criteria for piling operations are summarised in Table 6.9 for the four fish groupings.

Table 6.9: Potential Risk for the Onset of Behavioural Effects in Fish from Piling (Popper *et al*., 2014)[a]

Type of Fish	Masking[a]	Behaviour[a]
Group 1 Fish: no swim bladder (particle motion detection)	N: Moderate risk I: Low risk F: Low risk	N: High risk I: Moderate risk F: Low risk
Group 2 Fish: swim bladder is not involved in hearing (particle motion detection)	N: Moderate risk I: Low risk F: Low risk	N: High risk I: Moderate risk F: Low risk
Groups 3 and 4 Fish: swim bladder involved in hearing (pressure and particle motion detection)	N: High risk I: High risk F: Moderate risk	N: High risk I: High risk F: Moderate risk
Eggs and larvae	N: Moderate risk I: Low risk F: Low risk	N: Moderate risk I: Low risk F: Low risk

[a] Note: Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near field (N; i.e. 10s of metres), intermediate (I; i.e. 100s of metres), and far field (F; i.e. 1000s of metres); Popper *et al.* (2014).

291 Group 1 Fish (including sea and river lampreys) and Group 2 Fish (including Atlantic salmon) are less sensitive to sound pressure, with these species detecting sound in the environment through particle motion. However, sensitivity to particle motion in fish is also more likely to be important for behavioural responses rather than injury (Hawkins, 2009; Mueller-Blenkle *et al*., 2010; Hawkins *et al*., 2014a).

292 A number of studies have examined the behavioural effects of the sound pressure component of impulsive noise (including piling operations and seismic airgun surveys) on fish species. Mueller-Blenkle *et al*. (2010) measured behavioural responses of cod and sole to sounds representative of those produced during marine piling, with considerable variation across subjects (i.e. depending on the age, sex, condition etc. of the fish, as well as the possible effects of confinement in cages on the overall stress levels in the fish). This study concluded that it was not possible to find an obvious relationship between the level of exposure and the extent of the behavioural response, although an observable behavioural response was reported at 140 dB to 161 dB re 1 µPa SPL_{pk} for cod and 144 dB to 156 dB re 1 µPa SPL_{pk} for sole. However, these thresholds should not be interpreted as the level at which an avoidance reaction will be elicited, as the study was not able to show this.

293 A study by Pearson *et al*. (1992) on the effects of geophysical survey noise on caged rockfish Sebastes spp. Observed a startle or “C-turn response” at peak pressure levels beginning around 200 dB re 1 µPa, although this was less common with the larger fish. Studies by Curtin University in Australia for the oil and gas industry by McCauley *et al*. (2000) exposed various fish species in large cages to seismic airgun noise and assessed behaviour, physiological and pathological changes. The study made the following observations:

- A general fish behavioural response to move to the bottom of the cage during periods of high level exposure (greater than root mean square (RMS) levels of around 156 dB to 161 dB re 1 ?Pa; approximately equivalent to SPL_{pk} levels of around 168 dB to 173 dB re 1 ?Pa);
- A greater startle response by small fish to the above levels;
- A return to normal behavioural patterns some 14 to 30 minutes after airgun operations ceased;
- No significant physiological stress increases attributed to air gun exposure; and
- Some preliminary evidence of damage to the hair cells when exposed to the highest levels, although it was determined that such damage would only likely occur at short range from the source.

294 The authors did point out that any potential seismic effects on fish may not necessarily translate to population scale effect or disruption to fisheries and McCauley *et al*. (2000) show that caged fish experiments can lead to variable results. While these studies are informative to some degree, these, and other similar studies, do not provide an evidence base that is sufficiently robust to propose quantitative criteria for behavioural effects (Hawkins and Popper, 2016; Popper *et al*., 2014) and as such the qualitative criteria outlined in Table 6.9 are proposed.

295 For the purposes of the underwater noise modelling, an un-weighted sound pressure level of 150 dB re 1 µPa (RMS) was used as the criterion for indicating the extent of behavioural effects due to impulsive piling based on the Washington State Department of Transport Biological Assessment Preparation for Transport Projects Advanced Training Manual (WSDOT, 2011). At sound pressure levels in excess of 150 dB re 1 µPa (RMS) temporary behavioural changes, such as elicitation of a startle response, disruption of feeding, or avoidance of an area may be expected to occur. It is important to note that this threshold is for onset of potential effects, and not necessarily an ‘adverse effect’ threshold and should be considered alongside other information (including those studies outlined above) in addition to the qualitative criteria set out by Popper *et al*. (2014) in Table 6.9. Using this criterion, site specific modelling indicated that behavioural responses may occur to ranges of approximately 17 km for single pile driving and 23 km for concurrent piling. Initial outputs of post construction monitoring at the BOWL (BOWL, 2021a) concluded that for sandeel there was no evidence of adverse effects on sandeel populations between pre and post construction levels over a six-year period. Cod spawning was also monitored at the same wind farm site (BOWL, 2021b) and similarly, it was concluded that there was no change in the presence of cod spawning between pre and post construction (although spawning intensity was found to be low across both surveys). From these studies, it can be inferred that noise impacts associated with installation of an offshore wind development are temporary and that fish communities (specifically cod and sandeel in this case) show a high degree of recoverability following construction.

Summary of potential effects

296 Injury and/or mortality for diadromous fish species can only be expected for individuals within very close proximity to piling operations. However, this is unlikely to result in significant mortality due to soft start procedures allowing individuals in close proximity to flee the area prior to maximum hammer energy levels which may cause injury to greater ranges.

297 In contrast, behavioural effects are expected over larger ranges, as discussed above. To illustrate this, Figures 9.1 and 9.2 show the modelled underwater noise levels for SPL_{pk} relative to the six SACs designated for Annex II diadromous fish and freshwater pearl mussel taken forward to Appropriate Assessment. Figure 6.1 and Figure 6.2 show noise contours for two hammer energies (i.e. the maximum 4,000 kJ hammer energy and the average maximum hammer energy of 3,000 kJ, respectively) at the south-west modelled location. This location was chosen as it is closest to the coastline and, therefore, most likely to cause barrier effects to diadromous species at that location.

298 Diadromous fish species may experience behavioural effects in response to piling noise, including a startle response, disruption of feeding, or avoidance of an area. These would be expected to occur at ranges of 10 km to 20 km, depending on the species and their relative sensitivities to underwater noise (i.e. in order of lowest to highest sensitivities: lamprey species, Atlantic salmon and sea trout, European eel and shad species). Research from Harding *et al.* (2016) failed to produce physiological or behavioural responses in Atlantic salmon when subjected to noise similar to piling. However, the noise levels tested were estimated at <160 dB re 1 µPa RMS, below the level at which injury or behavioural disturbance would be expected for Atlantic salmon. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development fish and shellfish ecology study area and the migration routes of diadromous species along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as demonstrated in Figure 6.1 and Figure 6.2). This is the case for both downstream migration of smolts and upstream migration of adults.

299 The low risk of effects on migration of diadromous fish species extends to the freshwater pearl mussel, which is included in the diadromous species assessment, as part of its life stage is reliant on diadromous fish species including Atlantic salmon.

300 Diadromous fish species are deemed to have low vulnerability, high recoverability and therefore low sensitivity.

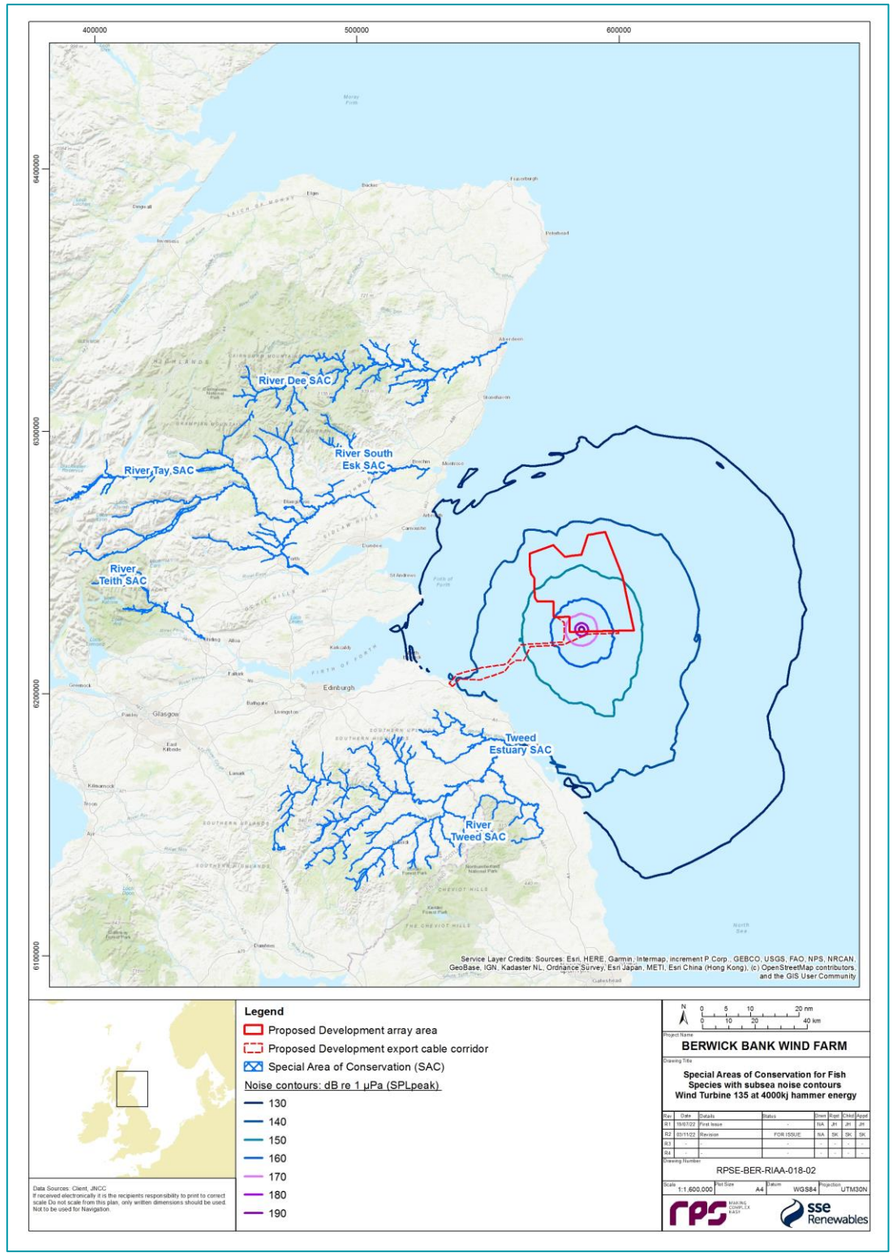

Figure 6.1: Special Areas of Conservation for Annex II Fish with Underwater Noise Contours (Unweighted SPL_{pk}) Associated with the Southwest Piling Location at 4,000 kJ Hammer Energy

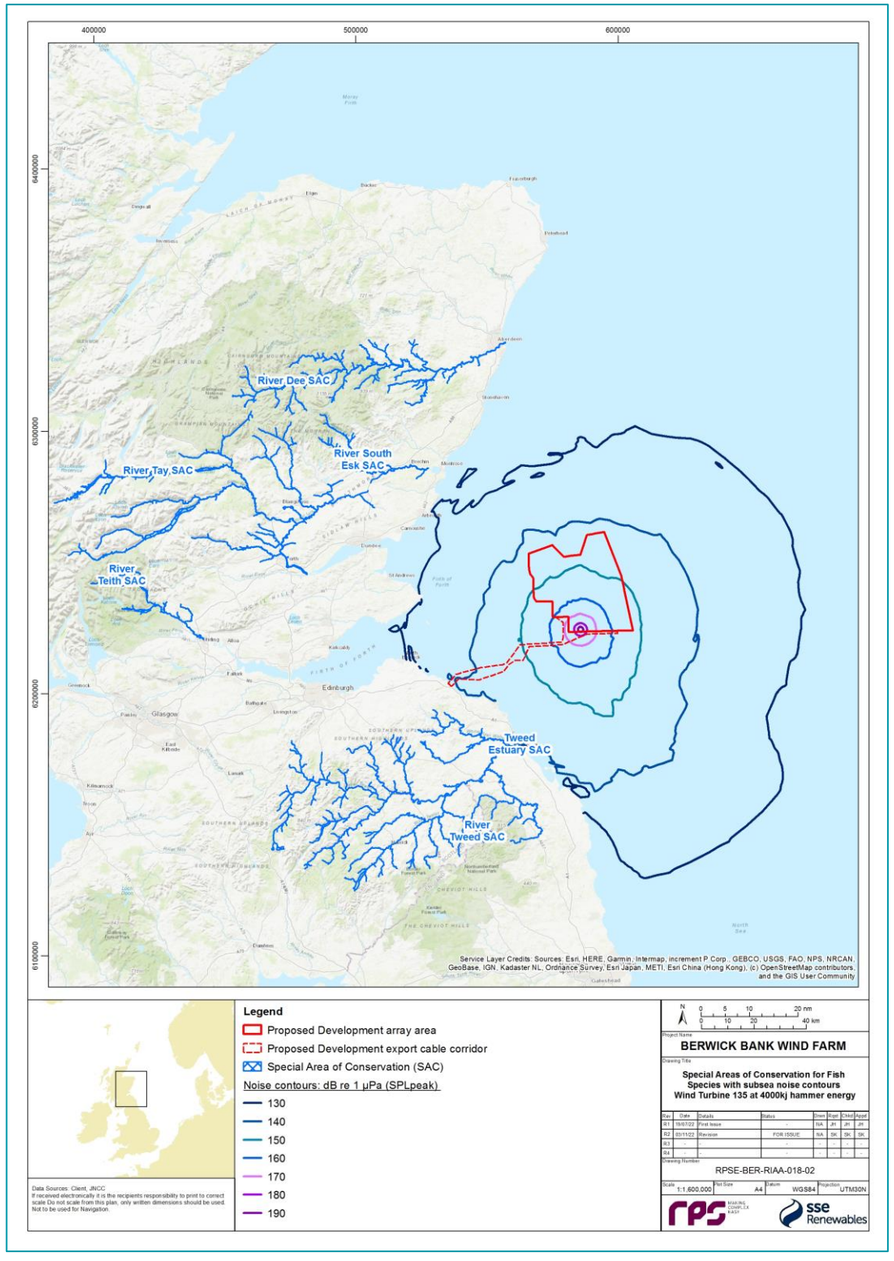

Figure 6.2: Special Areas of Conservation for Annex II Fish with Underwater Noise Contours (Unweighted SPL_{pk}) Associated with the Southwest Piling Location at 3,000 kJ Hammer Energy

6.3.2 INCREASED SUSPENDED SEDIMENT CONCENTRATIONS AND ASSOCIATED SEDIMENT DEPOSITION

301 Increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in migratory fish (see paragraph 315 for further detail). Increases in SSC and associated sediment deposition are predicted to occur during the construction and decommissioning phases as a result of seabed preparation (seabed feature clearance prior to cable installation), the installation/removal of wind turbine and OSP/Offshore convertor station platform foundations and installation/removal of inter-array, interconnector and offshore export cables.

302 Impacts are predicted to be of local spatial extent (i.e. largely within the Proposed Development fish and shellfish ecology study area), short-term duration, and intermittent during construction and decommissioning.

Maximum design scenario relevant to the assessment of adverse effects on integrity

303 The maximum design scenarios considered for the assessment of potential impacts on Annex II diadromous fish from increases in SSC and sediment deposition during construction and decommissioning are set out in Table 6.10.

Table 6.10: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from SSC and Sediment Deposition during Construction and Decommissioning

Potential Impact	Maximum Design Scenario	Justification
Increased SSC and associated sediment deposition	**Construction Phase** Wind turbines and OSP/Offshore convertor station platforms installed on piled jacket foundations: • Drilling of foundations associated with 179 wind turbine structures, with 2 x 5.5 m piles per leg and four legs per foundation; • Drilling undertaken for 20% of total 80 m depth (estimated at 16 m) with a rate of 0.5 m/h; • Modelling undertaken for drilling events at locations across the area encompassing a range of dispersion characteristics with 2 concurrent drilling events; and • drilling of foundations associated with up to 5 OSP/Offshore convertor station platforms for up to 4 piles of 3.5 m diameter associated with each of the 8 legs, with 4 per foundation requiring drilling to 20% depth (i.e. 12 m) and drilling at 2 OSP/Offshore convertor station platforms for 4 piles of 4 m diameter are associated with each of the 8 legs, with 4 per foundation requiring drilling to 20% depth (i.e. 12 m). Installation of inter-array and offshore export cables (maximum trench width of 2 m and maximum trench depth of 3 m: • inter-array cables length up to 1,225 km; • buried offshore export cable length up to 872 km;	Greatest volume of sediment released into the water column. Maximum design scenario assumed complete removal of all infrastructure, if any infrastructure is left in situ this will result in reduced levels of suspended sediment and associated deposition during decommissioning.

Potential Impact	Maximum Design Scenario	Justification
	• OSP/Offshore convertor station platform Interconnector cable length up to 94 km; • sand wave clearance over 30% of inter-array and OSP/Offshore convertor station platform interconnector cables (395.7 km) and 20% of offshore export cables (174.4 km); • boulder clearance over 20% of inter-array, OSP/Offshore convertor station platform interconnector cables (367.7263.8 km) and offshore export cables (174.4 km); • installation using jet trenching which mobilises material from a depth of up to 3 m deep 2 m wide trench; and • modelling assumes that the cable routes extend over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column). **Decommissioning Phase** • piled substructures will be cut at an agreed depth below the level of the seabed for partial removal, suction caisson foundations will be removed; • decommissioning of inter-array and offshore export cables: – inter-array cables length up to 1,225 km; – offshore export cable length up to 872 km; and – OSP/Offshore convertor station platform interconnector cable length up to 94 km; • decommissioning using jet dredging which mobilises material from up to 3 m deep, 2 m wide trench; and • modelling assumes that the offshore cable routes extend over areas of sand suitable for jetting (i.e. which mobilises the greatest volume of sediment throughout the water column.	

Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity

304 Designed in measures (and the associated commitments) of relevance to the assessments of potential impacts on Annex II diadromous fish from increased SSC and associated sediment deposition during construction and decommissioning are set out in Table 6.11.

Table 6.11: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Diadromous Fish from Increased SSC and associated Sediment Deposition during Construction and Decommissioning

Effect/Impact Pathway	Detail of Measure	Justification
Increased SSC and sediment deposition	Development of, and adherence to, an appropriate Code of Construction Practice (CoCP)	These measures have been identified during the design of the offshore and intertidal elements of the Project as part of the EIA process. They include strategies, control measures and monitoring procedures for managing the potential environmental impacts of constructing the Project and limiting disturbance from construction activities as far as reasonably practicable.
	Development of, and adherence to, a Decommissioning Plan	The aim of this plan is to adhere to the existing UK and international legislation and guidance. With decommissioning industry best practice applied. Overall, this will ensure the legacy of the Project will result in the minimum amount of long-term disturbance to the environment as far as reasonably practicable. While this measure has been committed to as part of the Proposed Development, the maximum design scenario for the decommissioning phase has been considered for the purposes of this assessment.

Information to inform the appropriate assessments

305 The Appropriate Assessments for sites for Annex II diadromous fish are presented in section 9.5. Information common to inform the Appropriate Assessments in presented in this section.

306 The installation of infrastructure within the Proposed Development fish and shellfish ecology study area may lead to increases SSC and associated sediment deposition. Full details of the modelling undertaken to inform this assessment are presented in volume 3, appendix 7.1 of the Offshore EIA Report, including the individual scenarios considered and assumptions within these and full modelling outputs for suspended sediments and associated sediment deposition. For the purposes of this assessment, the following activities have been considered:

- seabed feature clearance prior to cable installation;
- drilling for foundation installation; and
- inter-array, OSP/Offshore convertor station platform interconnector, and offshore export cable installation.

307 Seabed feature (sand wave) clearance for cable installation would involve disturbance of seabed material within a corridor of up to 25 m width for the 20% the Proposed Development offshore export cables, where it is necessary. Modelling of suspended sediments associated with the site preparation showed a large variation. SSC reaches its peak in the disposal phase with concentrations reaching 2,500 mg/l at the release site, but the plume is at its most extensive when the deposited material is redistributed on the successive tides, under these circumstance concentrations of 100 mg/l – 250 mg/l have been modelled (see volume 3 appendix 7.1 of the Offshore EIA Report for further details on modelling assumptions for SSC). The average SSC during the course of the clearance activities showed values less than 100 mg/l with a plume width of 10 km. Sedimentation of deposited material is focussed within 100 m of the site of release with a maximum depth 0.5 m – 0.75 m whilst the finer sediment fractions are distributed in the vicinity at much lesser depths circa 5 mm – 10 mm within a range of hundreds of meters to a small number of kilometres. Sedimentation one day following cessation of operation is similar to during operation with a

small extension to the area over which sedimentation has occurred but with no increase in maximum sedimentation depth.

308 The maximum design scenario for the inter-array cable sand wave clearance also accounts for up to a 25 m wide corridor. The resulting SSC showed similar characteristics to the Proposed Development offshore export cable clearance. At the Proposed Development array area, the greatest area of increased SSC was also shown to be associated with re-mobilisation of the deposited material on subsequent tides. In this scenario, the plume was found to extend 10 km from the site, with peak concentrations of 100 mg/l – 250 mg/l and average levels are less than 100 mg/l. Again, SSCs were predicted to reach their peak in the deposition phase with concentrations reaching 2,500 mg/l at the release site. The average sedimentation depth is typically half that of the Proposed Development offshore export cable works, with maximum sedimentation of 100 mm – 300 mm, which is only reached in very small areas along the Proposed Development export cable corridor, and almost all within the Proposed Development Fish and Shellfish Ecology study area. The sedimentation one day following the cessation of the clearance operation shows deposited material at the site of release with depth 0.2 m – 0.4 m, whilst in the locality, lower depths, typically less than 5 mm, are present at 50 m distance from the release.

309 The maximum design scenario for foundation installation assumes all wind turbine and OSP/Offshore convertor station platform foundations will be installed by drilling 5.5 m diameter piles for jacket foundations (Table 6.10). Drilling was modelled for three wind turbines at different locations in the Proposed Development array area. The locations represent the dominant physical environmental conditions experienced in the Proposed Development array area. Modelling of SSCs associated with the foundation installation showed the plume related directly to the sediment releases was less than 5 mg/l and this drops to lower levels within a very short distance, typically less than 500 m. Furthermore, these sediment plumes are predicted to be temporary, returning to background levels within a few tides. The maximum sedimentation depth is typically 0.05 mm to 0.1 mm during pile installation, with that maximum dropping to 0.0005 mm – 0.001 mm one day following cessation of operations. These demonstrate the dispersive nature of the site, dispersing material the full extent of the tidal excursion (12 km), and even using a very small contour interval this settlement would be imperceptible from the background sediment transport activity with plotted sediment depths less than typical grain diameters.

310 The maximum design scenario for the installation of inter-array and OSP/Offshore convertor station platform interconnector cables assumes installation of all cables through jet trenching, with assumptions (e.g. trench width and depth) summarised in Table 6.10. Modelling was undertaken for installation of inter-array and OSP/Offshore convertor station platform interconnector cables along a number of paths which connect groups of wind turbines to OSP/Offshore convertor station platforms or connect two OSP/Offshore convertor station platforms to each other. Each route would be undertaken as a separate operation and thus a single example has been selected to quantify the potential suspended sediment levels during the installation. The inter-array cabling was modelled along a route with a trench 2 m wide and 3 m in depth. The modelling outputs for SSCs associated with the installation of cabling showed a very wavy plume extending from trenching route, the majority of which sits within the Proposed Development array area. It is clear that the sediment is re-suspended and dispersed on subsequent tides as the plume envelope is most extensive towards the start of the route to the south-east of the site with peak values of 100 mg/l extending hundreds of meters to a small number of kilometres. The volume of material mobilised is relatively large, and elevated tidal currents disperse the material giving rise to concentrations of up to 500 mg/l. The sedimentation is greatest at the location of the trenching and may be up to 30 mm in depth however within close proximity, circa 100 m, the depths reduce significantly.

311 The modelling for offshore export cables also took a precautionary approach, assuming that cable installation would involve disturbance of seabed material up to 2 m wide and up to 3 m deep. Modelling outputs indicated average SSC along the route ranged between 50 mg/l and 500 mg/l. Average sedimentation peaks at 0.5 mm – 1.0 mm during offshore export cable installation and one day after cessation of operations this maximum increased to 10 mm – 30 mm, however this only accounts for a very small area with most of the impacted area displaying deposition depths considerably reduced at distance from the cable trench.

312 The impact is predicted to be of local spatial extent (i.e. largely within the Proposed Development Fish and Shellfish Ecology study area boundaries), short term duration, intermittent during the construction phase with high reversibility.

313 Decommissioning of the infrastructure will lead to increases in SSCs and associated sediment deposition. The maximum design scenario is represented by the cutting and removal of all infrastructure including piled jacket foundations at seabed level, removal of inter-array, OSP/Offshore convertor station platform interconnector and offshore export cables by jet dredging mobilising material from a 3 m deep and 2 m wide trench.

314 Decommissioning of foundations is predicted to result in increases in suspended sediments and associated deposition that are no greater than those produced during construction, and likely to be less as seabed clearance is less likely to be required. For the purposes of this assessment, the impacts of decommissioning activities are predicted to be no greater than those for construction.

Impacts of increased SSC and sediment deposition on diadromous fish species

315 All diadromous fish species known to occur in the area are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC that are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As it is predicted that construction activities associated with the Proposed Development will produce temporary and short-term increases in SSC, with levels well below those experienced in estuarine environments, it would be expected that any diadromous species will be temporarily affected (if they are affected at all). Any adverse effects on these species are likely to be short term behavioural effects (i.e. avoidance) and are not expected to create a barrier to migration to rivers or estuaries used by these species in the Proposed Development northern North Sea fish and shellfish ecology study area.

316 Diadromous fish species are deemed to be of low vulnerability, high recoverability and therefore low sensitivity.

6.4 OPERATION AND MAINTENANCE

6.4.1 ELECTROMAGNETIC FIELDS (EMF) FROM SUBSEA ELECTRICAL CABLING

317 The installation of inter-array, interconnector and offshore export cables will result in either high voltage alternating current (HVAC) or high voltage direct current (HVDC) under the maximum design scenario (Table 6.12). The conduction of electricity through subsea power cables will result in emission of localised electromagnetic fields (EMFs) which could potentially affect the sensory mechanisms of some species of fish and shellfish, particularly electrosensitive species (including elasmobranchs) and diadromous fish species (Centre for Marine and Coastal Studies (CMACS, 2003).

318 The impact is predicted to be of local spatial extent (within a few metres of the buried cables), of long-term duration, continuous and not reversible during the operation and maintenance phase (impact is reversible upon decommissioning, see paragraph 321 *et seq.* for further detail).

Maximum design scenario relevant to the assessment of adverse effects on integrity

319 The maximum design scenarios considered for the assessment of potential impacts on Annex II diadromous fish from EMF are set out in Table 6.12.

Table 6.12: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from EMF during Operation and Maintenance

Potential Impact	Maximum Design Scenario	Justification
EMF from subsea electrical cabling	**Operation and Maintenance Phase** Presence of inter-array and offshore export cables: • up to 1,225 km of 66 kV inter-array cables; • up to 872 km of 275 kV offshore export cables; • minimum burial depth 0.5 m; • up to 15% of inter-array cables and offshore export cable route may require cable protection; and • cables will also require cable protection at asset crossings (up to 78 crossings for inter-array cables and up to 16 crossings for offshore export cables). Operation and maintenance phase of up to 35 years.	Maximum length of cables across the Proposed Development array area and offshore export cable route and minimum burial depth (the greater the burial depth, the more the EMF is attenuated). The maximum design scenario for EMF is based on the greatest cable length as this provides the greatest potential for EMF effects on diadromous fish.

Designed in measures relevant to the assessment of adverse effects on integrity

320 Designed in measures (and the associated commitments) of relevance to the assessments of potential impacts on Annex II diadromous fish from EMF are set out in Table 6.13.

Table 6.13: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Diadromous Fish from EMF during Operation and Maintenance

Effect/Impact Pathway	Detail of Measure	Justification
EMF	Preparation and implementation of a Cable Plan (CAP), including a cable burial risk assessment (CBRA) to inform cable burial depth	A CAP will be prepared prior to the construction phase and will include a detailed cable laying plan, including geotechnical data, cable laying techniques and a CBRA which will include details on target and minimum burial depths. While the sediments in which cables are buried burial of cables will not reduce the strength of EMF, the burial of cables it does increase the distance between cables and fish and shellfish IEFs, with greater attenuation of EMFs with greater distance from the cable, thereby potentially reducing the effect of EMFs on those IEFs.
	Development of, and adherence to, a Decommissioning Plan	The aim of this plan is to adhere to the existing UK and international legislation and guidance. With decommissioning industry best practice applied. Overall, this will ensure the legacy of the Project will result in the minimum amount of long-term disturbance to the environment as far as reasonably practicable. While this measure has been committed to as part of the Proposed Development, the maximum design scenario for the decommissioning phase has been considered for the purposes of this assessment.

Information to inform Appropriate Assessment

321 The Appropriate Assessments for sites for Annex II diadromous fish are presented in section 6.5. Information common to inform the Appropriate Assessments in presented in this section.

322 The presence and operation of inter-array, interconnector and offshore export cables within the Proposed Development fish and shellfish ecology study area will result in emission of localised EMFs which has the potential to affect diadromous fish. EMF comprise both the electrical (E) fields, measured in volts per metre (V/m), and the magnetic (B) fields, measured in microtesla (µT) or milligauss (mG). Background measurements of the magnetic field are approximately 50 µT in the North Sea, and the naturally occurring electric field in the North Sea is approximately 25 µV/m (Tasker *et al*., 2010).

323 It is common practice to block the direct electrical field (E) using conductive sheathing, meaning that the EMFs that are emitted into the marine environment are the magnetic field (B) and the resultant induced electrical field (iE). It is generally considered impractical to assume that cables can be buried at depths that will reduce the magnitude of the B field, and hence the sediment-sea water interface iE field, to below that at which these fields could be detected by certain marine organisms on or close to the seabed (Gill *et al*., 2005; Gill *et al*., 2009). By burying a cable, the magnetic field at the seabed is reduced due to the distance between the cable and the seabed surface as a result of field decay with distance from the cable (CSA, 2019).

324 A variety of design and installation factors affect EMF levels in the vicinity of the cables. These include current flow, distance between cables, cable orientation relative to the earth's magnetic field (DC only), cable insulation, number of conductors, configuration of cable and burial depth. Clear differences between AC and DC systems are apparent: the flow of electricity associated with an AC cable changes direction (as per the frequency of the AC transmission) and creates a constantly varying electric field in the surrounding marine environment (Huang, 2005). Conversely, DC cables transmit energy in one direction creating a static electric and magnetic field. Average magnetic fields of DC cables are also higher than those of equivalent AC cables (Table 9.27).

325 The strength of the magnetic field (and consequently, induced electrical fields) decreases rapidly horizontally and vertically with distance from source. A recent study conducted by CSA (2019) found that inter-array and offshore export cables buried between depths of 1 m to 2 m reduces the magnetic field at the seabed surface four-fold. For cables that are unburied and instead protected by thick concrete mattresses or rock berms, the field levels were found to be similar to buried cables.

326 CSA (2019) found magnetic field levels directly over live AC undersea power cables associated with offshore wind energy projects range between 65 mG (at seafloor) and 5 mG (1 m above sea floor) for inter-array cables and 165 mG (at seafloor) and 10 mG (1 m above seafloor) for offshore export cables. At lateral distances from the cable, magnetic fields greatly reduced at the sea floor to between 10 mG and

<0.1 mG (from 3 to 7.5 m respectively) for inter-array cables, and at 1 m above the sea floor, magnetic fields reduced to between 15 mG and <0.1 mG (from 3 to 7.5 m respectively) for offshore export cables.

327 The induced electric fields directly over live AC undersea power cables ranged between 1.7 mV/m (at seafloor) and 0.1 mV/m (1 m above seafloor) for inter-array cables and 3.7 mV/m (at seafloor) and 0.2 mV/m (1 m above seafloor) for offshore export cables (CSA, 2019). At lateral distances electric fields at the sea floor reduced to between 0.01 mV/m and 1.1 mV/m (from 3 to 7.5 m respectively) for inter-array cables and 1 m above the sea floor, the magnetic fields reduced to between 0.02 mV/m and 1.3 mV/m (from 3 to 7.5 m respectively) for offshore export cables. There is, therefore, a pattern of reduction in the level of magnetic fields with increasing lateral and vertical distance from export cables.

328 Normandeau *et al*. (2011) provided additional data (Table 6.14) demonstrating the rapid drop off of magnetic fields with increasing vertical and horizontal distance from both AC and DC cables. This supports the findings from the CSA (2019) study, with AC cables ranging from 7.85 µT on the seafloor with no horizontal distance to 0.08µT at 10 m above the seafloor and 10 m horizontal distance. DC cables showed a similar decrease albeit starting from a higher level with cables ranging from 78.27µT on the seafloor with no horizontal distance to 0.46µT at 10 m above the seafloor and 10 m horizontal distance.

Table 6.14: Average Magnetic Fields (µT) Generated for AC and DC Offshore Export Cables at Horizontal Distances from the Cable (Assuming Cable Burial to a Depth of 1 m; Source: Modified from Normandeau *et al*., 2011)

Distance Above Seabed (m)	Magnetic Field (µT) Measured at Horizontal Distance from Cable					
	0 m AC	0 m DC	4 m AC	4 m DC	10 m AC	10 m DC
0	7.85	78.27	1.47	5.97	0.22	1.02
5	0.35	2.73	0.29	1.92	0.14	0.75
10	0.13	0.83	0.12	0.74	0.08	0.46

329 Fish species, particularly elasmobranchs (sharks, skates and rays), are able to detect applied or modified magnetic fields. Species for which there is evidence of a response to E and/or B fields include, elasmobranchs and diadromous fish species (including river lamprey, sea lamprey, and Atlantic salmon) (Gill *et al*., 2005; CSA, 2019). It can be inferred that the life functions supported by an electric sense may include detection of prey, predators or conspecifics to assist with feeding, predator avoidance, and social or reproductive behaviours. Life functions supported by a magnetic sense may include orientation, homing, and navigation to assist with long or short-range migrations or movements (Gill *et al*., 2005; Normandeau *et al*., 2011).

330 EMF may interfere with the navigation of sensitive diadromous species. Lampreys possess specialised ampullary electroreceptors that are sensitive to weak, low frequency electric fields (Bodznick and Northcutt, 1981; Bodznick and Preston, 1983), but information regarding what use they make of the electric sense is limited. Chung-Davidson *et al*. (2008) found that weak electric fields may play a role in the reproduction of sea lamprey and it was suggested that electrical stimuli mediate different behaviours in feeding-stage and spawning-stage individuals. This study (Chung-Davidson *et al*., 2008) showed that migration behaviour of sea lamprey was affected (i.e. adults did not move) when stimulated with electrical fields of intensities of between 2.5 and 100 mV/m, with normal behaviour observed at electrical field intensities higher and lower than this range. It should be noted, however, that these levels are considerably higher than modelled induced electrical fields expected from AC subsea cables (see Table 6.14).

331 Atlantic salmon has been found to possess magnetic material of a size suitable for magnetoreception, and this species can use the earth's magnetic field for orientation and direction-finding during migration (Gill and Bartlett, 2010; CSA, 2019).

332 Research in Sweden on the effects of a HVDC cable on the migration patterns of a range of fish species, including salmonids, failed to find any effect (Westerberg *et al*., 2007; Wilhelmsson *et al*., 2010). Research conducted at the Trans Bay cable, a DC undersea cable near San Francisco, California, found that migration success and survival of another salmonid (chinook salmon *Oncorhynchus tshawytscha*) was not impacted by the cable. However, behavioural changes were noted when these fish were near the cable (Kavet *et al*., 2016) with salmon appearing to remain around the cable for longer periods. These studies demonstrate that while DC undersea power cables can result in altered patterns of fish behaviour, these changes are temporary and do not interfere with migration success or population health.

333 Diadromous fish are therefore considered to be of low vulnerability and high recoverability. The sensitivity to EMF is considered to be low.

6.4.2 COLONISATION OF FOUNDATIONS, SCOUR PROTECTION AND CABLE PROTECTION

334 Foundation, cable protection and scour protection components of offshore wind farms can be viewed as artificial reefs, as these add hard substrate to areas typically characterised by soft, sedimentary environments. Man-made structures placed on the seabed attract many marine organisms including benthic species normally associated with hard substrates and therefore, may have indirect effects on fish and shellfish populations through their potential to act as artificial reefs and to bring about changes to food resources (Inger *et al*., 2009). Additionally, man-made structures may also have direct effects on fish through their potential to act as fish aggregation devices (Petersen and Malm, 2006).

335 The presence of infrastructure associated with the Proposed Development may result in the colonisation of foundations, scour protection and cable protection. The maximum design scenario is for up to 10,198,971 m^2 of habitat created due to the installation of jacket foundations, associated scour protection and cable protection associated with inter-array cables, OSP/Offshore convertor station platform interconnector cables and offshore export cables (Table 6.15). This value is, however, likely to be an over estimation of habitat creation as it is based on solid panels being used for the 317 jacket foundations. The four sides of these jackets will be made of a lattice structure; however, the precise dimensions of these lattices are unknown at the time of writing. A solid structure has therefore been assumed from the values available, noting that this will result in an overestimate of the habitat created. It is expected that the foundations and scour and cable protection will be colonised by species already occurring in the area (e.g. tunicates, Bryozoa sp., mussels and barnacles which are typical of temperate seas). The increased availability of prey species may lead to increased numbers of fish and shellfish species utilising the additional prey resource and hard substrate habitats.

336 These effects are only considered for the operation and maintenance phase as it takes time for organisms to colonise a structure post-installation. The impact is predicted to be of long term duration (35-year operation phase), continuous with medium reversibility and local spatial extent.

Maximum design scenario relevant to the assessment of adverse effects on integrity

337 The maximum design scenarios considered for the assessment of potential impacts on Annex II diadromous fish from colonised structures during the operation and maintenance phase are set out in Table 6.15.

Table 6.15: Maximum Design Scenario Considered for the Assessment of Potential Impacts on Annex II Diadromous Fish from Colonised Structures during Operation and Maintenance

Potential Impact	Maximum Design Scenario	Justification
Colonisation of foundations, scour protection and cable protection	**Operation and Maintenance Phase** Long term habitat creation of up to 10,198,971 m2 due to: • presence of up to 307 wind turbines and 10 OSP/Offshore convertor station platforms on jacket foundations; • presence of scour protection associated with wind turbines and OSP/Offshore convertor station platforms; • presence of cable protection associated with up to 1,225 km of inter-array cables, up to 94 km of interconnector cables and up to 872 km of offshore export cables. Assumes up to 15% of inter-array, OSP/Offshore convertor station platform interconnector and offshore export cables may require cable protection; • presence of cable protection for cable crossings, 78 cable crossings for array and OSP/Offshore convertor station platform interconnector cables and 16 crossings for the offshore export cable; and • operation phase of up to 35 years.	Maximum number of wind turbines and OSP/Offshore convertor station platform foundations and associated scour protection, maximum length of cables and cable protection resulting in greatest surface area for colonisation. The estimate of habitat creation from the presence of foundations has been calculated as if the foundations were a solid structure. This is, therefore, a conservative estimate of habitat creation on the basis that the jacket foundations will have a lattice design rather than a solid surface, as has been assumed.

Designed in measures relevant to the assessment of adverse effects on integrity

338 There are no designed in measures which are of relevance to the assessment of potential impacts on Annex II diadromous fish features from colonisation of structures during the operation and maintenance phase.

Information to inform Appropriate Assessments

339 Appropriate Assessments for sites for Annex II diadromous fish are presented in section 9.5. Information common to inform the Appropriate Assessments in presented in this section.

340 Hard substrate habitat created by the introduction of wind turbine foundations and scour/cable protection are likely to be primarily colonised within hours or days after construction by demersal and semi-pelagic fish species (Andersson, 2011). Continued colonisation has been seen for a number of years after the initial construction, until a stratified recolonised population is formed (Krone *et al*., 2013). Feeding opportunities or the prospect of encountering other individuals may attract fish aggregate from the surrounding areas, which may increase the carrying capacity of the area (Andersson and Öhman, 2010; Bohnsack, 1989).

341 The dominant natural substrate character of the Proposed Development fish and shellfish ecology study area (e.g. soft sediment or hard rocky seabed) will determine the number of new species found on the introduced vertical hard surface and associated scour protection. When placed on an area of seabed which is already characterised by rocky substrates, few species will be added to the area, but the increase in total hard substrate could sustain higher abundance (Andersson and Öhman, 2010). Conversely, when placed on a soft seabed, most of the colonising fish will be normally associated with rocky (or other hard bottom) habitats, thus the overall diversity of the area may increase (Andersson *et al*., 2009). A new baseline species assemblage will be formed via recolonisation and the original soft-bottom population will be displaced (Desprez, 2000). This was observed in studies by Leonhard *et al*. (Danish Energy Agency, 2013) at the Horns Rev offshore wind farm, and Bergström *et al*. (2013) at the Lillgrund offshore wind farm. An increase in fish species associated with reefs such as goldsinny wrasse *Ctenolabrus rupestris*, lumpsucker *Cycloplerus lumpus* and eelpout *Zoarces viviparous*, and a decrease in the original sandy-bottom fish population were reported (Danish Energy Agency, 2012; Bergström *et al*., 2013). A decrease in soft sediment species is contradictory to findings of Degraer *et al*. (2020) where an increase in density of soft sediment species was seen, although this increase may be related to reduced fishing pressure within the array. However, it is noted by Degraer *et al*. (2020) that these effects were site specific and therefore may not necessarily be extrapolated to other offshore wind farms.

342 The longest monitoring programme conducted to date at the Lillgrund offshore wind farm in the Öresund Strait in southern Sweden, showed no overall increase in fish numbers, although redistribution towards the foundations within the offshore wind farm area was noticed for some species (i.e. cod, eel and eelpout; Andersson, 2011). More species were recorded after construction than before, which is consistent with the hypothesis that localised increases in biodiversity may occur following the introduction of hard substrates in a soft sediment environment. Overall, results from earlier studies reported in the scientific literature did not provide robust data (e.g. some were visual observations with no quantitative data) that could be generalised to the effects of artificial structures on fish abundance in offshore wind farm areas (Wilhelmsson *et al*., 2010). More recent papers are, however, beginning to assess population changes and observations of recolonisation in a more quantitative manner (Krone *et al*., 2013).

343 There is uncertainty as to whether artificial reefs facilitate recruitment in the local population, or whether the effects are simply a result of concentrating biomass from surrounding areas (Inger *et al*., 2009). Linley *et al*. (2007) concluded that finfish species were likely to have a neutral to beneficial likelihood of benefitting, which is supported by evidence demonstrating that abundance of fish can be greater within the vicinity of wind turbine foundations than in the surrounding areas, although species richness and diversity show little difference (Wilhelmsson *et al*., 2006a; Inger *et al*., 2009). A number of studies on the effects of vertical structures and offshore wind farm structures on fish and benthic assemblages have been undertaken in the Baltic Sea (Wilhelmsson *et al*., 2006a; 2006b). These studies have shown evidence of increased abundances of small demersal fish species (including gobies Gobidae, and goldsinny wrasse) in the vicinity of structures, most likely due to the increase in abundance of epifaunal communities which increase the structural complexity of the habitat (e.g. mussels and barnacles Cirripedia spp.). It was speculated that in true marine environments (e.g. the North Sea), offshore wind farms may enhance local species richness and diversity, with small demersal species such as gobies providing prey items for larger, commercially important species including cod (which have been recorded aggregating around vertical steel constructions in the North Sea; Wilhelmsson *et al*., 2006a). Monitoring of fish populations in the vicinity of an offshore wind farm off the coast of the Netherlands indicated that the offshore wind farm acted as a refuge for at least part of the cod population (Lindeboom *et al*., 2011; Winter *et al*., 2010).

344 In contrast, post construction fisheries surveys conducted in line with the Food and Environmental Protection Act (FEPA) licence requirements for the Barrow and North Hoyle offshore wind farms, found no evidence of fish abundance across these sites being affected, either beneficially or adversely, by the presence of the offshore wind farms (Cefas, 2009; BOWind, 2008) therefore suggesting that any effects, if seen, are likely to be highly localised and while of uncertain duration, the evidence suggests effects are not adverse.

<u>Impacts to diadromous fish from colonisation of structures</u>

345 Diadromous species that are likely to interact with the Proposed Development are only likely to do so by passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate within

the Proposed Development fish and shellfish ecology study area for feeding or shelter opportunities as they are only likely to be in the vicinity when passing through during migration.

346 However, there is potential for impacts upon diadromous fish species resulting from increased predation by marine mammal species within offshore wind farms. Tagging of harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus* around Dutch and UK wind farms provided significant evidence that the seal species were utilising wind farm sites as foraging habitats (Russel *et al*., 2014), specifically targeting introduced structures such as wind turbine foundations. However, a further study using similar methods concluded that there was no change in behaviour within the wind farm (McConnell *et al*., 2012), so it is not certain exactly to what extent seals utilise offshore wind developments and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, diadromous fish species may be impacted by the increased predation in an area where predation was lower prior to development. It is, however, unlikely that this would result in significant predation on diadromous species.

347 Research has shown that Atlantic salmon smolts spend little time in the coastal waters, and instead are very active swimmers through coastal waters, making their way to feeding grounds in the north quickly (Gardiner *et al*., 2018a; Gardiner *et al*., 2018a; Newton *et al*., 2017; Newton *et al*., 2019; Newton *et al*., 2021) (see volume 3, appendix 9.1 for further detail on Atlantic salmon migration). Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland, it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators.

348 The low risk of effects on diadromous fish species extends to the freshwater pearl mussel, which is included in the diadromous species section, as part of its life stage is reliant on diadromous fish species including Atlantic salmon.

349 Sea lamprey and river lamprey are parasitic in their marine phase, feeding off larger fish and marine mammals (Hume, 2017). As such it is not expected that they will be particularly attracted to structures associated with offshore wind developments. However, this is not certain, as there is limited information available on the utilisation of the marine environment by sea lamprey.

350 Overall, Annex II diadromous fish species are deemed to be of low vulnerability, high recoverability and therefore low sensitivity. This is based on the expected limited attraction/overlap to offshore structure by diadromous fish species, specifically lamprey species and Atlantic salmon, as discussed above, and therefore there is not expected to be a significant risk of increase predation around colonised foundation structures.

6.5 INFORMATION TO INFORM ASSESSMENT OF ADVERSE EFFECTS ON INTEGRITY

6.5.1 TWEED ESTUARY SAC

European site information

351 The Tweed Estuary SAC is located 46.5 km from the Proposed Development array area and 29 km from the Proposed Development export cable corridor. The site, located in Northumberland, encompasses the Tweed Estuary, a long and narrow estuary discharging into the North Sea. The site is designated for Annex I habitats and Annex II species, including diadromous fish species river lamprey and sea lamprey. The condition of the SAC's features had not been assessed at the time of writing.

352 Further information on this European site is presented in appendix A.

Conservation objectives

353 The conservation objectives for the Tweed Estuary SAC have been developed by Natural England and apply to the site and the individual species and/or assemblage of species for which the site has been classified. These high-level objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the favourable conservation status of its qualifying features, by maintaining or restoring:

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

354 A condition assessment has not yet been undertaken for this site.

355 Supplementary advice on conservation objectives, last updated on the 13 March 2020, provides the site-specific attributes and targets specific to the sea lamprey and river lamprey features of the site. These supplementary attributes and targets are considered in the assessments below and are provided for reference in appendix A.

356 Supplementary advice is available for sea lamprey and river lamprey. Attributes and targets are summarised in appendix A. All targets for these species have been set as 'Maintain' by Natural England, using expert judgement based on knowledge of the sensitivity of the feature to activities that are occurring/have occurred on the site.

Features and effects for assessment

357 Table 6.16 summarises the LSEs that were identified for the Annex II diadromous fish species features of the Tweed Estuary SAC and the features and effects which have been considered in the assessment of Adverse Effects on Integrity for this site.

Table 6.16: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the Tweed Estuary SAC

Annex II Species Feature	Injury and/or Disturbance from Underwater Noise and Vibration	Increased SSC and Sediment Deposition	EMF from Subsea Electrical Cabling	Colonisation of Hard Structures
Sea lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
River lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase

Construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

Sea lamprey

358 As discussed in section 6.3.1, pile driving during the installation of foundations for wind turbines and OSP/Offshore convertor station platforms within the Proposed Development array area and UXO clearance pre-construction, have the potential to lead to injury and/or disturbance to sea lamprey due to underwater noise impacts. Sea lamprey, which are considered to be a Group 1 fish in terms of hearing sensitivity, has relatively low sensitivity to underwater noise.

359 The results of project specific modelling, as discussed in paragraphs 283 to 287, indicate that injury and/or mortality to sea lamprey can be expected only for individuals within approximately 138 m of the piling. A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4.161 km for Group 1 species from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 138 m for Group 1 species) TTS ranges for Group 1 fish (sea lamprey) may increase up to 7.1 km from the piling location for the maximum energy scenario (Table 6.7).

360 However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

361 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to sea lamprey. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish species. The results of project specific modelling, discussed in paragraphs 288 to 289, indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation (the dominant method of UXO detonation). Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

362 However, due to the nature of diadromous fish species such as sea lamprey being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of sea lamprey is not expected. Sea lamprey spend most of their adult life at sea and it has been suggested that they are widely dispersed at sea, possibly feeding in deeper offshore waters (OSPAR Commission, 2009). They are rarely captured in coastal and estuarine waters, suggesting that they are solitary hunters and widely dispersed at sea as opposed to remaining in coastal waters (Marine Scotland Directorate, 2019).

363 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 295 to 296. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development fish and shellfish ecology study area and the migration routes of sea lamprey along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

364 Given the above, the population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the Tweed Estuary SAC as a result of underwater noise impacts during the construction and decommissioning phases.

River lamprey

365 River lamprey is, like sea lamprey, classified as a Group 1 fish for the purposes of hearing sensitivity and as such the assessment for sea lamprey presented above in paragraphs 358 to 363 also applies to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with the Proposed Development.

366 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC therefore the extent and distribution of river lamprey habitat will be unaffected. There will, therefore, be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the Tweed Estuary SAC, as a result of underwater noise impacts during the construction and decommissioning phases.

Conclusion

367 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Tweed Estuary SAC, so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the relatively low sensitivity of the qualifying species to underwater noise impacts, the low probability of individuals being present within the ZoI of underwater noise impacts at the time of piling and UXO activities, the use of soft start procedures allowing individuals to flee areas where they may be exposed to noise levels that would lead to injury, and the absence of any barrier effects to migration of adult or juvenile diadromous species, the populations and the distribution of the qualifying species will be maintained.

368 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity of the Tweed Estuary SAC as a result of underwater noise impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Increased suspended sediment concentrations and associated sediment deposition

Sea lamprey

369 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in migratory fish. This in turn has the potential to result in barriers to migration.

370 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of sea lamprey are expected.

371 Given the above, the population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II

diadromous fish feature, sea lamprey of the Tweed Estuary SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

River lamprey

372 River lamprey will have a similar sensitivity to SSC as sea lamprey therefore the assessment for sea lamprey, presented in paragraphs 369 to 370, is applicable to river lamprey.

373 In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with SSC and sediment deposition arising from the construction and decommissioning of the Proposed Development.

374 Given the above, the population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey, of the Tweed Estuary SAC, as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Conclusion

375 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Tweed Estuary SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given that any increases in SSC are predicted to be temporary, short lived and lower than estuarine levels, there will be no barriers to the migration of the qualifying species. As such, the population and the distribution of the qualifying species will be maintained.

376 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity of the Tweed Estuary SAC as a result of increased SSC and sediment deposition impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

EMF from subsea electrical cabling

Sea lamprey

377 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of diadromous fish species such as sea lamprey. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables (see Table 6.14). Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient.

378 Given the above, the population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced., The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the Tweed Estuary SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

River lamprey

379 River lamprey will have a similar sensitivity to EMF as sea lamprey therefore the assessment presented in paragraphs 377 to 378 for sea lamprey is also applicable to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with cables associated with the Proposed Development.

380 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the Tweed Estuary SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Conclusion

381 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Tweed Estuary SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given any impacts from EMF will be localised and transient and predicted low sensitivity of the qualifying species to this impact, the population and distribution of the qualifying species will be maintained.

382 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of EMF impacts with respect to operation and maintenance of the Proposed Development acting alone.

Colonisation of foundations, scour protection and cable protection

Sea lamprey

383 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. It is not certain exactly to what extent seals utilise offshore wind developments (as discussed in paragraph 346) and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, sea lamprey may be impacted by the increased predation in an area where predation was lower prior to development.

384 There is limited available information on the utilisation of the marine environment by sea lamprey. However, as they are parasitic in their marine phase, feeding off larger fish and marine mammals (Hume, 2017), it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected.

385 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the Tweed Estuary SAC as a result of colonisation of foundations, scour protection and cable protection impacts during the operation and maintenance phase.

River lamprey

386 River lamprey will have a similar sensitivity to colonisation of foundations, scour protection and cable protection impacts as sea lamprey therefore the assessment presented in paragraphs 383 to 384 for sea

lamprey will also apply to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development.

387 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the Tweed Estuary SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the Tweed Estuary SAC are not predicted to occur as a result of colonisation of foundations, scour protection and cable protection impacts during the operation and maintenance phase.

Conclusion

388 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Tweed Estuary SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the limited interaction between the qualifying species and the Proposed Development significant predation in relation the colonisation of foundations, scour protection and cable protection impact are not expected therefore the population and distribution of the qualifying species will be maintained.

389 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of colonisation of foundation, scour protection and cable protection impact with respect to the operation and maintenance of the Proposed Development acting alone.

Effects in-combination

390 An assessment of in-combination effects upon the qualifying Annex II diadromous fish species of the Tweed Estuary SAC arising from each identified impact is provided below.

Assessment of In-combination Effects During Construction

Injury and/or disturbance from underwater noise and vibration

391 There is potential for in-combination effects from injury and/or disturbance from underwater noise and vibration to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase); and
  - Seagreen 1A Project (construction phase).
- Tier 3:
  - There is no information provided regarding UXO clearance for the Cambois connection therefore no meaningful assessment can be made at this time.

Tier 2

392 The Tier 2 projects included in the in-combination assessment (i.e. Inch Cape and Seagreen 1A Project) include similar construction activities as those described for the Proposed Development alone including piling of wind turbine and OSP/Offshore convertor station platform foundations. All other noise sources including cable installation and foundation drilling will result in much lower noise levels than piling and will not represent a risk to injury or cause significant disturbance to diadromous fish, such that they would result in in-combination effects with or from other projects. As such, the scope of this assessment focusses on piling noise, which represents the greatest risk to diadromous fish receptors.

393 The construction phases of Inch Cape Offshore Wind Farm and Seagreen 1A Project overlap the construction phase of the Proposed Development with construction for Inch Cape Offshore Wind Farm predicted to end in 2025 and Seagreen 1A Project predicted to end in 2025. During the time when construction phases overlap, there is the potential for in-combination effects.

394 Neither Inch Cape Offshore Wind Farm nor Seagreen Alpha/Bravo Offshore Wind Farm EIA Reports predicted significant effects on fish and shellfish receptors. Any effects were predicted to be temporary and reversible following cessation of piling activities. Additionally, the injury ranges reported are likely to be conservative as soft start measures will be implemented as part of the Inch Cape Offshore Wind Farm and Seagreen 1A Project construction programmes, which will reduce the risk of injury considerably. Due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and Inch Cape Offshore Wind Farm and Seagreen 1A Project, in-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

395 The in-combination effect is predicted to be of regional spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

396 Significant adverse effects on the qualifying Annex II diadromous fish species, sea lamprey and river lamprey, of the Tweed Estuary SAC are not predicted to occur as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects.

397 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of injury and/or disturbance from underwater noise and vibration with respect to the Proposed Development acting in-combination with Tier 2 projects.

Increased Suspended Sediment Concentrations and Associated Sediment Deposition

398 There is potential for in-combination effects from increased SSC and associated sediment deposition impacts to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase);
  - Seagreen 1A Project (construction phase);
  - Seagreen 1 (operation and maintenance phase);
  - Seagreen 1A Export Cable (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase);
  - Eastern Link 1 (construction phase);
  - Eastern Link 2 (construction phase); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

Tier 2

399 The Inch Cape Offshore Wind Farm will be in the final year of construction, with the installation of the offshore export cable being programmed for the period of overlap with the Proposed Development. The cable route is located to the east of the Proposed Development and should trenching activities be

undertaken simultaneously the sediment plumes would not interact with those from the Proposed Development.

400 The construction phase of the Proposed Development coincides with the construction phase for the Seagreen 1A Project. Construction of its 36 wind turbines will be completed by the end of 2025, which will lead to a potential overlap with the construction phase of the Proposed Development.

401 During the Proposed Development's construction phase the Neart na Gaoithe Offshore Wind Farm and the Seagreen 1A Export Cable Corridor will be in operational phase and maintenance activities may result in increased SSCs, however these activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development.

402 The Eastern Link 1 Cable has a Scottish landfall near Thorntonloch Beach, East Lothian. The landfall installation is proposed to be by Horizontal Directional Drilling (HDD) and although it is not yet confirmed which subsea trenching techniques will be used to install the cables, it is anticipated that mechanical ploughing or cutting and/or water jetting or mass flow excavator techniques will be used at different points along the route, in response to the seabed sediment conditions. Installation of the cables into soft sediments will seek to achieve a target burial depth of at least 1.5 m to 2 m and below the depth of mobile sediments depending on the nature of the seabed and potential hazards. These activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development.

403 The Eastern Link 2 Cable runs to the east of the Proposed Development. The preferred subsea cable protection method is burial through trenching. It is not yet confirmed what subsea trenching equipment will be used to install the cables; however, it is anticipated similar methods to those proposed for Eastern Link 1 may be required, but this is dependent on the seabed conditions present within the cable corridor. These activities would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development.

404 The in-combination effects assessment considers sea disposal of dredged material at the Eyemouth disposal site, located 31 km and 16.5 km from the Proposed Development array area and Proposed Development export cable corridor respectively. If offshore cable installation and dredge material disposal coincided, both resultant plumes would be advected on the tidal currents. The plumes would travel in parallel, and not towards one another, and are unlikely to interact in the event that offshore cables installation coincides with the use of the licensed sea disposal site (see volume 3, appendix 7.1 of the Offshore EIA Report).

405 The in-combination effect is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

406 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

407 During the construction phase of the Proposed Development there is the potential for in-combination effects with one Tier 3 cable installation. The Cambois connection is a 170 km cable route extending southwards from the Proposed Development array area. Scoping indicates the project will consist of four cables installed in 2 m wide trenches up to 3 m in depth. Installation techniques may include jet trenching or cable ploughing, as ground conditions dictate. Site preparation will be required, such as boulder and sand wave clearance as part of the 36-month construction programme.

408 The in-combination effect is predicted to be of local spatial extent, short term duration, intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect. As such, there will be no effect on the ability of diadromous fish to migrate to and from the relevant SACs considered within this RIAA.

409 Significant adverse effects on the qualifying Annex II diadromous fish species, sea lamprey and river lamprey, of the Tweed Estuary SAC are not predicted to occur as a result of increased SSC and associated sediment deposition during the construction phase of the Proposed Development in-combination with other projects.

410 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 3 projects.

<u>Assessment of in-combination effects during the operation and maintenance phase</u>

EMF from subsea electrical cabling

411 There is potential for in-combination effects from EMFs from subsea electrical cabling impacts to Annex II diadromous fish during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

Tier 2

412 Inch Cape Offshore Wind Farm has the potential to produce EMF from 553 km of inter-array cables suitably buried and protected where burial is not possible. Additionally, the offshore export cables are approximately 83 km for each six cables, therefore the offshore export cables total length is 498 km. This project will use a combination of HVAC and HVDC, however the design was not finalised in the environmental statement.

413 Neart na Gaoithe Offshore Wind Farm has the potential to produce EMF from 66 km of offshore export cables as well as 140 km of inter-array cables. This project will use a combination of HVAC and HVDC, however the design was not finalised in the environmental statement.

414 Seagreen 1 and Seagreen 1A Project have the potential to produce EMF from 710 km of inter-array cables and 530 km of offshore export cables resulting in 1,240 km of subsea cabling. These projects will use a combination of HVAC and HVDC however the design was not finalised in the environmental statement. The Seagreen 1A Export Cable environmental statement does not provide details of the cable specifications used, but provides an approximate cable length of 110 km, which will have the potential to cause EMF effects. Eastern Link 1 and Eastern Link 2 cables also have the potential to cause EMF effects.

415 The potential for in-combination effects of EMF on diadromous fish species during the Proposed Development operation and maintenance phase results from up to 6,112 km of subsea cabling, including the cables associated with the Proposed Development.

416 Whilst any in-combination effects are predicted to be of long-term duration, continuous and not reversible during the operation of the relevant projects, they are also predicted to be of local spatial extent. Diadromous fish species have been assessed as having low sensitivity to EMF from electrical subsea cabling. This can be concluded as EMF effects are confined to the close vicinity of cables. Diadromous fish species are pelagic, swimming in the water column and therefore less likely to interact with emitted EMF from subsea cables. While the sediments in which cables are buried will not reduce the strength of EMF, the burial of cables does increase the distance between cables and diadromous fish, with greater attenuation of EMFs with greater distance from the cable, thereby reducing the effect of EMFs on diadromous fish.

417 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

418 The Tier 3 project which has the potential to result in in-combination EMF effects from subsea electrical cabling within the Proposed Development fish and shellfish ecology study area is the Cambois connection. There is, however, currently no information on the impact that this project will have on diadromous fish, however effects of EMF from the Cambois connection are likely to be similar in magnitude and extent as that discussed for the Proposed Development and the other projects considered in the in combination assessment as set out above.

419 The in-combination effect is predicted to be low and the sensitivity of diadromous fish species is predicted to be low with high recoverability.

420 Significant adverse effects on the qualifying Annex II diadromous fish species, sea lamprey and river lamprey, of the Tweed Estuary SAC are not predicted to occur as a result of EMF from subsea electrical cabling during the operation of the Proposed Development in-combination with other projects.

421 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 3 projects.

Colonisation of foundations, scour protection and cable protection

422 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. This impact is only relevant to the operation and maintenance phase as it takes time for colonisation to establish post construction. The presence of the following projects has the potential to lead to in-combination effects arising from the colonisation of hard structures:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection

Tier 2

423 There are no values for long term habitat loss provided in the EIA Report for Seagreen 1A Export Cable Corridor however 20% of the 110 km may require cable protection up to 6 m wide (Seagreen Wind Energy Ltd., 2021).

424 Inch Cape Offshore Wind Farm will contribute to in-combination effects from the colonisation of hard structures through the presence of wind turbines, substations, and meteorological masts, as well as cable protection for the inter-array and offshore export cables. In the Inch Cape EIA Report it is stated that the amount of new hard substrate resulting from Inch Cape Offshore Wind Farm is equivalent to the amount of long-term habitat loss (Inch Cape Offshore Limited, 2018) equates to 2,470,000 m^2 of new hard structures (Inch Cape Offshore Limited, 2018).

425 At the Neart na Gaoithe Offshore Wind Farm, colonisation of hard substrate is predicted to result from the presence of gravity base foundations for the wind turbine foundations, substation foundations, scour protection and cable protection. The amount of new hard substrate available is equivalent to the amount of long-term habitat loss which equates to 460,000 m^2 of new hard structures (Mainstream Renewable Power, 2019).

426 Seagreen 1 and Seagreen 1A Project maximum design scenario for the colonisation of hard structures, as stated in the environmental statements (Seagreen Wind Energy, 2012), show that the area available for colonisation is expected to be approximately the same area as is considered for as for long-term habitat loss, which equates to 2,184,100 m^2 of new hard structure (Seagreen Wind Energy, 2012).

427 The hard substrate installed for Eastern Link 1 includes rock berm with a maximum width of 7 m, no further values regarding hard substrate have been provided (National Grid Electricity Transmission and Scottish Power Transmission, 2022). The hard substrate installed for Eastern Link 2 includes rock berms up to 138 km, six pipeline crossings, 18 cable crossings and rock protection at the landfall. The amount of new hard substrate available equates to 2,200,200 m^2 (National Grid Electricity Transmission and Scottish Hydro Electric Transmission plc, 2022).

428 The presence of the Tier 2 projects has the potential to lead to cumulative impacts arising from the colonisation of up to 17,513,271 m^2 of hard structures.

429 The assessment of effects on diadromous fish from the Proposed Development alone concluded that Annex II diadromous fish species have low vulnerability, high recoverability, and therefore low sensitivity to colonisation of foundations, scour protection and cable protection. This is because, diadromous fish are only likely to interact with the Proposed Development when passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate from the Proposed Development for feeding or shelter opportunities. Whilst there is potential for increased predation of diadromous fish by marine mammal species attracted to offshore wind farm structures, again impacts on diadromous fish are not anticipated to be significant given diadromous fish spend little time in coastal waters and are unlikely to spend time foraging around wind turbines foundations and therefore are at low risk from increased predation.

430 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

431 Significant adverse effects on the qualifying Annex II diadromous fish species, sea lamprey and river lamprey, of the Tweed Estuary SAC are not predicted to occur as a result of colonisation of foundations, scour protection and cable protection during the operation of the Proposed Development in-combination with other projects.

432 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

433 The Tier 3 project which has the potential to result in in-combination effects associated with the colonisation of structures is the Cambois connection. The Cambois connection has the potential to create 306,000 m^2 of new hard habitat associated with rock/mattress cable protection which represents protection covering 15% the total length the four offshore export cables, therefore it is likely that only a proportion of the cable protection will occupy the fish and shellfish ecology CEA study area, or potentially none of it. The cable protection represents a change in seabed type, however as the cable protection does not extend into the water column the opportunity for colonisation by some species is reduced. The presence of the Tier 2 and 3 projects has the potential to lead to cumulative impacts arising from the colonisation of up to 17,543,971 m^2 of hard structures.

434 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

435 Significant adverse effects on the qualifying Annex II diadromous fish species, sea lamprey and river lamprey, of the Tweed Estuary SAC are not predicted to occur as a result of colonisation of foundations, scour protection and cable protection during the operation of the Proposed Development in-combination with other projects.

436 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Tweed Estuary SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 3 projects.

Site conclusion

437 In conclusion, with reference to the conservation objectives set for the Annex II diadromous fish features of the site and the information presented in sections 6.3, 6.4 and 6.5.1, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the Tweed Estuary SAC in respect of the sea lamprey and river lamprey qualifying interests.

438 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

6.5.2 RIVER TWEED SAC

European site information

439 The River Tweed SAC is located 51.6 km from the Proposed Development array site and 34.1 km from the Proposed Development export cable corridor. The site, located in Eastern Scotland and Northumberland and Tyne and Wear encompasses 3742.62 ha of the River Tweed's catchment and 1,285 km of watercourse (NatureScot, 2020). The site is designated for Annex I habitats and Annex II species, including diadromous fish species sea lamprey, river lamprey and Atlantic salmon.

440 Further information on this European site is presented in appendix A.

Conservation objectives

441 The River Tweed SAC crosses the border between England and Scotland. Management of the River Tweed SAC is shared by Natural England and NatureScot and conservation objectives for the site have been published by both SNCBs (NatureScot, 2020; Natural England, 2018). In this assessment, both sets of conservation objectives have been consulted as the features being assessed are diadromous fish, and therefore may migrate to/from the English or Scottish parts of the SAC.

442 Conservation objectives and related supplementary advice developed by Natural England apply to those parts of the SAC lying in England (Natural England, 2019). The high-level objectives for the site are:

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

443 Supplementary advice on conservation objectives, published on 19 March 2019 (Natural England, 2019), provides the site-specific attributes and targets specific to the sea lamprey, river lamprey and Atlantic salmon features of the site: These supplementary attributes and targets are considered in the assessments below and are provided for reference in appendix A.

444 A Conservation Advice Package for River Tweed SAC has been also developed by NatureScot (NatureScot 2020). Conservation objectives for all qualifying species are:

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

445 Conservation objectives for sea lamprey and river lamprey are as follows:

- 2a. Maintain the population of the lamprey species' as viable components of the site;
- 2b. Maintain the distribution of the lamprey species throughout the site; and
- 2c. Maintain the habitats supporting the lamprey species within the site, and availability of food.

446 Conservation objectives for Atlantic salmon are as follows:

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

447 The condition of diadromous fish features at the site was assessed in 2011 and 2018 (NatureScot, 2020). The outcome of the feature condition assessment was as follows:

- Sea lamprey (assessed 2018): Unfavourable declining;
- River lamprey (assessed 2018): Favourable maintained; and
- Atlantic salmon (assessed 2011): Favourable maintained.

Features and effects for assessment

448 Table 6.17 summarises the LSEs that were identified for the Annex II diadromous fish species features of the River Tweed SAC and the features and effects which have been considered in the assessment of Adverse Effects on Integrity for this site.

Table 6.17: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Tweed SAC

Annex II Species Feature	Injury and/or Disturbance from Underwater Noise and Vibration	Increased SSC and Sediment Deposition	EMF from Subsea Electrical Cabling	Colonisation of Hard Structures
Sea lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
River lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
Atlantic salmon (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase

Construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

Atlantic salmon

449 Atlantic salmon which are a Group 2 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to Atlantic salmon can be expected for individuals within approximately 228 m of the piling.

450 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 2 fish from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m for Group 2 fish) TTS ranges for Group 2 fish may be increased to up to 7.1 km from the piling location for the maximum energy scenario (Table 6.7). However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

451 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to Atlantic salmon. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish. The results of project specific modelling, discussed in paragraphs 288 to 289 indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation (the dominant method of UXO detonation). Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

452 However, due to the nature of diadromous fish species such as Atlantic salmon being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of Atlantic salmon is not expected.

453 Additionally, available evidence on Atlantic salmon migration patterns from and to Scottish rivers (detailed in section 6.2.5) suggests that Atlantic salmon smolts migrating from rivers take advantage of east flowing currents and cross the North Sea relatively rapidly. Therefore, it is likely that whilst migrating salmon moving to and from the River Tweed SAC will pass through the Proposed Development fish and shellfish ecology study area, either in their outward or inward migration, this migration will be rapid, reducing the potential for interaction with the Proposed Development.

454 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 296 to 300. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development and the migration routes of Atlantic salmon along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

455 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Tweed SAC, so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tweed SAC as a result of underwater noise impacts during the construction and decommissioning phases.

Sea lamprey

456 As discussed in section 6.3.1, sea lamprey, which are considered to be a Group 1 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to sea lamprey can be expected for individuals within approximately 138 m of the piling.

457 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 1 species from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 138 m for Group 1 species) TTS ranges for Group 1 fish (sea lamprey) may increase up to 7.1 km from the piling location for the maximum energy scenario (Table 6.7).

458 However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

459 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to sea lamprey. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish species. The results of project specific modelling, discussed in paragraphs 288 to 289, indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

460 However, due to the nature of diadromous fish species such as sea lamprey being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study

area to pass through during migration, significant mortality of sea lamprey is not expected. Sea lamprey spend most of their adult life at sea and it has been suggested that they are widely dispersed at sea, possibly feeding in deeper offshore waters (OSPAR Commission, 2009). They are rarely captured in coastal and estuarine waters, suggesting that they are solitary hunters and widely dispersed at sea as opposed to remaining in coastal waters (Marine Scotland Directorate, 2019).

461 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 297 to 298. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development and the migration routes of sea lamprey along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

462 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tweed SAC as a result of underwater noise impacts during the construction and decommissioning phases.

River lamprey

463 River lamprey is, like sea lamprey, classified as a Group 1 fish for the purposes of hearing sensitivity and as such the assessment for sea lamprey presented above also applies to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with the underwater noise arising from the Proposed Development.

464 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Tweed SAC as a result of underwater noise impacts during construction/decommissioning.

Conclusion

465 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Tweed SAC, so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the relatively low sensitivity of the qualifying species to underwater noise impacts, the low probability of individuals being present within the ZoI of underwater noise impacts at the time of piling and UXO activities, and the use of soft start procedures allowing individuals to flee areas where they may be exposed to noise levels that would lead to injury, the populations and the distribution of the qualifying species will be maintained.

466 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of underwater noise impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Increased suspended sediment concentrations and associated sediment deposition

Atlantic salmon

467 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in Atlantic salmon. This in turn has the potential to result in barriers to migration.

468 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of Atlantic salmon are expected.

469 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tweed SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Sea lamprey

470 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in sea lamprey. This in turn has the potential to result in barriers to migration.

471 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of sea lamprey are expected.

472 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tweed SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

River lamprey

473 River lamprey will have a similar sensitivity to increased SSC as sea lamprey therefore the assessment for sea lamprey, presented in paragraphs 471 to 472, will also apply to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with elevated SSC arising from the construction or decommissioning of the Proposed Development.

474 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying species of the River Tweed SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Conclusion

475 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Tweed Estuary SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given that any increases in SSC are predicted to be temporary, short lived and lower than estuarine levels, there will be no barriers to the migration of the qualifying species. As such, the population and the distribution of the qualifying species will be maintained.

476 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of increased SSC and sediment deposition with respect to construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

EMF from subsea electrical cabling

Atlantic salmon

477 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of Atlantic salmon. However, impacts related to EMF are predicted to be of local spatial extent (i.e. within a few metres of buried cables). Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Whilst research shows that undersea power cables can result in altered patterns of salmonid behaviour, these changes are temporary and do not interfere with migration success or population health. Atlantic salmon is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

478 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tweed SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Sea lamprey

479 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of sea lamprey. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables (see Table 6.14). Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient. Sea lamprey is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

480 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Tweed SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tweed SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

River lamprey

481 River lamprey will have a similar sensitivity to EMF as sea lamprey therefore the assessment presented in paragraph 479 to 480 for sea lamprey will also apply to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with cables associated with the Proposed Development.

482 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey and will not be reduced, and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Tweed SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Conclusion

483 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Tweed SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given any impacts from EMF will be localised and transient and the predicted low sensitivity of the qualifying species to this impact, the population and distribution of the qualifying species will be maintained.

484 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity of the River Tweed SAC as a result of EMF impacts with respect to operation and maintenance of the Proposed Development acting alone.

Colonisation of foundations, scour protection and cable protection

Atlantic salmon

485 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. It is not certain exactly to what extent seals utilise offshore wind developments (as discussed in paragraph 346) and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, Atlantic salmon may be impacted by the increased predation in an area where predation was lower prior to development.

486 It is, however, unlikely that this would result in significant predation on Atlantic salmon, as research has shown that Atlantic salmon smolts spend little time in the coastal waters and instead quickly make their way to feeding grounds in the north (as discussed in paragraph 347). Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland (see paragraph 347), it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators.

487 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tweed SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

Sea lamprey

488 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. Assuming that seals do utilise offshore wind developments as foraging areas, sea lamprey may be impacted by the increased predation in an area where predation was lower prior to development.

489 There is limited available information on the utilisation of the marine environment by sea lamprey, however, as they are parasitic in their marine phase, feeding off larger fish and marine mammals (Hume, 2017), it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected.

490 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tweed SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

River lamprey

491 River lamprey will have a similar sensitivity to colonisation of foundations, scour protection and cable protection impacts as sea lamprey therefore the assessment for sea lamprey presented in paragraphs 488 to 489 is also applicable to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development.

492 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Tweed SAC as a result of colonisation of foundations, scour protection and cable protection impacts during the operation and maintenance phase.

Conclusion

493 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Tweed SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the limited interaction between the qualifying species and the Proposed Development significant predation in relation the colonisation of foundations, scour protection and cable protection impact are not expected therefore the population and distribution of the qualifying species will be maintained.

494 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC from colonisation of foundations, scour protection and cable protection impacts with respect to operation and maintenance of the Proposed Development acting alone.

Effects in-combination

495 An assessment of in-combination effects upon the qualifying Annex II diadromous fish species of the Tweed Estuary SAC arising from each identified impact is presented in section 6.5.1. Since the results are generic to diadromous fish species, the results of the assessments for each impact apply to the other SACs. Therefore, full details of the in-combination assessments are not repeated here for the River Tweed SAC. The in-combination effects conclusions for the River Tweed SAC are summarised below.

Assessment of In-combination Effects During Construction and Decommissioning

Injury and/or disturbance from underwater noise and vibration

496 There is potential for in-combination effects from injury and/or disturbance from underwater noise and vibration to Annex II diadromous fish features of the site (i.e. sea lamprey and river lamprey and Atlantic salmon) during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm; and
  - Seagreen 1A Project.
- Tier 3:
  - There is no information provided regarding UXO clearance for the Cambois connection therefore no meaningful assessment can be made at this time.

497 As discussed in section 6.5.1, these projects include similar construction activities as those described for the Proposed Development alone in section 6.3.1, including piling to install wind turbine and OSP/Offshore convertor station platform foundations.

498 Neither Inch Cape Offshore Wind Farm nor Seagreen Alpha/Bravo Offshore Wind Farm EIA Reports predicted significant effects on fish and shellfish receptors. Any effects were predicted to be temporary and reversible following cessation of piling activities. Additionally, the injury ranges reported are likely to be conservative as soft start measures will be implemented as part of the Inch Cape Offshore Wind Farm and Seagreen 1A Project construction programmes, which will reduce the risk of injury considerably. Due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and Inch Cape Offshore Wind Farm and Seagreen 1A Project, in-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

499 The in-combination effect is predicted to be of regional spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

500 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of injury and/or disturbance from underwater noise and vibration with respect to the Proposed Development acting in-combination with Tier 2 projects.

Increased suspended sediment concentrations and associated sediment deposition

501 There is potential for in-combination effects from increased SSC and associated sediment deposition impacts to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase);
  - Seagreen 1A Project (construction phase);
  - Seagreen 1 (operation and maintenance phase);
  - Seagreen 1A Export Cable (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase);
  - Eastern Link 1 (construction phase);
  - Eastern Link 2 (construction phase); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

502 Any increase in SSC and associated sediment deposition for the Proposed Development alone has been assessed as being of local spatial extent, short term duration with high reversibility of any changes to the

baseline. Whilst there may be some temporal overlap between the construction phase of the Proposed Development and the projects listed above, any impacts from increased SSC and associated sediment deposition from these projects will also be of limited spatial extent, short-term duration and they are unlikely to interact with the sediment plumes of the Proposed Development.

503 The in-combination effect is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect. As such, there will be no effect on the ability of diadromous fish to migrate to and from the relevant SACs considered within this RIAA.

504 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

EMF from subsea electrical cabling

505 There is potential for in-combination effects from EMFs from subsea electrical cabling impacts to Annex II diadromous fish during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

506 Whilst any in-combination effects are predicted to be of long-term duration, continuous and not reversible during the operation of the relevant projects, they are also predicted to be of local spatial extent. Diadromous fish species have been assessed as having low sensitivity and high recoverability from EMF from electrical subsea cabling impacts. This can be concluded as EMF effects are confined to the close vicinity of cables. Diadromous fish species are pelagic, swimming in the water column and therefore less likely to interact with emitted EMF from subsea cables. While the sediments in which cables are buried will not reduce the strength of EMF, the burial of cables does increase the distance between cables and diadromous fish, with greater attenuation of EMFs with greater distance from the cable, thereby reducing the effect of EMFs on diadromous fish. The sensitivity of diadromous fish species is predicted to be low with high recoverability. There is, however, currently no information on the impact that this project will have on diadromous fish, however effects of EMF from the Cambois connection are likely to be similar in magnitude and extent as that discussed for the Proposed Development and the other projects considered in the in combination assessment as set out above.

507 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Colonisation of foundations, scour protection and cable protection

508 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. This impact is only relevant to the operation and maintenance phase as it takes time for colonisation to establish post construction. The presence of the following projects has the potential to lead to in-combination effects arising from the colonisation of hard structures:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

509 The assessment of effects on diadromous fish from the Proposed Development alone concluded that Annex II diadromous fish species have low vulnerability, high recoverability, and therefore low sensitivity to colonisation of foundations, scour protection and cable protection. This is because, diadromous fish are only likely to interact with the Proposed Development when passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate from the Proposed Development for feeding or shelter opportunities. Whilst there is potential for increased predation of diadromous fish by marine mammal species attracted to offshore wind farm structures, again impacts on diadromous fish are not anticipated to be significant given diadromous fish spend little time in coastal waters and are unlikely to spend time foraging around wind turbines foundations and therefore are at low risk from increased predation.

510 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

511 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Site conclusion

512 In conclusion, with reference to the conservation objectives set for the Annex II diadromous fish features of this site and the information presented in sections 6.3, 6.4 and 6.5.2, it can be concluded beyond all reasonable scientific doubt that there is will be no Adverse Effect on Integrity on the River Tweed SAC in respect of the sea lamprey, river lamprey and Atlantic salmon qualifying interests.

513 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

6.5.3 RIVER SOUTH ESK SAC

European site information

514 River South Esk SAC is located 51.35 km from the Proposed Development array area and 76.45 km from the Proposed Development export cable corridor. The site is located in Angus in Eastern Scotland and

spans 471.85 ha. The site is designated for two Annex II fish species: Atlantic salmon and freshwater pearl mussel.

515 Further information on this European site is presented in appendix A.

Conservation objectives

516 Conservation objectives for the River South Esk SAC have been developed by NatureScot as part of a Conservation Advice Package (NatureScot, 2020). Conservation objectives for all qualifying features are:

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

517 Conservation objectives for freshwater pearl mussel are as follows:

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

518 Conservation objectives for Atlantic salmon are as follows:

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

519 The condition of freshwater pearl mussel at the site was assessed in 2009 and Atlantic salmon condition was assessed in 2011 (NatureScot, 2020). The outcomes of these feature condition assessments were as follows:

- Freshwater pearl mussel: Unfavourable no change; and
- Atlantic salmon: Unfavourable recovering.

520 Freshwater pearl mussel has been assessed through NatureScot's site condition monitoring programme as being in unfavourable condition at River South Esk SAC due to the low number and density of freshwater pearl mussels present, low levels of juvenile recruitment, biological oxygen demand (fine sediments), and disturbance of mussel beds through largely historical illegal pearl fishing.

Features and effects for assessment

521 Table 6.18 summarises the LSEs that were identified for the Annex II diadromous fish species feature, and dependent species (i.e. freshwater pearl mussel), of the River South Esk SAC and the features and effects which have been considered in the assessment of Adverse Effects on Integrity for this site.

Table 6.18: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River South Esk SAC

Annex II Species Feature	Injury and/or Disturbance from Underwater Noise and Vibration	Increased SSC and Sediment Deposition	EMF from Subsea Electrical Cabling	Colonisation of Hard Structures
Atlantic salmon (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
Freshwater pearl mussel (dependent species)	✓Construction and Decommissioning - indirect effects via host species (Atlantic salmon)	✓Construction and Decommissioning - indirect effects via host species (Atlantic salmon)	✓ Operation and maintenance phase - indirect effects via host species (Atlantic salmon)	✓ Operation and maintenance phase - indirect effects via host species (Atlantic salmon)

Construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

Atlantic salmon

522 Atlantic salmon which are a Group 2 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to Atlantic salmon can be expected for individuals within approximately 228 m of the piling.

523 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 2 fish from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m for Group 2 fish) TTS ranges for Group 2 fish may be increased to up to 7.1 km from the piling location for the maximum energy scenario. However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

524 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to sea lamprey. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish. The results of project specific modelling, discussed in paragraphs 288 to 289, indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation (the dominant method of UXO detonation). Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

525 However, due to the nature of diadromous fish species such as Atlantic salmon being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of Atlantic salmon is not expected.

526 Additionally, available evidence on Atlantic salmon migration patterns from and to Scottish rivers (detailed in section 6.2.5) suggests that Atlantic salmon smolts migrating from rivers take advantage of east flowing currents and cross the North Sea relatively rapidly. Therefore, it is likely that whilst migrating salmon moving to and from the River South Esk will pass through the Proposed Development fish and shellfish ecology study area, either in their outward or inward migration, this migration will be rapid, reducing the potential for interaction with the Proposed Development fish and shellfish ecology study area.

527 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 296 to 300. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development fish and shellfish ecology study area and the migration routes of Atlantic salmon along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

528 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River South Esk SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River South Esk SAC as a result of underwater noise impacts during the construction and decommissioning phase.

Freshwater pearl mussel

529 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts.

530 There is potential for indirect adverse effects on the larval stage of freshwater pearl mussel if there are adverse effects on the individual salmon (their host species for the first year of their life) to which they are attached. The assessment for Atlantic salmon above in paragraphs 522 to 530 concluded that underwater noise will not lead to significant adverse effects on the population, distribution and supporting habitats of Atlantic salmon, therefore there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, freshwater pearl mussel of the River South Esk SAC as a result of underwater noise impacts during the construction and decommissioning phase.

Conclusion

531 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River South Esk SAC, so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the relatively low sensitivity of the qualifying species to underwater noise impacts, the low probability of individuals being present within the ZoI of underwater noise impacts at the time of piling and UXO activities, and the use of soft start procedures allowing individuals to flee areas where they may be exposed to noise levels that would lead to injury, the populations and the distribution of the qualifying species will be maintained.

532 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC as a result of underwater noise impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Increased suspended sediment concentrations and associated sediment deposition

Atlantic salmon

533 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in Atlantic salmon. This in turn has the potential to result in barriers to migration.

534 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of Atlantic salmon are expected.

535 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River South Esk SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River South Esk SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Freshwater pearl mussel

536 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during construction and decommissioning as a result of increased SSC and sediment deposition.

537 There is potential for indirect adverse effects on the larval stage of freshwater pearl mussel if there are adverse effects on the individual salmon (their host species for the first year of their life) to which they are attached. The assessment for Atlantic salmon above in paragraphs 533 to 535 concluded that increases in SSC and associated sediment deposition will not lead to significant adverse effects on the population, distribution and supporting habitats of Atlantic salmon, therefore there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, freshwater pearl mussel of the River South Esk SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phase.

Conclusion

538 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River South Esk SAC, and so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species will not be reduced. Given that any increases in SSC are predicted to be temporary, short lived and lower than estuarine levels, there will be no barriers to the migration of the qualifying species. As such, the population and the distribution of the qualifying species will be maintained.

539 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC as a result from increased SSC and sediment deposition impacts with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

EMF from subsea electrical cabling

Atlantic salmon

540 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of Atlantic salmon. However, impacts related to EMF are predicted to be of local spatial extent (i.e. within a few metres of buried cables). Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Whilst research shows that undersea power cables can result in altered patterns of salmonid behaviour, these changes are temporary and do not interfere with migration success or population health. Atlantic salmon is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

541 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River South Esk SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River South Esk SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Freshwater pearl mussel

542 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during the operation and maintenance phase as a result of EMF.

543 There is potential that adverse effects to host species such as Atlantic salmon could lead to indirect effects to freshwater pearl mussel. The assessment for Atlantic salmon above in paragraphs 540 and 541 concluded that EMF will not lead to adverse effects on the population, distribution and supporting habitats of Atlantic salmon, therefore there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II freshwater pearl mussel feature of the River South Esk SAC as a result of EMF from subsea electrical cabling impacts during the construction and decommissioning phase.

Conclusion

544 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River South Esk SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given any impacts from EMF will be localised and transient and the predicted low sensitivity of the qualifying species to this impact, the population and distribution of the qualifying species will be maintained. Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC as a result of EMF impacts with respect to the operation and maintenance of the Proposed Development acting alone.

Colonisation of foundations, scour protection and cable protection

Atlantic salmon

545 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. It is not certain exactly to what extent seals utilise offshore wind developments (as discussed in paragraph 346) and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, Atlantic salmon may be impacted by the increased predation in an area where predation was lower prior to development.

546 It is, however, unlikely that this would result in significant predation on Atlantic salmon. Research has shown that Atlantic salmon smolts spend little time in the coastal waters, and instead quickly make their way to feeding grounds in the north. (. Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland (see paragraph 347), it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators.

547 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced, and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River South Esk SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

Freshwater pearl mussel

548 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during the operation and maintenance phase as a result of colonisation of hard structures.

549 There is potential that adverse effects to the populations of host species such as Atlantic salmon could lead to indirect effects to freshwater pearl mussel. The assessment for Atlantic salmon above in paragraphs 545 and 547 concluded that colonisation of structures will not lead to increased predation and therefore, there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II freshwater pearl mussel feature of the River South Esk SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the construction and decommissioning phase.

Conclusion

550 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River South Esk SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the limited interaction between the qualifying species and the Proposed Development significant predation in relation the colonisation of foundations, scour protection and cable protection impact are not expected therefore the population and distribution of the qualifying species will be maintained. Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC from colonisation of foundations, scour protection and cable protection impacts with respect to operation and maintenance of the Proposed Development acting alone.

Effects in-combination

551 An assessment of in-combination effects upon the qualifying Annex II diadromous fish species of the Tweed Estuary SAC arising from each identified impact is presented in section 6.5.1. Since the results are generic to diadromous fish species and therefore the results of the assessments for each impact apply to

the other SACs, full details of the in-combination assessments are not repeated here for the River South Esk SAC. The in-combination effects conclusions for the River South Esk SAC are summarised below.

Assessment of in-combination effects during construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

552 There is potential for in-combination effects from injury and/or disturbance from underwater noise and vibration to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm; and
  - Seagreen 1A Project.
- Tier 3:
  - There is no information provided regarding UXO clearance for the Cambois connection therefore no meaningful assessment can be made at this time.

553 As discussed in section 6.5.1, effects in-combination, these projects include similar construction activities as those described for the Proposed Development alone in section 6.3.1, including piling to install wind turbine and OSP/Offshore convertor station platform foundations.

554 Neither Inch Cape Offshore Wind Farm nor Seagreen Alpha/Bravo Offshore Wind Farm EIA Reports predicted significant effects on fish and shellfish receptors. Any effects were predicted to be temporary and reversible following cessation of piling activities. Additionally, the injury ranges reported are likely to be conservative as soft start measures will be implemented as part of the Inch Cape Offshore Wind Farm and Seagreen 1A Project construction programmes, which will reduce the risk of injury considerably. Due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and Inch Cape Offshore Wind Farm and Seagreen 1A Project, in-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

555 The in-combination effect is predicted to be of regional spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

556 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC as a result of injury and/or disturbance from underwater noise and vibration with respect to the Proposed Development acting in-combination with Tier 2 projects.

Increased suspended sediment concentrations and associated sediment deposition

557 There is potential for in-combination effects from increased SSC and associated sediment deposition impacts to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase);
  - Seagreen 1A Project (construction phase);
  - Seagreen 1 (operation and maintenance phase);
  - Seagreen 1A Export Cable (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase);
  - Eastern Link 1 (construction phase);
  - Eastern Link 2 (construction phase); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

558 Any increase in SSC and associated sediment deposition for the Proposed Development alone has been assessed as being of local spatial extent, short term duration with high reversibility of any changes to the baseline. Whilst there may be some temporal overlap between the construction phase of the Proposed Development and the projects listed above, any impacts from increased SSC and associated sediment deposition from these projects will also be of limited spatial extent, short-term duration and they are unlikely to interact with the sediment plumes of the Proposed Development.

559 The in-combination effect is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect. As such, there will be no effect on the ability of diadromous fish to migrate to and from the relevant SACs considered within this RIAA.

560 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

EMF from subsea electrical cabling

561 There is potential for in-combination effects from EMFs from subsea electrical cabling impacts to Annex II diadromous fish during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

562 Whilst any in-combination effects are predicted to be of long-term duration, continuous and not reversible during the operation of the relevant projects, they are also predicted to be of local spatial extent. Diadromous fish species have been assessed as having low sensitivity and high recoverability from EMF from electrical subsea cabling impacts. This can be concluded as EMF effects are confined to the close vicinity of cables. Diadromous fish species are pelagic, swimming in the water column and therefore less likely to interact with emitted EMF from subsea cables. While the sediments in which cables are buried will not reduce the strength of EMF, the burial of cables does increase the distance between cables and diadromous fish, with greater attenuation of EMFs with greater distance from the cable, thereby reducing the effect of EMFs on diadromous fish. The sensitivity of diadromous fish species is predicted to be low

with high recoverability. There is, however, currently no information on the impact that this project will have on diadromous fish, however effects of EMF from the Cambois connection are likely to be similar in magnitude and extent as that discussed for the Proposed Development and the other projects considered in the in combination assessment as set out above.

563 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River South Esk SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Colonisation of foundations, scour protection and cable protection

564 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. This impact is only relevant to the operation and maintenance phase as it takes time for colonisation to establish post construction. The presence of the following projects has the potential to lead to in-combination effects arising from the colonisation of hard structures:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

565 The assessment of effects on diadromous fish from the Proposed Development alone concluded that Annex II diadromous fish species have low vulnerability, high recoverability, and therefore low sensitivity to colonisation of foundations, scour protection and cable protection. This is because, diadromous fish are only likely to interact with the Proposed Development when passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate from the Proposed Development for feeding or shelter opportunities. Whilst there is potential for increased predation of diadromous fish by marine mammal species attracted to offshore wind farm structures, again impacts on diadromous fish are not anticipated to be significant given diadromous fish spend little time in coastal waters and are unlikely to spend time foraging around wind turbines foundations and therefore are at low risk from increased predation.

566 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

567 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Site conclusion

568 In conclusion, with reference to the conservation objectives set for the Annex II diadromous fish features of this site, and dependant qualifying features (i.e. freshwater pearl mussel) and the information presented in sections 6.3, 6.4 and 6.5.3, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the River South Esk SAC in respect of the Atlantic salmon and freshwater pearl mussel qualifying interests.

569 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

6.5.4 RIVER TAY SAC

European site information

570 At its closest point, the River Tay SAC is located 87.15 km from the Proposed Development array area and 102.67 km from the Proposed Development export cable corridor. The site comprises the longest river in Scotland, originating in western Scotland, flowing easterly across the Highlands before becoming tidal at the Firth of Tay. The site covers an area of 9461.63 ha. The site is designated for Annex I habitats and Annex II species including three diadromous fish species: sea lamprey, river lamprey and Atlantic salmon.

571 Further information on this European site is presented in appendix A.

Conservation objectives

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

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

573 Conservation objectives for sea lamprey and river lamprey are as follows:

- 2a. Maintain the population of the lamprey species' as viable components of the site;
- 2b. Maintain the distribution of the lamprey species throughout the site; and
- 2c. Maintain the habitats supporting the lamprey species within the site, and availability of food.

574 Conservation objectives for Atlantic salmon are as follows:

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

575 The condition of sea and river lamprey was assessed in 2007 and Atlantic salmon condition was assessed in 2011. The outcomes of these feature condition assessments were as follows:

- Sea lamprey: favourable maintained;
- River lamprey: favourable maintained; and
- Atlantic salmon: favourable maintained.

Features and effects for assessment

576 Table 6.19 summarises the LSEs that were identified for the Annex II diadromous fish species features of the River Tay SAC and the features and effects which have been considered in the assessment of Adverse Effects on Integrity for this site.

Table 6.19: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Tay SAC

Annex II Species Feature	Injury and/or Disturbance from Underwater Noise and Vibration	Increased SSC and Sediment Deposition	EMF from Subsea Electrical Cabling	Colonisation of Hard Structures
Sea lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
River lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
Atlantic salmon (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase

Construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

Atlantic salmon

577 Atlantic salmon which are a Group 2 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to Atlantic salmon can be expected for individuals within approximately 228 m of the piling.

578 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 2 fish from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m for Group 2 fish) TTS ranges for Group 2 fish may be increased to up to 7.1 km from the piling location for the maximum energy scenario. However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

579 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to Atlantic salmon. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish. The results of project specific modelling, discussed in paragraphs 288 to 289 indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation (the dominant method of UXO detonation). Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

580 However, due to the nature of diadromous fish species such as Atlantic salmon being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of Atlantic salmon is not expected.

581 Additionally, available evidence on Atlantic salmon migration patterns from and to Scottish rivers (detailed in section 6.2.5) suggests that Atlantic salmon smolts migrating from rivers take advantage of east flowing currents and cross the North Sea relatively rapidly. Therefore, it is likely that whilst migrating salmon moving to and from the River Tay Estuary will pass through the Proposed Development fish and shellfish ecology study area, either in their outward or inward migration, this migration will be rapid, reducing the potential for interaction with the Proposed Development.

582 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 296 to 300. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development and the migration routes of Atlantic salmon along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

583 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Tay SAC, so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tay SAC as a result of underwater noise impacts during the construction and decommissioning phases.

Sea lamprey

584 As discussed in section 6.3.1, sea lamprey, which are considered to be a Group 1 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to sea lamprey can be expected for individuals within approximately 138 m of the piling.

585 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 1 species from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 138 m for Group 1 species) TTS ranges for Group 1 fish (sea lamprey) may increase up to 7.1 km from the piling location for the maximum energy scenario (Table 6.7).

586 However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

587 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to sea lamprey. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish species. The results of project specific modelling, discussed in paragraphs 288 to 289, indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

588 However, due to the nature of diadromous fish species such as sea lamprey being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of sea lamprey is not expected. Sea lamprey spend most of their adult life at sea and it has been suggested that they are widely dispersed at sea, possibly feeding in deeper offshore waters (OSPAR Commission, 2009). They are rarely captured in

coastal and estuarine waters, suggesting that they are solitary hunters and widely dispersed at sea as opposed to remaining in coastal waters (Marine Scotland Directorate, 2019).

589 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 296 to 300. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development fish and shellfish ecology study area and the migration routes of sea lamprey along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

590 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tay SAC as a result of underwater noise impacts during the construction and decommissioning phases.

River lamprey

591 River lamprey, like sea lamprey, is classified as a Group 1 fish for the purposes of hearing sensitivity and as such the assessment for sea lamprey presented above in paragraphs 584 to 590 also applies to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with Proposed Development.

592 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Tay SAC as a result of underwater noise impacts during construction/decommissioning.

Conclusion

593 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Tay SAC, so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the relatively low sensitivity of the qualifying species to underwater noise impacts, the low probability of individuals being present within the ZoI of underwater noise impacts at the time of piling and UXO activities, and the use of soft start procedures allowing individuals to flee areas where they may be exposed to noise levels that would lead to injury, the populations and the distribution of the qualifying species will be maintained.

594 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC as a result of underwater noise impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Increased suspended sediment concentrations and associated sediment deposition

Atlantic salmon

595 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in migratory fish. This in turn has the potential to result in barriers to migration.

596 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of Atlantic salmon are expected.

597 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore. There will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tay SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Sea lamprey

598 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in migratory fish. This in turn has the potential to result in barriers to migration.

599 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of sea lamprey are expected.

600 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tay SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

River lamprey

601 River lamprey will have a similar sensitivity to increased SSC as sea lamprey therefore the assessment for sea lamprey, presented in paragraphs 370 to 371, will also apply to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with elevated SSC arising from the construction or decommissioning of the Proposed Development.

602 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying species of the River Tay SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Conclusion

603 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the Tay SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given that any increases in SSC are predicted to be

temporary, short lived and lower than estuarine levels, there will be no barriers to the migration of the qualifying species. As such, the population and the distribution of the qualifying species will be maintained.

604 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC as a result of increased SSC and sediment deposition impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

EMF from subsea electrical cabling

Atlantic salmon

605 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of Atlantic salmon. However, impacts related to EMF are predicted to be of local spatial extent (i.e. within a few metres of buried cables). Given that salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Whilst research shows that undersea power cables can result in altered patterns of salmonid behaviour, these changes are temporary and do not interfere with migration success or population health. Atlantic salmon is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

606 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tay SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Sea lamprey

607 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of sea lamprey. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables (see Table 6.14). Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient. Sea lamprey is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

608 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Tay SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tay SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

River lamprey

609 River lamprey will have a similar sensitivity to EMF as sea lamprey therefore the assessment for sea lamprey presented in paragraphs 607 and 608 is also applicable to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with Proposed Development fish and shellfish ecology study area.

610 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey and will not be reduced, and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Tay SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Conclusion

611 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Tay SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given any impacts from EMF will be localised and transient and the predicted low sensitivity of the qualifying species to this impact, the population and distribution of the qualifying species will be maintained.

612 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC as a result of EMF impacts with respect to operation and maintenance of the Proposed Development acting alone.

Colonisation of foundations, scour protection and cable protection

Atlantic salmon

613 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. It is not certain exactly to what extent seals utilise offshore wind developments (as discussed in paragraph 346) and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, Atlantic salmon may be impacted by the increased predation in an area where predation was lower prior to development.

614 It is, however, unlikely that this would result in significant predation on Atlantic salmon, as research has shown that Atlantic salmon smolts spend little time in the coastal waters and instead quickly make their way to feeding grounds in the north (as discussed in paragraph 347). Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland (see paragraph 347), it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators.

615 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Tay SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

Sea lamprey

616 As discussed in section 6.4.2, colonisation of foundation, scour protection and cable protection, has the potential to result in increased predation by marine mammal species within offshore wind farms. Assuming that seals do utilise offshore wind developments as foraging areas, sea lamprey may be impacted by the increased predation in an area where predation was lower prior to development.

617 There is limited available information on the utilisation of the marine environment by sea lamprey, however, as they are parasitic in their marine phase, feeding off larger fish and marine mammals (Hume, 2017), it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do

so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected.

618 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Tay SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

River lamprey

619 River lamprey will have a similar sensitivity to colonisation of foundations, scour protection and cable protection impacts as sea lamprey therefore the assessment presented in paragraphs 616 to 618 for sea lamprey is also applicable to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development.

620 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Tay SAC as a result of colonisation of foundations, scour protection and cable protection impacts during the operation and maintenance phase.

Conclusion

621 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Tay SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the limited interaction between the qualifying species and the Proposed Development significant predation in relation the colonisation of foundations, scour protection and cable protection impact are not expected therefore the population and distribution of the qualifying species will be maintained.

622 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC from colonisation of foundations, scour protection and cable protection impacts with respect to operation and maintenance of the Proposed Development acting alone.

Effects in-combination

623 An assessment of in-combination effects upon the qualifying Annex II diadromous fish species of the Tweed Estuary SAC arising from each identified impact is presented in section 6.5.1. Since the results are generic to diadromous fish species and therefore the results of the assessments for each impact apply to the other SACs, full details of the in-combination assessments are not repeated here for the River Tay SAC. The in-combination effects conclusions for the River Tay SAC are summarised below.

Assessment of in-combination effects during construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

624 There is potential for in-combination effects from injury and/or disturbance from underwater noise and vibration to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm; and
  - Seagreen 1A Project.
- Tier 3:
  - There is no information provided regarding UXO clearance for the Cambois connection therefore no meaningful assessment can be made at this time.

625 As discussed in section 6.5.1, effects in-combination, these projects include similar construction activities as those described for the Proposed Development alone in section 6.3.1, including piling to install wind turbine and OSP/Offshore convertor station platform foundations.

626 Neither Inch Cape Offshore Wind Farm nor Seagreen Alpha/Bravo Offshore Wind Farm EIA Reports predicted significant effects on fish and shellfish receptors. Any effects were predicted to be temporary and reversible following cessation of piling activities. Additionally, the injury ranges reported are likely to be conservative as soft start measures will be implemented as part of the Inch Cape Offshore Wind Farm and Seagreen 1A Project construction programmes, which will reduce the risk of injury considerably. Due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and Inch Cape Offshore Wind Farm and Seagreen 1A Project, in-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

627 The in-combination effect is predicted to be of regional spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

628 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC as a result of injury and/or disturbance from underwater noise and vibration with respect to the Proposed Development acting in-combination with Tier 2 projects.

Increased suspended sediment concentrations and associated sediment deposition

629 There is potential for in-combination effects from increased SSC and associated sediment deposition impacts to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase);
  - Seagreen 1A Project (construction phase);
  - Seagreen 1 (operation and maintenance phase);
  - Seagreen 1A Export Cable (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase);
  - Eastern Link 1 (construction phase);
  - Eastern Link 2 (construction phase); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

630 Any increases in SSC and associated sediment deposition for the Proposed Development alone has been assessed as being of local spatial extent, short term duration with high reversibility of any changes to the baseline. Whilst there may be some temporal overlap between the construction phase of the Proposed Development and the projects listed above, any impacts from increased SSC and associated sediment deposition from these projects will also be of limited spatial extent, short-term duration and they are unlikely to interact with the sediment plumes of the Proposed Development.

631 The in-combination effect is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect. As such, there will be no effect on the ability of diadromous fish to migrate to and from the relevant SACs considered within this RIAA.

632 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

EMF from subsea electrical cabling

633 There is potential for in-combination effects from EMFs from subsea electrical cabling impacts to Annex II diadromous fish during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

634 Whilst any in-combination effects are predicted to be of long-term duration, continuous and not reversible during the operation of the relevant projects, they are also predicted to be of local spatial extent. Diadromous fish species have been assessed as having low sensitivity and high recoverability from EMF from electrical subsea cabling impacts. This can be concluded as EMF effects are confined to the close vicinity of cables. Diadromous fish species are pelagic, swimming in the water column and therefore less likely to interact with emitted EMF from subsea cables. While the sediments in which cables are buried will not reduce the strength of EMF, the burial of cables does increase the distance between cables and diadromous fish, with greater attenuation of EMFs with greater distance from the cable, thereby reducing the effect of EMFs on diadromous fish. The sensitivity of diadromous fish species is predicted to be low with high recoverability. There is, however, currently no information on the impact that this project will have on diadromous fish, however effects of EMF from the Cambois connection are likely to be similar in magnitude and extent as that discussed for the Proposed Development and the other projects considered in the in combination assessment as set out above.

635 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tay SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Colonisation of foundations, scour protection and cable protection

636 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. This impact is only relevant to the operation and maintenance phase as it takes time for colonisation to establish post construction. The presence of the following projects has the potential to lead to in-combination effects arising from the colonisation of hard structures:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

637 The assessment of effects on diadromous fish from the Proposed Development alone concluded that Annex II diadromous fish species have low vulnerability, high recoverability, and therefore low sensitivity to colonisation of foundations, scour protection and cable protection. This is because, diadromous fish are only likely to interact with the Proposed Development when passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate from the Proposed Development for feeding or shelter opportunities. Whilst there is potential for increased predation of diadromous fish by marine mammal species attracted to offshore wind farm structures, again impacts on diadromous fish are not anticipated to be significant given diadromous fish spend little time in coastal waters and are unlikely to spend time foraging around wind turbines foundations and therefore are at low risk from increased predation.

638 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

639 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Tweed SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Site conclusion

640 In conclusion, with reference to the conservation objectives set for the Annex II diadromous fish features of this site and the information presented sections 6.3, 6.4 and 6.5.4, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the River Tay SAC in respect of the sea lamprey, river lamprey and Atlantic salmon qualifying interests.

641 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

6.5.5 RIVER DEE SAC

European site information

642 At its closest point, the River Dee SAC is located 79.78 km from the Proposed Development array area and 106.57 km from the Proposed Development export cable corridor. The entire length of the River Dee is designated as an SAC due to its importance for salmon, freshwater pearl mussel, and otter (note that otter were screened out in the Berwick Bank Wind Farm Onshore HRA Screening Report (SSE Renewables, 2021b). The river rises in the Cairngorms and flows through southern Aberdeenshire to reach

the North Sea at Aberdeen. The site covers an area of 2334.48 ha and is designated for Annex II species including Atlantic salmon and freshwater pearl mussel.

643 Further information on this European site is presented in appendix A.

Conservation objectives

644 Conservation objectives for the River Dee SAC have been developed by NatureScot as part of a Conservation Advice Package (NatureScot, 2020). Conservation objectives for all qualifying features are:

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

645 Conservation objectives for freshwater pearl mussel are as follows:

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

646 Conservation objectives for Atlantic salmon are as follows:

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

647 The condition of freshwater pearl mussel at the site was assessed in 2014 and Atlantic salmon condition was assessed in 2011 (NatureScot, 2020). The outcomes of these feature condition assessments were as follows:

- Freshwater pearl mussel: unfavourable declining; and
- Atlantic salmon: favourable maintained.

648 Freshwater pearl mussel has been assessed through NatureScot's site condition monitoring programme as being in unfavourable condition at River Dee SAC due to the low number and density of freshwater pearl mussels present, low levels of juvenile recruitment, water flow, river morphology, presence of filamentous algae and water quality.

Features and effects for assessment

649 Table 6.20 summarises the LSEs that were identified for the Annex II diadromous fish feature, and dependent species (i.e. freshwater pearl mussel) of the River Dee SAC and the features and effects which have been considered in the assessment of Adverse Effects on Integrity for this site.

Table 6.20: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Dee SAC

Construction and decommissioning

Annex II Species Feature	Injury and/or Disturbance from Underwater Noise and Vibration	Increased SSC and Sediment Deposition	EMF from Subsea Electrical Cabling	Colonisation of Hard Structures
Atlantic salmon (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
Freshwater pearl mussel (dependent species)	✓Construction and Decommissioning - indirect effects via host species (Atlantic salmon)	✓Construction and Decommissioning - indirect effects via host species (Atlantic salmon)	✓ Operation and maintenance phase - indirect effects via host species (Atlantic salmon)	✓ Operation and maintenance phase - indirect effects via host species (Atlantic salmon)

Injury and/or disturbance from underwater noise and vibration

Atlantic salmon

650 Atlantic salmon which are a Group 2 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to Atlantic salmon can be expected for individuals within approximately 228 m of the piling.

651 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 2 fish from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m for Group 2 fish) TTS ranges for Group 2 fish may be increased to up to 7.1 km from the piling location for the maximum energy scenario. However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

652 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to sea lamprey. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish. The results of project specific modelling, discussed in paragraphs 288 to 289, indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation (the dominant method of UXO detonation). Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

653 However, due to the nature of diadromous fish species such as Atlantic salmon being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of Atlantic salmon is not expected.

654 Additionally, available evidence on Atlantic salmon migration patterns from and to Scottish rivers (detailed in section 6.2.5) suggests that Atlantic salmon smolts migrating from rivers take advantage of east flowing currents and cross the North Sea relatively rapidly. Therefore, it is likely that whilst migrating salmon moving to and from the River Dee will pass through the Proposed Development fish and shellfish ecology

study area, either in their outward or inward migration, this migration will be rapid, reducing the potential for interaction with the Proposed Development fish and shellfish ecology study area.

655 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 296 to 300. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development fish and shellfish ecology study area and the migration routes of Atlantic salmon along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

656 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Dee SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Dee SAC as a result of underwater noise impacts during the construction and decommissioning phase.

Freshwater pearl mussel

657 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts.

658 There is potential indirect adverse effects on the larval stage of freshwater pearl mussel if there are adverse effects on the individual salmon (their host species for the first year of their life) to which they are attached. The assessment for Atlantic salmon above in paragraphs 650 to 656 concluded that underwater noise will not lead to significant adverse effects on the population, distribution and supporting habitats of Atlantic salmon, therefore, there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, freshwater pearl mussel of the River Dee SAC as a result of underwater noise impacts during the construction and decommissioning phase.

Conclusion

659 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Dee SAC, so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the relatively low sensitivity of the qualifying species to underwater noise impacts, the low probability of individuals being present within the ZoI of underwater noise impacts at the time of piling and UXO activities, and the use of soft start procedures allowing individuals to flee areas where they may be exposed to noise levels that would lead to injury, the populations and the distribution of the qualifying species will be maintained.

660 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC as a result of underwater noise impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Increased suspended sediment and associated sediment deposition

Atlantic salmon

661 As detailed in section 6.3.2, increases in SSC and associated sediment deposition during the construction and decommissioning phases have the potential to cause behavioural responses (avoidance) in Atlantic salmon. This in turn has the potential to result in barriers to migration.

662 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of Atlantic salmon are expected.

663 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Dee SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Dee SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Freshwater pearl mussel

664 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during construction and decommissioning as a result of increased SSC and sediment deposition.

665 There is potential for indirect adverse effects on the larval stage of freshwater pearl mussel if there are adverse effects on the individual salmon (their host species for the first year of their life) to which they are attached. The assessment for Atlantic salmon above concluded that increases in SSC and associated sediment deposition will not lead to significant adverse effects on the population, distribution and supporting habitats of Atlantic salmon, therefore there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the freshwater pearl mussel feature of the River Dee SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phase.

Conclusion

666 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Dee SAC, and so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species will not be reduced. Given that any increases in SSC are predicted to be temporary, short lived and lower than estuarine levels, there will be no barriers to the migration of the qualifying species. As such, the population and the distribution of the qualifying species will be maintained.

667 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC as a result from increased SSC and sediment deposition with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

EMF from subsea electrical cabling

Atlantic salmon

668 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of diadromous fish species such as Atlantic salmon. However, impacts related to EMF are predicted to be of local spatial extent (i.e. within a few metres of buried cables). Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Whilst research shows that undersea power cables can result in altered patterns of salmonid behaviour, these changes are temporary and do not interfere with migration success or population health. Atlantic salmon is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

669 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Dee SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Dee SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Freshwater pearl mussel

670 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during the operation and maintenance phase as a result of EMF.

671 There is potential that adverse effects to host species such as Atlantic salmon could lead to indirect effects to freshwater pearl mussel. The assessment for Atlantic salmon above concluded that EMF will not lead to adverse effects on the population, distribution and supporting habitats of Atlantic salmon, therefore there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, freshwater pearl mussel of the River Dee SAC as a result of EMF from subsea electrical cabling impacts during the construction and decommissioning phase.

Conclusion

672 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Dee SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given any impacts from EMF will be localised and transient and the predicted low sensitivity of the qualifying species to this impact, the population and distribution of the qualifying species will be maintained. Therefore, it can be concluded that there is no risk of an Adverse Effect on the Integrity of the River Dee SAC as a result of EMF impacts with respect to the operation and maintenance of the Proposed Development acting alone.

Colonisation of foundations, scour protection and cable protection

Atlantic salmon

673 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. It is not certain exactly to what extent seals utilise offshore wind developments (as discussed in paragraph 346) and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, Atlantic salmon may be impacted by the increased predation in an area where predation was lower prior to development.

674 It is, however, unlikely that this would result in significant predation on Atlantic salmon. Research has shown that Atlantic salmon smolts spend little time in the coastal waters, and instead quickly make their way to feeding grounds in the north. Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland (see paragraph 347), it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators.

675 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced, and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Dee SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

Freshwater pearl mussel

676 As adult freshwater pearl mussel are confined to freshwater habitats there is no pathway for direct effects to this species during the operation and maintenance phase as a result of colonisation of hard structures.

677 There is potential that adverse effects to the populations of host species such as Atlantic salmon could lead to indirect effects to freshwater pearl mussel. The assessment for Atlantic salmon above concluded that colonisation of structures will not lead to increased predation and therefore, there will be no significant indirect effects to freshwater pearl mussel. The population of freshwater pearl mussel will be maintained as a viable component of the site, the extent and distribution of freshwater pearl mussel and its natural habitat will not be reduced, and the structure and function of freshwater pearl mussel habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying freshwater pearl mussel feature of the River Dee SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the construction and decommissioning phase.

Conclusion

678 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Dee SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the limited interaction between the qualifying species and the Proposed Development significant predation in relation the colonisation of foundations, scour protection and cable protection impact are not expected therefore the population and distribution of the qualifying species will be maintained. Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC from colonisation of foundations, scour protection and cable protection impacts with respect to operation and maintenance of the Proposed Development acting alone.

Effects in-combination

679 An assessment of in-combination effects upon the qualifying Annex II diadromous fish species of the Tweed Estuary SAC arising from each identified impact is presented in section 6.5.1. Since the results are generic to diadromous fish species and therefore the results of the assessments for each impact apply to the other SACs, full details of the in-combination assessments are not repeated here for the River Dee SAC. The in-combination effects conclusions for the River Dee SAC are summarised below.

Assessment of in-combination effects during construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

680 There is potential for in-combination effects from injury and/or disturbance from underwater noise and vibration to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm; and
  - Seagreen 1A Project.
- Tier 3:
  - There is no information provided regarding UXO clearance for the Cambois connection therefore no meaningful assessment can be made at this time.

681 As discussed in section 6.5.1, effects in-combination, these projects include similar construction activities as those described for the Proposed Development alone in section 6.3.1, including piling to install wind turbine and OSP/Offshore convertor station platform foundations.

682 Neither Inch Cape Offshore Wind Farm nor Seagreen Alpha/Bravo Offshore Wind Farm EIA Reports predicted significant effects on fish and shellfish receptors. Any effects were predicted to be temporary and reversible following cessation of piling activities. Additionally, the injury ranges reported are likely to be conservative as soft start measures will be implemented as part of the Inch Cape Offshore Wind Farm and Seagreen 1A Project construction programmes, which will reduce the risk of injury considerably. Due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and Inch Cape Offshore Wind Farm and Seagreen 1A Project, in-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

683 The in-combination effect is predicted to be of regional spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

684 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC as a result of injury and/or disturbance from underwater noise and vibration with respect to the Proposed Development acting in-combination with Tier 2 projects.

Increased suspended sediment concentrations and associated sediment deposition

685 There is potential for in-combination effects from increased SSC and associated sediment deposition impacts to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase);
  - Seagreen 1A Project (construction phase);
  - Seagreen 1 (operation and maintenance phase);
  - Seagreen 1A Export Cable (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase);
  - Eastern Link 1 (construction phase);
  - Eastern Link 2 (construction phase); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

686 Any increases in SSC and associated sediment deposition for the Proposed Development alone has been assessed as being of local spatial extent, short term duration with high reversibility of any changes to the baseline. Whilst there may be some temporal overlap between the construction phase of the Proposed Development and the projects listed above, any impacts from increased SSC and associated sediment deposition from these projects will also be of limited spatial extent, short-term duration and they are unlikely to interact with the sediment plumes of the Proposed Development.

687 The in-combination effect is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect. As such, there will be no effect on the ability of diadromous fish to migrate to and from the relevant SACs considered within this RIAA.

688 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

<u>Assessment of in-combination effects during operation and maintenance</u>

EMF from subsea electrical cabling

689 There is potential for in-combination effects from EMFs from subsea electrical cabling impacts to Annex II diadromous fish during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

690 Whilst any in-combination effects are predicted to be of long-term duration, continuous and not reversible during the operation of the relevant projects, they are also predicted to be of local spatial extent. Diadromous fish species have been assessed as having low sensitivity and high recoverability from EMF from electrical subsea cabling impacts. This can be concluded as EMF effects are confined to the close vicinity of cables. Diadromous fish species are pelagic, swimming in the water column and therefore less likely to interact with emitted EMF from subsea cables. While the sediments in which cables are buried will not reduce the strength of EMF, the burial of cables does increase the distance between cables and diadromous fish, with greater attenuation of EMFs with greater distance from the cable, thereby reducing the effect of EMFs on diadromous fish. The sensitivity of diadromous fish species is predicted to be low with high recoverability. There is, however, currently no information on the impact that this project will have on diadromous fish, however effects of EMF from the Cambois connection are likely to be similar in magnitude and extent as that discussed for the Proposed Development and the other projects considered in the in combination assessment as set out above.

691 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Colonisation of foundation, scour protection and cable protection

692 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. This impact is only relevant to the operation and maintenance phase as it takes time for colonisation to establish post construction. The presence of the following projects has the potential to lead to in-combination effects arising from the colonisation of hard structures:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

693 The assessment of effects on diadromous fish from the Proposed Development alone concluded that Annex II diadromous fish species have low vulnerability, high recoverability, and therefore low sensitivity to colonisation of foundations, scour protection and cable protection. This is because, diadromous fish are only likely to interact with the Proposed Development when passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate from the Proposed Development for feeding or shelter opportunities. Whilst there is potential for increased predation of diadromous fish by marine mammal species attracted to offshore wind farm structures, again impacts on diadromous fish are not anticipated to be significant given diadromous fish spend little time in coastal waters and are unlikely to spend time foraging around wind turbines foundations and therefore are at low risk from increased predation.

694 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

695 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Dee SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Site conclusion

696 In conclusion, with reference to the conservation objectives set for the Annex II diadromous fish feature of this site, and dependant qualifying features (i.e. freshwater pearl mussel) and the information presented in sections 6.3, 6.4 and 6.5.5, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the River Dee SAC in respect of the Atlantic salmon and freshwater pearl mussel qualifying interests.

697 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

6.5.6 RIVER TEITH SAC

European site information

698 At its closest point, the River Teith SAC is located 148.1 km from the Proposed Development array area and 113.81 km from the Proposed Development export cable corridor. The River Teith is a large river that flows eastwards through central Scotland and the SAC covers an area of 1,289.33 ha. The river is the most significant tributary of the River Forth. The site is designated for Annex II species including three diadromous fish species: sea lamprey, river lamprey and Atlantic salmon.

699 Further information on this European site is presented in appendix A.

Conservation objectives

700 A Conservation Advice Package has not yet been published for the River Teith SAC. Conservation objectives for all qualifying species features are:

- to avoid deterioration of the habitats of the qualifying species (listed below) or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
- to ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species, including range of genetic types for salmon, as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

701 There is no information available as to the current condition status of the designated features of the River Teith SAC.

Features and effects for assessment

702 Table 6.21 summarises the LSEs that were identified for the Annex II diadromous fish species features of the River Teith SAC and the features and effects which have been considered in the assessment of Adverse Effects on Integrity for this site.

Table 6.21: Summary of Features and Effects Considered in the Assessment of Adverse Effects on Integrity for the River Teith SAC

Annex II Species Feature	Injury and/or Disturbance from Underwater Noise and Vibration	Increased SSC and Sediment Deposition	EMF from Subsea Electrical Cabling	Colonisation of Hard Structures
Sea lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
River lamprey (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase
Atlantic salmon (migrating)	✓Construction and Decommissioning	✓Construction and Decommissioning	✓ Operation and maintenance phase	✓ Operation and maintenance phase

Construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

Atlantic Salmon

703 Atlantic salmon which are a Group 2 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to Atlantic salmon can be expected for individuals within approximately 228 m of the piling.

704 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 2 fish from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m for Group 2 fish) TTS ranges for Group 2 fish may be increased to up to 7.1 km from the piling location for the maximum energy scenario. However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

705 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to Atlantic salmon. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish. The results of project specific modelling, discussed in paragraphs 288 to 289 indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation (the dominant method of UXO detonation). Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

706 However, due to the nature of diadromous fish species such as Atlantic salmon being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of Atlantic salmon is not expected.

707 Additionally, available evidence on Atlantic salmon migration patterns from and to Scottish rivers (detailed in section 6.2.5) suggests that Atlantic salmon smolts migrating from rivers take advantage of east flowing currents and cross the North Sea relatively rapidly. Therefore, it is likely that whilst migrating salmon moving to and from the River Teith Estuary will pass through the Proposed Development fish and shellfish ecology study area, either in their outward or inward migration, this migration will be rapid, reducing the potential for interaction with the Proposed Development.

708 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 296 to 300. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development and the migration routes of Atlantic salmon along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

709 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Teith SAC, so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Teith SAC as a result of underwater noise impacts during the construction and decommissioning phases.

Sea lamprey

710 As discussed in section 6.3.1, sea lamprey, which are considered to be a Group 1 fish in terms of hearing sensitivity have relatively low sensitivity to underwater noise. The results of project specific modelling, as discussed in paragraphs 283 to 287, indicates that injury and/or mortality to sea lamprey can be expected for individuals within approximately 138 m of the piling.

711 A temporary hearing impairment (i.e. TTS), from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Group 1 species from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 138 m for Group 1 species) TTS ranges for Group 1 fish (sea lamprey) may increase up to 7.1 km from the piling location for the maximum energy scenario (Table 6.7).

712 However, as discussed in paragraph 286, the risk of fish injury will be considerably lower due to hammer energies being considerably lower than the absolute maximum modelled. Additionally, the expected fleeing behaviour of fish from the area affected when exposed to high levels of noise and the soft start procedure, which will be employed for all piling, mean that fish will have sufficient time to vacate the areas where injury may occur prior to noise levels reaching that level.

713 As discussed in paragraph 268, pre-construction UXO clearance may also lead to injury and/or disturbance to sea lamprey. Detonation of UXO would represent a short term (i.e. seconds) increase in underwater noise which will be elevated to levels which may result in injury or behavioural effects on fish species. The results of project specific modelling, discussed in paragraphs 288 to 289, indicate that mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. Higher order detonations may also occur if low order is not successful or unintentionally as part of the low order process. In this case mortality would occur within 410-680 m of the noise source.

714 However, due to the nature of diadromous fish species such as sea lamprey being highly mobile and tending to only utilise the environment within the Proposed Development fish and shellfish ecology study area to pass through during migration, significant mortality of sea lamprey is not expected. Sea lamprey spend most of their adult life at sea and it has been suggested that they are widely dispersed at sea, possibly feeding in deeper offshore waters (OSPAR Commission, 2009). They are rarely captured in coastal and estuarine waters, suggesting that they are solitary hunters and widely dispersed at sea as opposed to remaining in coastal waters (Marine Scotland Directorate, 2019).

715 In contrast, behavioural effects (including startle response, disruption of feeding or avoidance of an area) in response to piling are expected over much larger ranges of 10 km to 20 km, as discussed in paragraphs 297 to 298. Due to the distance between the Proposed Development array area and the coast, these behavioural impacts are unlikely to cause barrier effects between the Proposed Development and the migration routes of sea lamprey along the east coast of Scotland, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses (as shown in Figure 6.1 and Figure 6.2).

716 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Teith SAC as a result of underwater noise impacts during the construction and decommissioning phases.

River lamprey

717 River lamprey is, like sea lamprey, classified as a Group 1 species for the purposes of hearing sensitivity and as such the assessment for sea lamprey presented above also applies to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with underwater noise arising from the Proposed Development.

718 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Teith SAC as a result of underwater noise impacts during construction/decommissioning.

Conclusion

719 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Teith SAC, so the extent and distribution and structure and function of supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the relatively low sensitivity of the qualifying species to underwater noise impacts, the low probability of individuals being present within the ZoI of underwater noise impacts at the time of piling and UXO activities, and the use of soft start procedures allowing individuals to flee areas where they may be exposed to noise levels that would lead to injury, the populations and the distribution of the qualifying species will be maintained.

720 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC as a result of underwater noise impacts with respect to construction and decommissioning of the Proposed Development acting alone.

Increased suspended sediment concentrations and associated deposition

Atlantic salmon

721 As detailed in section 6.3.2, increased SSC and associated sediment deposition during construction and decommissioning have the potential to cause behavioural responses (avoidance) in Atlantic salmon. This in turn has the potential to result in barriers to migration.

722 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of Atlantic salmon are expected.

723 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore. There will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Teith SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Sea lamprey

724 The results of project specific modelling summarised in section 6.3.2, indicate that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development northern North Sea fish and shellfish ecology study area. As such, no barriers to the migratory patterns of sea lamprey are expected.

725 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Teith SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

River lamprey

726 River lamprey will have a similar sensitivity to increased SSC as sea lamprey therefore the assessment for sea lamprey, presented in paragraphs 370 to 371, will also apply to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with elevated SSC arising from the construction or decommissioning of the Proposed Development.

727 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying species of the River Teith SAC as a result of increased SSC and sediment deposition impacts during the construction and decommissioning phases.

Conclusion

728 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Teith SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given that any increases in SSC are predicted to be temporary, short lived and lower than estuarine levels, there will be no barriers to the migration of the qualifying species. As such, the population and the distribution of the qualifying species will be maintained.

729 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC as a result of increased SSC and sediment deposition with respect to construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

EMF from subsea electrical cabling

Atlantic salmon

730 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of diadromous fish species such as Atlantic salmon. However, impacts related to EMF are predicted to be of local spatial extent (i.e. within a few metres of buried cables). Given that salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Whilst research shows that undersea power cables can result in altered patterns of salmonid behaviour,

these changes are temporary and do not interfere with migration success or population health. Atlantic salmon is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

731 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Teith SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Sea lamprey

732 As discussed in section 6.4.1, the emission of localised EMFs from the operation of inter-array, interconnector and offshore export cables could potentially interfere with the navigation of diadromous fish species such as sea lamprey. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables (see Table 6.14). Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient. Sea lamprey is therefore deemed to have low sensitivity to, and high recoverability from, EMF.

733 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced. The Proposed Development does not overlap with the River Teith SAC so the extent and distribution and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Teith SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

River lamprey

734 River lamprey will have a similar sensitivity to EMF as sea lamprey therefore the assessment presented in paragraphs 732 and 733 for sea lamprey will also apply to river lamprey. In addition, due to river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with cables associated with the Proposed Development.

735 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey and will not be reduced, and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Teith SAC as a result of EMF from subsea electrical cabling impacts during the operation and maintenance phase.

Conclusion

736 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Teith SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given any impacts from EMF will be localised and transient and the predicted low sensitivity of the qualifying species to this impact, the population and distribution of the qualifying species will be maintained.

737 Therefore, it can be concluded that there is no risk of an adverse effect on the integrity of the River Teith SAC as a result of EMF impacts with respect to operation and maintenance of the Proposed Development acting alone.

Colonisation of foundations, scour protection and cable protection

Atlantic salmon

738 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. It is not certain exactly to what extent seals utilise offshore wind developments (as discussed in paragraph 346) and therefore effects may be site specific. Assuming that seals do utilise offshore wind developments as foraging areas, it is unlikely that this would result in significant predation on Atlantic salmon. Research has shown that Atlantic salmon smolts spend little time in the coastal waters and instead quickly make their way to feeding grounds in the north (as discussed in paragraph 347). Due to the evidence that Atlantic salmon tend not to forage in the coastal waters of Scotland (see paragraph 347), it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators.

739 The population of Atlantic salmon will be maintained as a viable component of the site and the extent and distribution of Atlantic salmon will not be reduced. and the structure and function of Atlantic salmon habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, Atlantic salmon of the River Teith SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

Sea lamprey

740 As discussed in section 6.4.2, colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species within offshore wind farms. Assuming that seals do utilise offshore wind developments as foraging areas, sea lamprey may be impacted by the increased predation in an area where predation was lower prior to development.

741 There is limited available information on the utilisation of the marine environment by sea lamprey, however, as they are parasitic in their marine phase, feeding off larger fish and marine mammals (Hume, 2017), it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected.

742 The population of sea lamprey will be maintained as a viable component of the site and the extent and distribution of sea lamprey will not be reduced and the structure and function of sea lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, sea lamprey of the River Teith SAC as a result of colonisation of foundation, scour protection and cable protection impacts during the operation and maintenance phase.

River lamprey

743 River lamprey will have a similar sensitivity to colonisation of foundations, scour protection and cable protection impacts as sea lamprey therefore the assessment for sea lamprey in paragraphs 740 to 742 is also applicable to river lamprey. In addition, due to the preference of river lamprey' for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development.

744 The population of river lamprey will be maintained as a viable component of the site and the extent and distribution of river lamprey will not be reduced. and the structure and function of river lamprey habitat will be unaffected. Therefore, there will be no significant adverse effects on the qualifying Annex II diadromous fish feature, river lamprey of the River Teith SAC as a result of colonisation of foundations, scour protection and cable protection impacts during the operation and maintenance phase.

Conclusion

745 The assessment has concluded that there is no direct spatial overlap between the Proposed Development and the River Teith SAC, and so the extent and distribution and structure and function of the supporting habitats of the qualifying species will not be reduced. Similarly, the supporting processes on which the habitats of the qualifying species rely will be unaffected. Given the limited interaction between the qualifying species and the Proposed Development significant predation in relation the colonisation of foundations, scour protection and cable protection impact are not expected therefore the population and distribution of the qualifying species will be maintained.

746 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC from colonisation of foundations, scour protection and cable protection impacts with respect to operation and maintenance of the Proposed Development acting alone.

Effects in-combination

747 An assessment of in-combination effects upon the qualifying Annex II diadromous fish species of the Tweed Estuary SAC arising from each identified impact is presented in section 6.5.1. Since the results are generic to diadromous fish species and therefore the results of the assessments for each impact apply to the other SACs, full details of the in-combination assessments are not repeated here for the River Teith SAC. The in-combination effects conclusions for the River Teith SAC are summarised below.

Assessment of in-combination effects during construction and decommissioning

Injury and/or disturbance from underwater noise and vibration

748 There is potential for in-combination effects from injury and/or disturbance from underwater noise and vibration to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm; and
  - Seagreen 1A Project.
- Tier 3:
  - There is no information provided regarding UXO clearance for the Cambois connection therefore no meaningful assessment can be made at this time.

749 As discussed in section 6.5.1, effects in-combination, these projects include similar construction activities as those described for the Proposed Development alone in section 6.3.1, including piling to install wind turbine and OSP/Offshore convertor station platform foundations.

750 Neither Inch Cape Offshore Wind Farm nor Seagreen Alpha/Bravo Offshore Wind Farm EIA Reports predicted significant effects on fish and shellfish receptors. Any effects were predicted to be temporary and reversible following cessation of piling activities. Additionally, the injury ranges reported are likely to be conservative as soft start measures will be implemented as part of the Inch Cape Offshore Wind Farm and Seagreen 1A Project construction programmes, which will reduce the risk of injury considerably. Due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and Inch Cape Offshore Wind Farm and Seagreen 1A Project, in-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

751 The in-combination effect is predicted to be of regional spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

752 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC as a result of injury and/or disturbance from underwater noise and vibration with respect to the Proposed Development acting in-combination with Tier 2 projects.

Increased suspended sediment concentrations and associated sediment deposition

753 There is potential for in-combination effects from increased SSC and associated sediment deposition impacts to Annex II diadromous fish during the construction phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm (construction phase);
  - Seagreen 1A Project (construction phase);
  - Seagreen 1 (operation and maintenance phase);
  - Seagreen 1A Export Cable (operation and maintenance phase);
  - Neart na Gaoithe Offshore Wind Farm (operation and maintenance phase);
  - Eastern Link 1 (construction phase);
  - Eastern Link 2 (construction phase); and
  - Eyemouth disposal site.
- Tier 3:
  - Cambois connection (construction and operation and maintenance phases).

754 Any increases in SSC and associated sediment deposition for the Proposed Development alone has been assessed as being of local spatial extent, short term duration with high reversibility of any changes to the baseline. Whilst there may be some temporal overlap between the construction phase of the Proposed Development and the projects listed above, any impacts from increased SSC and associated sediment deposition from these projects will also be of limited spatial extent, short-term duration and they are unlikely to interact with the sediment plumes of the Proposed Development.

755 The in-combination effect is predicted to be of local spatial extent, short term duration and intermittent and of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect. As such, there will be no effect on the ability of diadromous fish to migrate to and from the relevant SACs considered within this RIAA.

756 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC as a result of increased SSC and associated sediment deposition impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

EMF from subsea electrical cabling

757 There is potential for in-combination effects from EMFs from subsea electrical cabling impacts to Annex II diadromous fish during the operation and maintenance phase of the Proposed Development with activities associated with the following projects:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:

– Cambois connection.

758 Whilst any in-combination effects are predicted to be of long-term duration, continuous and not reversible during the operation of the relevant projects, they are also predicted to be of local spatial extent. Diadromous fish species have been assessed as having low sensitivity and high recoverability from EMF from electrical subsea cabling impacts. This can be concluded as EMF effects are confined to the close vicinity of cables. Diadromous fish species are pelagic, swimming in the water column and therefore less likely to interact with emitted EMF from subsea cables. While the sediments in which cables are buried will not reduce the strength of EMF, the burial of cables does increase the distance between cables and diadromous fish, with greater attenuation of EMFs with greater distance from the cable, thereby reducing the effect of EMFs on diadromous fish. The sensitivity of diadromous fish species is predicted to be low with high recoverability. There is, however, currently no information on the impact that this project will have on diadromous fish, however effects of EMF from the Cambois connection are likely to be similar in magnitude and extent as that discussed for the Proposed Development and the other projects considered in the in combination assessment as set out above.

759 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC as a result of EMF impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Colonisation of foundations, scour protection and cable protection

760 The introduction of hard substrate into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. This impact is only relevant to the operation and maintenance phase as it takes time for colonisation to establish post construction. The presence of the following projects has the potential to lead to in-combination effects arising from the colonisation of hard structures:

- Tier 2:
  - Inch Cape Offshore Wind Farm;
  - Neart na Gaoithe Offshore Wind Farm;
  - Seagreen 1;
  - Seagreen 1A Project;
  - Seagreen 1A Export Cable Corridor;
  - Eastern Link 1; and
  - Eastern Link 2.
- Tier 3:
  - Cambois connection.

761 The assessment of effects on diadromous fish from the Proposed Development alone concluded that Annex II diadromous fish species have low vulnerability, high recoverability, and therefore low sensitivity to colonisation of foundations, scour protection and cable protection. This is because, diadromous fish are only likely to interact with the Proposed Development when passing through the area during migrations to and from rivers located on the east coast of Scotland. In most cases, it is expected that diadromous fish are unlikely to utilise the increase in hard substrate from the Proposed Development for feeding or shelter opportunities. Whilst there is potential for increased predation of diadromous fish by marine mammal species attracted to offshore wind farm structures, again impacts on diadromous fish are not anticipated to be significant given diadromous fish spend little time in coastal waters and are unlikely to spend time foraging around wind turbines foundations and therefore are at low risk from increased predation.

762 Whilst the in-combination effect is predicted to be of long-term duration and continuous, it is predicted to be of local spatial extent, of high reversibility and diadromous fish species are assessed as having low sensitivity to the effect.

763 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the River Teith SAC as a result of colonisation of foundations, scour protection and cable protection impacts with respect to the Proposed Development acting in-combination with Tier 2 or Tier 3 projects.

Site conclusion

764 In conclusion, with reference to the conservation objectives set for the Annex II diadromous fish features of this site and the information presented in sections 6.3, 6.4 and 6.5.6, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the River Teith SAC in respect of the sea lamprey, river lamprey and Atlantic salmon qualifying interests.

765 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

7 APPRAISAL OF ADVERSE EFFECTS ON INTEGRITY: MARINE MAMMALS

7.1 INTRODUCTION

766 The Screening exercise (at Stage One of the HRA process) as updated in response to consultation on the HRA Screening Report (SSE Renewables, 2021b) (see volume 2, chapter 10 of the Offshore EIA Report) identified LSEs on the following five European sites designated for Annex II marine mammal features (as summarised in Table 3.1):

- Berwickshire and North Northumberland Coast SAC (grey seal);
- Isle of May SAC (grey seal);
- Firth of Tay and Eden Estuary SAC (harbour seal);
- Southern North Sea SAC (harbour porpoise); and
- Moray Firth SAC (bottlenose dolphin).

767 This section explains the approach taken to assessing the potential impacts of the Proposed Development on European sites designated for Annex II marine mammal features and presents the Stage Two assessments for the above sites. Broadly, the potential effects to these sites are as follows (and addressed explicitly in the sections below):

768 During the construction and decommissioning phases:

- **Underwater noise***:* direct injury or mortality and/or behavioural changes due to exposure to underwater noise generated by construction activities namely:
  - piling;
  - clearance of UXO;
  - pre-construction surveys; and
  - vessels and other vessel activities.
- **Changes** in **prey availability*:*** potential changes in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

769 During the operation and maintenance phase:

- **Underwater noise**: behavioural changes due to exposure to underwater noise generated by vessels and other vessel activities; and

- **Changes in prey availability.**

770 The Stage Two assessments (considering effects both alone and in-combination) for sites designated for Annex II marine mammals are presented in this chapter. Integrity matrices summarising the assessments for the site are provided in Table 9.8 through to Table 9.12 in section 98. A summary of all Appropriate Assessments undertaken within this report is provided in the concluding section of this report (see section 8).

7.2 ASSESSMENT INFORMATION

7.2.1 MAXIMUM DESIGN SCENARIOS

771 The maximum design scenario relevant to Annex II marine mammal features are set out in Table 7.10Table 7.10, Table 7.39 and Table 7.41 in this section. An overview of the maximum design scenario for all receptor groups is provided in Table 5.1 in section 5.

7.2.2 DESIGNED IN MEASURES

772 Designed in measures relevant to Annex II marine mammal features are set out in Table 5.3 and in Table 7.11 and Table 7.40 in this section.

1.1.1. Baseline Information

773 The key data sources are presented within the volume 3, appendix 10.2 of the Offshore EIA Report and summarised below. The following information has informed the assessments:

- Existing studies and dataset (see Table 4.1 in volume 3, appendix 10.2 of the Offshore EIA Report);
- Surveys (see section 4.2 in volume 3, appendix 10.2 of the Offshore EIA Report); and
- Digital Aerial Surveys (DAS) for the Proposed Development (see volume 3, appendix 10.2, annex A of the Offshore EIA Report).

774 Detailed European site information is presented in appendix A.

7.2.3 CONSERVATION OBJECTIVES

775 The conservation objectives for sites designated for Annex II marine mammal features identified for Stage Two assessment are provided in section 7.6. Where Supplementary Advice to the conservation objectives, or site-specific conservation advice describes minimum targets for qualifying features in more detail, this detail is provided in appendix A and/or referenced within the relevant Stage Two Appropriate Assessments.

7.2.4 SPECIES ACCOUNTS

776 This section introduces the distribution and abundance/densities of the relevant Annex II marine mammal features in the region. Site-specific populations, distributions, and abundances are provided in each assessment of adverse effects in sections 7.4 and 7.6.

777 For the purposes of marine mammal characterisation, two appropriate marine mammal study areas were defined:

- Proposed Development marine mammal study area: this is an area encompassing the Proposed Development array area and the Proposed Development export cable corridor plus a (approximate) 16 km buffer, including the area to the north and south of the proposed landfall location. This combined area was surveyed by the 2019 to 2021 DAS (see Figure 4.3 in the volume 3, appendix 10.2 of the Offshore EIA Report). It should be noted that the Proposed Development marine mammal study area has been defined based on the Proposed Development array boundaries at the time of the Scoping phase (SSE Renewables, 2021b). The Proposed Development array area has been subsequently amended. As The refinements resulted in a reduction of the Proposed Development array area, the Proposed Development marine mammal study area encompasses larger buffer and is therefore considered to remain representative and conservative for the current assessment. Given that the Proposed Development marine mammal study area has not been realigned to the current Proposed Development boundary, the buffer encompassing the Proposed Development array area may be equal to or greater than 16 km in some locations, including to the north-west, south-west and south-east of the Proposed Development array area; and
- Regional marine mammal study area: marine mammals are highly mobile and may range over large distances and therefore, to provide a wider context, the desktop review considers the marine mammal ecology, distribution and density/abundance within the wider northern North Sea. The Regional marine mammal study area also informs the assessment where the Zone of Influence (ZoI) for a given impact (e.g. underwater noise) may extend beyond the Proposed Development marine mammal study area.

778 Regional marine mammal study area boundaries were discussed with NatureScot and MSS during Road Map Meeting 1 and Road Map Meeting 2 (volume 3, appendix 10.3 of the Offshore EIA Report).

Grey seal

779 Telemetry data for grey seals tagged on the east coast of Scotland confirmed usage of the Proposed Development marine mammal study area (Sinclair, 2021). In total, 46 adult grey seals have been tagged in the East Scotland MU between 1990 and 2013, with a further 23 tagged in the Northeast England MU between 1991 and 2008 (Sinclair, 2021). Of the 69 adult grey seals tagged on the east coast of Scotland, 59 of these had telemetry tracks within the Proposed Development marine mammal study area.

780 The tagging data illustrated connectivity between the Proposed Development marine mammal study area and SACs with marine mammal notified interest features. A high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Berwickshire and North Northumberland Coast SAC (73%) and Isle of May SAC (41%) (Sinclair, 2021). A very small proportion of tagged seals (two to 3%) had telemetry tracks within the Faray and Holm of Faray SAC, the Humber Estuary SAC, the North Rona SAC and the Monach Islands SAC. Given that these four SACs are located at large distances from the Proposed Development array area (>298 km), there are lower levels of expected connectivity between these SACs and the Proposed Development. As highlighted in Table 2.1, sites screened into this assessment were agreed through consultation with stakeholders. As with the tagged adult grey seals, there was also connectivity demonstrated between the Proposed Development marine mammal study area and SACs for pups/juveniles. Tracks were recorded between the Proposed Development marine mammal study area and the Berwickshire and Northumberland Coast SAC and Isle of May SAC; a small number (5% of tagged animals) were also recorded within the Humber Estuary SAC (298 km from the Proposed Development array).

781 Historic Seagreen Firth of Forth Round 3 boat-based surveys (2010 – 2011) recorded highest numbers of grey seals over sandy shallow banks such as Scalp Bank, Marr Bank, Wee Bankie and Berwick Bank, which are thought to be important areas for sandeel, a key prey item of grey seal (Sparling, 2012).

782 Grey seals were also recorded throughout the Proposed Development marine mammal study area during the DAS. Assuming that all seal species were grey seal, the mean encounter rate was 0.011 animals per km (95% CI = 0.014 to 0.007).

783 Mean grey seal at sea usage in the vicinity of the Proposed Development is variable, with hot spots at Berwickshire and North Northumberland Coast SAC, Firth of Forth, Tay and Eden Estuary and North of Aberdeen (Carter *et al*., 2020). Carter *et al*. (2020) used the most up-to-date Sea Mammal Research Unit

(SMRU) telemetry data and habitat preference models to estimate at-sea seal usage and, as agreed through consultation with key stakeholders, these data were deemed most appropriate for grey seal surface density calculations (see Figure 6.25 in volume 3, appendix 10.2 of the Offshore EIA Report). Within the Proposed Development array area, the average value (of the mean at sea usage) within grid cells was estimated at 30.3 (95% CI = 15.9 to 43.1) animals per 5 x 5 km grid cell, equating to a density of 1.2 (95% CI = 0.64 to 1.7) animals per km^2.

784 Density values from Carter *et al.,* (2020) within the Proposed Development export cable corridor are generally lower than those estimated for the Proposed Development array area. There is, however, a single cell overlapping the Proposed Development export cable corridor closest to the shore with an estimated density of 108.87 (95% CI = 46.5 to 188.6) grey seals per 5 x 5 km grid cell, equating to 4.35 (95% CI = 1.9 to 7.5) grey seals per km^2.

Harbour seal

785 Telemetry data confirmed harbour seal usage within the Proposed Development marine mammal study area. Of the 46 adult harbour seals tagged in east Scotland between 2001 and 2017, 25 had telemetry track data recorded within the Proposed Development Marine Mammal study area (see Figure 6.16 in volume 3, appendix 10.2 of the Offshore EIA Report). The telemetry tracks were concentrated to the north-west of the Proposed Development marine mammal study area, with comparatively lower numbers of telemetry tracks within the east and south-east of the Proposed Development array area or the Proposed Development export cable corridor. All 25 of these harbour seals also showed connectivity with the Firth of Tay and Eden Estuary SAC. There were also no harbour seal haul-outs recorded within the Proposed Development Marine Mammal study area.

786 Harbour seal populations along the east coast of Scotland have generally declined since the early 2000s (Special Committee on Seals (SCOS), 2020). Populations in the Firth of Tay and Eden Estuary SAC are continuing to decline although this is considered to be localised to the SAC and not reflective of the wider East Scotland MU population (SCOS, 2020). For example, while this MU has shown a large decline in numbers since the 1996 to 1997 count period, the most recent haul-out count in the 2016 to 2019 period (343) was higher than that in the 2011 to 2015 count period (224) suggesting that the MU population overall may be starting to increase in recent years. The main population surveys are carried out when harbour seals are moulting, during the first three weeks of August. The most recent harbour seal August moult count for the East Scotland MU is 343 (2016 to 2019 count period; SCOS, 2020). The population in this MU is mainly concentrated in the Firth of Tay and Eden Estuary SAC and in the Firth of Forth.

787 Mean harbour seal at sea usage in the vicinity of the Proposed Development is low, with the main area of usage within the Firth of Forth (Carter *et al*., 2020). Within the Proposed Development array area the average value (of the mean at sea usage) is estimated at 0.003 (95% CI = 0.0002 to 0.039) animals per 5 x 5 km grid cell, equating to a density of 0.0001 (95% CI = 0.00008 to 0.0016) animals per km^2. The peak count of harbour seals within grid cells overlapping the Proposed Development array area was 0.05 (95% CI = 0.0002 to 0.01) animals per km^2. This peak density aligned with the peak density previously reported by Russell *et al*. (2017) across the Proposed Development array area. A density of 0.0005 (94% CI = 0.00003 to 0.04) animals per km^2 is representative of the mean densities of harbour seal along the Proposed Development export cable corridor.

Harbour porpoise

788 Harbour porpoises are widely distributed throughout the North Sea and through the Regional Marine Mammal study area. Heinänen and Skov (2015) found that in the North Sea MU (Figure 6.4 in volume 3, appendix 10.2 of the Offshore EIA Report) the water depths and hydrodynamic variables are the most important factors for the probability of presence of harbour porpoise. During the summer period (i.e. April to September) animals seem to avoid well-mixed areas showing preference for more stable areas (in terms of temperature differences). Studies indicated an avoidance of estuarine water masses.

789 Based on spatio-temporal modelling using species and environmental data, Heinänen and Skov (2015) concluded that during the summer period, harbour porpoises avoid muddy sediments and hard substrate areas. A study using long term passive acoustic data revealed however, that within the Moray Firth, harbour porpoise occurred in both sandy and muddy habitats (Williamson *et a*l., 2016). The study also found that the proportion of hours with acoustic detection in muddy habitats increased during the night by 18% (Williamson *et al*., 2016). Porpoise detections also differed in response to depth in the different sediment types during hours of darkness and day-time periods. In muddy, deeper areas (50 m to 60 m) detections at night were nearly double those during the day. Therefore, it can be assumed that harbour porpoises use different types of habitats during the day and at night and therefore their distribution may shift accordingly.

790 The Heinanen and Skov (2015) analysis concluded that in the summer months, harbour porpoise presence in the North Sea MU was best predicted by season, water depth and salinity of surface waters. In the winter months (October to March), the presence of harbour porpoise was best predicted by the season, water depth and the seabed surface sediments. For the winter months the modelling showed a peak in presence was observed at water depths of 30 to 40 m and that animals seemed to avoid waters with high current speeds as well as avoiding areas with muddy substrates.

791 Harbour porpoise was the most commonly identified cetacean during historic aerial surveys in the Forth and Tay Offshore Wind Developers Group (FTOWDG) region (Grellier and Lacey, 2011) and Seagreen Firth of Forth Round 3 boat-based surveys (Sparling, 2012). Harbour porpoises were distributed across the survey area (Figure 6.1 in volume 3, appendix 10.2 of the Offshore EIA Report), but there were a greater number of sightings offshore, most often seen singly although group size ranged from one to six individuals. Harbour porpoise was also recorded on all boat-based surveys and in all parts of the site (particularly near morphological bank features such as Scalp Bank to the north of the Proposed Development array area running down to the centre of the Proposed Development array area; Figure 6.2 in volume 3, appendix 10.2 of the Offshore EIA Report). These areas may represent good foraging grounds due to the sandy banks providing good habitat for prey species such as sandeel and whiting, both of which have been recorded as important constituents of the diet of harbour porpoises on the east coast of Scotland, with the relative proportion of each of these in the diet changing seasonally (Santos *et al*., 2004).

792 DAS survey data showed that harbour porpoise was distributed throughout the Proposed Development marine mammal study area. Sightings occurred throughout the survey area, however, the presence of harbour porpoise in May 2019 and June 2019 is more evident in the south-east of the Proposed Development array area. The spatial density maps produced using MRSea showed that during spring, the eastern half of the survey area appeared to be favoured by harbour porpoise. The highest encounter rate of harbour porpoise during the DAS was 0.212 individuals per km in April 2021. Mean monthly encounter rate was calculated as 0.037 (95% CI = 0.011 to 0.062). Harbour porpoise also had the second greatest overall encounter rate (0.013 sightings per km) from all marine species recorded during historic aerial surveys in the FTOWDG region (Grellier and Lacey, 2011).

793 Analysis by Heinänen and Skov (2015) has shown that areas of persistent high densities are estimated in the outer Moray Firth. The density estimates within the outer Firth of Forth and Firth of Tay region were predicted to be relatively low compared to other parts of the North Sea. Paxton *et al*. (2016) corroborated this finding by reporting that the Firth of Forth and the east coast of Scotland was not identified as being associated with the highest density for this species, compared to other regions such as west coast of Ireland or the Hebrides and that higher abundance was correlated with Moray Firth.

794 Harbour porpoise was the most common cetacean species encountered during historic aerial surveys with the mean density of 0.080 (CV=0.11) individuals per km^2 (Grellier and Lacey, 2011). Summer density estimates were calculated to be 0.099 (CV=0.12) individuals per km^2, and winter 0.048 (CV=0.24) individuals per km^2. These density estimates were minimum estimates based on inherent negative bias

due to the survey methodology (Mackenzie *et al*., 2012). Therefore, spatially explicit density surfaces were generated using all FTOWDG aerial and Round 3 boat-based sightings (Mackenzie *et al*., 2012, section 5.2). When all data across all years were pooled, depth was a significant predictor of occurrence, with fewer animals in shallow water. The data showed a great deal of variation in the spatial distribution of harbour porpoise across the survey years, with the main predictor of density being survey methodology. The likely explanation for variation in densities across the survey area may relate to changes in prey distribution. After correcting for availability, Mackenzie *et al*. (2012) estimated absolute abundance for the survey area (aerial and boat-based) across the survey period as 582 (95% CI = 581 to 1235). The correction factor (i.e. probability of an animal being available to be seen at the sea surface) for harbour porpoise was 0.434 (McKenzie *et al*., 2012). Harbour porpoise was also the most frequently recorded species of cetacean during Neart na Gaoithe boat-based surveys undertaken each month between November 2009 and October 2012 (Neart na Gaoithe, 2018).

795 Seasonal densities estimated from the DAS data highlighted that in spring months there were more harbour porpoise within the Proposed Development marine mammal study area. Mean monthly density was estimated as 0.127 (95% CI = 0.066 to 0.277) animals per km^2. Correcting this for availability bias based on tagged porpoises in the Baltic/North Sea (Teilman *et al*., 2013) mean monthly density was estimated as 0.299 (95% CI = 0.155 to 0.652) animals per km^2 with a peak mean density during spring months of 0.826 (95% CI = 0.440, 1.616) animals per km^2 (Table 7.1). Corrected abundance of harbour porpoise within the Proposed Development marine mammal study area ranged between 460 animals in winter and 4,108 animals in spring.

Table 7.1: Harbour Porpoise Modelled Absolute Density Estimates by Season for Proposed Development Array Area Including Lower Confidence Intervals (LCI) and Upper Confidence Intervals (UCI)[8]

Season	Mean Absolute Abundance	Mean Absolute Density (Animals per km^2)	LCI	UCI
Winter	460	0.092	0.045	0.195
Spring	4108	0.826	0.440	1.616
Summer	883	0.179	0.099	0.341
Autumn	479	0.096	0.035	0.452
All months	**-**	**0.299**	**0.155**	**0.652**

796 Comparison of harbour porpoise encounter rate during different seasons based on the historic aerial surveys in the FTOWDG region showed that harbour porpoises were recorded nearly three times as often in summer (2.01 sightings per 100 km) compared to winter (0.70 sightings per 100 km) (Grellier and Lacey, 2011). The same pattern of higher encounter rates during summer months was also recorded during boat-based surveys (Sparling, 2012). Boat-based surveys for Seagreen in summer 2017 recorded the highest counts of harbour porpoise between May and July (Seagreen Technical Report, 2018). These findings are different to JCP Phase III results, as the study reported highest densities of harbour porpoise during winter months (Paxton *et al.,* 2016).

797 Similarly, a temporal trend emerged from the DAS, with highest encounter rates during spring months each year (April and May,). Harbour porpoise encounter rate was lowest during winter and autumn (from November 2019 to March 2020 and from October 2020 to February 2021). MRSea modelling corroborated the above as the results showed highest densities during spring months and lowest densities during winter (see volume 3, appendix 10.3, annex A of the Offshore EIA Report).

[8] Mean Seasonal Abundance is Scaled up to the Proposed Development Array Area Plus 16 km Buffer

Bottlenose dolphin

798 The Moray Firth SAC boundary encompassed the core area of occurrence of the resident population of bottlenose dolphins in the North Sea based on the data collected in 1980s and early 1990s. However, studies have shown that the population of bottlenose dolphins off the east coast of Scotland is highly mobile with individuals ranging from Moray Firth to Firth of Forth (Quick *et al.,* 2014; Cheney *et al.,* 2018; Arso Civil *et al.,* 2019; Arso Civil *et al.,* 2021). Therefore, this range was established as the main distributional range of the population (Quick *et al.,* 2014; Cheney *et al.,* 2013).

799 Acoustic occupancy rates and habitat modelling in the East Coast Marine Mammal Acoustic Study (ECOMMAS) highlighted that the waters between Stonehaven and Aberdeen are a potential area of high occupancy (Palmer *et al.,* 2019). Instruments deployed in the Stonehaven group showed the second highest acoustic occupancy rates behind the Cromarty group (area close to Moray Firth). Quick *et al. (*2014) established that a high proportion of bottlenose dolphins from the east coast of Scotland population use both the Tayside and Fife area and the Moray Firth SAC, over a range of temporal scales. The same study reported that most encounters occurred at the entrance of the Tay (35 to 46% of the east coast of Scotland population) and that bottlenose dolphins were only seen on the north side of the Forth, mostly between Anstruther and Fife Ness. These findings were corroborated by Arso Civil *et al. (*2019) who reported that the east coast population expanded its distribution range since more than a half of the estimated population was consistently using the St Andrews Bay and the Tay estuary. The ECOMMAS study reported that between 2013 and 2015 there was relatively low number of detections at the St. Andrews survey location nearest the bay and it has been suggested that this area may represent habitat associated with rest or socializing rather than foraging, therefore there are fewer clicks to detect (Palmer *et al.,* 2019). The most recent data collected during boat-based trips between Moray Firth and Fife Ness (during summers 2017 to 2019) shows that the Tay estuary area and adjacent waters continues to be used by more than a half of the total estimated population every summer (in 2019 approx. 53.5%; Arso Civil *et al.,* 2021). This study also reported that the number of animals estimated to be using this area has increased by around 4.3% per year between 2009 and 2019, although it decreased between 2017 and 2019. The author suggested that it is likely that changes in the distribution range are continuing with a further southern range expansion (Arso-Civil *et al.,* 2021). In 2007 there was one confirmed sighting of a group near Whitley Bay and the Tyne river mouth (Cheney *et al.,* 2013) and there are ongoing citizen science projects, which has resulted in bottlenose dolphin sightings being reported as far as the Farne Islands (Chronic Live, 2020). However, C-PODs deployed at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). There is currently no reported survey effort to the south of the Firth of Forth that would indicate an increase in numbers of bottlenose dolphins present in the area.

800 The ECOMMAS C-POD study (Palmer *et al.,* 2019) found that broadband acoustic occupancy rates throughout the survey were generally higher for C-PODs closer to the shoreline which corroborates findings of Thompson *et al.* (2015) suggesting the bottlenose dolphins are more likely to be observed in coastal waters, within 5 km of shore and therefore are unlikely to be present in the offshore areas that may be exposed to significant construction noise from offshore wind farms. These results were corroborated by Quick *et al.* (2014) as the study reported that dolphins were mostly encountered in waters less than 30 m deep, generally in waters between 2 m and 20 m and within 2 km from the coast (volume 3, appendix 10.2

of the Offshore EIA Report). Paxton *et al.* (2016) also described bottlenose dolphin distribution as coastal and no bottlenose dolphins were recorded offshore during three years (2009 to 2012) of boat-based surveys within the Neart na Gaoithe Offshore Wind Farm area (Neart na Gaoithe, 2018).

801 Bottlenose dolphins were also positively identified in historic inshore (inside 12 nm) and offshore (outside 12 nm) aerial surveys between May 2009 and March 2010 (Grellier and Lacey, 2011). During summer there was just one encounter of one individual outside 12 nm and during winter two sightings of three individuals were recorded inside 12 nm. The average encounter rate of bottlenose dolphin during aerial surveys was 0.0002 individuals per km (Grellier and Lacey, 2011). Some unidentified cetacean and dolphin species were also recorded, in each case with an encounter rate of 0.0012 individuals per km, although no distinction was made between species for these sightings. No bottlenose dolphins were encountered during Seagreen Firth of Forth Round 3 boat-based surveys between 2010 and 2011 (Sparling, 2012).

802 Bottlenose dolphins were recorded in low numbers during the Proposed Development aerial digital surveys, with one and six individuals encountered in October 2019 and April 2021 respectively. The encounter rate varied between 0.0005 individuals per km in October 2019 and 0.0024 individuals per km in April 2021 (see volume 3, appendix 10.2 of the Offshore EIA Report).

803 Cheney *et al.* (2013) reported that the population estimate of bottlenose dolphin abundance for the Coastal East Scotland MU (volume 3, appendix 10.2 of the Offshore EIA Report) population is 195 individuals (95% CI = 162 to 253) based on photo ID counts between 2006 and 2007. More recently, a study by Cheney *et al.* (2018) estimated that the bottlenose dolphin population on the east coast of Scotland is increasing and varied from 129 (95% CI = 104 to 155) in 2001 to 189 (95% CI = 155 – 216) in 2015 (volume 3, appendix 10.2 of the Offshore EIA Report). Based on this later study, the IAMMWG recommended that the population in the Coastal East Scotland MU for bottlenose dolphin is taken as 189 individuals (IAMMWG, 2021). However, advice from NatureScot and MSS provided during the Road Map process (see volume 3, appendix 10.3 of the Offshore EIA Report) was to adopt the 5-year weighted average population estimate from data gathered between 2015 and 2019 (Arso Civil *et al.,* 2021). As advised by NatureScot in their formal response to the HRA Stage One Screening (MS-LOT, 2022), the most up-to-date bottlenose dolphin population estimate for Coastal East Scotland MU and Moray Firth SAC was taken as 224 individuals (Arso Civil *et al.,* 2021). Despite inter-annual variability, the number of dolphins using the Moray Firth SAC between 2001 and 2016 appeared to be stable (Cheney *et al., 2018*).

804 It is noted that the proportion of the population that uses the Moray Firth SAC has declined due to an overall increase in population size and expansion of range; whilst the Moray Firth is clearly an important area for this population, they are not restricted to either the Moray Firth SAC or the wider Moray Firth (Cheney *et al.,* 2018).

805 Based on historical photo ID data collected from 1997 to 2010 and 2012 to 2013 in the Tayside and Fife area (including Firth of Forth), Quick *et al.* (2014) reported that the majority of dolphin encounters were recorded within the Tay estuary (see volume 3, appendix 10.2 of the Offshore EIA Report). Between 71 and 91 bottlenose dolphins (35 to 46% of the total Scottish east coast population) were estimated to be using the Tay area during 2009 – 2013 (Quick *et al.,* 2014). Arso Civil *et al.* (2019) analysed and compared photoidentification data collected during consistent dedicated surveys from 2009 and 2015 in similar study areas to Quick *et al.* (2014), St Andrews Bay and the Tay estuary as well as the Moray Firth SAC. Over the study period, 35.2% of the marked animals were seen only in St Andrews Bay and the Tay estuary, 35.9% were seen only in the Moray Firth SAC, and 28.9% were seen in both areas. The study reported that the number of dolphins using the Tay estuary and adjacent waters increased and ranged from a minimum of 85 (95% CI = 77 to 93) animals in 2011 to a maximum of 121 (95% CI = 84 to 173) in 2014 which represented 52.5% of the estimated total east coast population (i.e. using the population's main range). The most recent study in the Tay estuary and adjacent waters integrated data collected during boat-based surveys in summers 2017 to 2019 (May to September) and data collected under the Moray Firth Marine Mammal Monitoring Programme (Arso Civil *et al.,* 2021; Graham *et al.,* 2017). This study corroborated previous findings and reported that this area continues to be used by more than half of the total estimated east coast population every summer; 53.8% between 2009 and 2019 (Arso-Civil *et al.* 2021). Studies suggest that inshore and offshore populations are often ecologically and genetically discrete (Cheney *et al.,* 2013).

806 To estimate the density of bottlenose dolphin in coastal areas, it was important to understand both the abundance and distribution of the east coast population. A five-year weighted average of the east coast bottlenose dolphin population provided an estimated population of 224 individuals (95% CI = 214 to 234) (Arso Civil *et al*., 2021). The main distributional range of this population is Moray Firth to the Firth of Forth (Cheney *et al*., 2013), however, as mentioned (see paragraph 805), approximately 53.8% of the east coast population (=120 individuals) use the Tay area and adjacent waters (Arso Civil *et al*., 2021). Therefore, it was assumed that the same proportion is likely to be present anywhere between Peterhead and further south as far as the Farne Islands (as recent studies reported that the east coast population is extending their range south). Previous studies reported that bottlenose dolphins are likely to be recorded within 5 km from the shore (Arso Civil *et al*., 2014; Palmer *et al*., 2019; Oudejans *et al*., 2015). Quick *et al*. (2014) provided that in the Tayside and Fife area as well as between Montrose and Aberdeen, dolphins were encountered usually in waters 2 m to 20 m deep. Therefore, the 2 m to 20 m depth contour polygon was identified as the key habitat preference of bottlenose dolphin along the east coast, between Peterhead and Farne Islands.

807 ECOMMAS data suggested that there was a patchiness in distribution along the east coast with occupancy of bottlenose dolphin (dolphin positive minutes) different across the five monitored locations (Palmer *et al*., 2019). Recent literature (Arso Civil *et al.,* 2019, Arso Civil *et al.,* 2021) and feedback from consultees during the Proposed Development Road Map meetings indicated that, in particular, the Firth of Tay is an important area for the east coast bottlenose dolphin population. There were, however, no C-POD arrays located in the Firth of Tay and therefore the occupancy of this area could not be compared with the other five areas monitored using ECOMMAS datasets. To capture the patchiness in coastal distribution of bottlenose dolphins and estimated density, a dual approach was applied. First, for all areas except the outer Firth of Tay, the east coast proportion of the population (120 animals), was assumed to be evenly distributed across the area between the 2 m to 20 m bathymetric contours, between Peterhead and the Farne Islands, giving a density of 0.197 animals per km^2. Second, to reflect the relative importance of the outer Firth of Tay in terms of bottlenose dolphin distribution, the habitat preference map for bottlenose dolphins in the Firth of Tay and adjacent areas as modelled by Arso Civil *et al*. (2019) was used. The map of habitat preference was analysed using the most precautionary scenario when current direction was between 300 to 010 degrees and associated bottlenose dolphin presence was recorded during the corresponding tidal condition. Four distinct segments were identified on the habitat preference maps: Fife Ness to St Andrews, Outer Firth of Tay, Arbroath and Montrose. A probability of occurrence value was assigned to each segment based on the value with widest spread across the segment and subsequently these values were used to weight each segment (as a percentage) in relation to other segments. The outer Firth of Tay had the highest weighting with a probability of occurrence of 0.8 (Table 7.2). As per the advice received from the Scoping Representation provided by MSS on 9 December 2021, it was conservatively assumed that 53.8% of the east coast proportion of the population (120 individuals) may be present within the Firth of Tay and adjacent waters and, using the weightings, the number of bottlenose dolphins was estimated for each of the segments (Table 7.2). Subsequently, to estimate density of bottlenose dolphins specifically within the outer Firth of Tay segment the number of dolphins (53.3 individuals) was divided by the area within that segment to give 0.294 animals per km^2 (Table 7.3).

Table 7.2: Approach to Estimating Abundance in Different Sectors for the Firth of Tay and Adjacent Areas Based on Arso Civil *et al.* (2019) Habitat Preference Map

Segment	Probability of Occurrence (from Arso Civil *et al*., 2019)	Percentage (Weighting) (=Probability of Occurrence/Sum of Probabilities)	Number of Dolphins (=120 Animals*Weighted Percentage)
Fife Ness to St Andrews	0.2	11.1	13.3
Outer Firth of Tay	0.8	44.4	53.3
Arbroath	0.3	16.7	20.0
Montrose	0.5	27.8	33.3
Totals	**1.8**	**100**	**120**

808 Within the Proposed Development array area (offshore), the density of bottlenose dolphin was taken as 0.0298 from SCANS-III (Hammond *et al.,* 2021) as described in paragraph 805 (Table 7.3).

Table 7.3: Summary of Bottlenose Dolphin Densities for Different Sections Within the Regional Marine Mammal Study Area

Section	Density (Animals per km^2)
Peterhead to Farne Islands (except for Firth of Tay); 2 to 20 m depth contour	0.197
Outer Firth of Tay; 2 to 20 m depth contour	0.294
Offshore	0.0298

Summary of Annex II densities and population estimates

809 Table 7.4 presents density estimates for Annex II marine mammals in the Proposed Development marine mammal study area for use in quantifying the scale of effects as part of the appropriate assessments.

Table 7.4: Density Estimates and Population Assessments for Annex II Marine Mammals in the Proposed Development Marine Mammal Study Area

Species	Density (Animals per km^2)
Harbour porpoise	0.299 to 0.826[1]
Bottlenose dolphin	Coastal: 0.197 to 0.294[2]
	Offshore: 0.0298[3]
Harbour seal	0.0001 to 0.002[4]
Grey seal	0.276 to 1.2[5]

[1] Site-specific densities (mean and seasonal peak) estimated from Proposed Development aerial digital survey data (2019 to 2021)
[2] Average coastal density derived from five-year average from Arso Civil *et al*. (2021) with proportion at the outer Firth of Tay assigned using habitat preference modelling data from Arso Civil *et al*. (2019)
[3] SCANS-III (Hammond *et al*., 2021)
[4] Mean and maximum across the Proposed Development marine mammal study area based on at-sea mean density maps (Carter *et al*., 2020)
[5] Mean monthly density based on site-specific Proposed Development aerial digital survey data (2019 to 2021) and density based on at-sea mean usage maps (Carter *et al*., 2020) across the Proposed Development marine mammal study area.

7.2.5 APPROACH TO THE IN-COMBINATION ASSESSMENTS

810 The in-combination assessment takes into account the impact associated with the Proposed Development together with other relevant plans, projects and activities. In-combination effects are therefore the combined effect of the Proposed Development in combination with the effects from a number of different projects, on the same receptor or resource. This is informed by the findings of the cumulative effects assessment presented in volume 2, chapter 10 of the Offshore EIA Report.

811 The projects and plans selected as relevant to the in-combination assessment presented within this section are based upon the results the assessment presented in volume 2, chapter 10 of the Offshore EIA Report. Each project or plan has been considered on a case by case basis for screening in or out of this assessment based upon data confidence, effect-receptor pathways and the spatial/temporal scales involved. The projects included in this in-combination assessment are detailed in Table 7.5 and volume 2, chapter 10 of the Offshore EIA Report.

812 The in-combination effects presented and assessed in this section have been selected from the details provided in volume 1, chapter 10 of the Offshore EIA Report as well as the information available on other projects and plans, to inform a maximum design scenario. Effects of greater adverse effects are not predicted to arise should any other development scenario, based on details within the Project Design Envelope (e.g. different wind turbine layout), to that assessed here, be taken forward in the final design scheme.

813 Where there is no spatial or temporal overlap with the activities during construction, operation or decommissioning of the Proposed Development, impacts associated with other projects listed in Table 7.5 may be excluded from further consideration. For the purposes of the assessment of impact on conservation objectives, in-combination effects have been screened in/out on the following basis:

- **Injury/disturbance to marine mammals from elevated underwater noise during pile driving (construction phase)** – the ZoI for pile driving can extend beyond the boundaries of proposed offshore wind farms and therefore, adopting a precautionary approach, the assessment has screened in projects within the regional marine mammal study area (harbour porpoise from the Southern North Sea SAC) and within the north-east of Scotland (bottlenose dolphin from Moray Firth SAC, grey seal from Berwickshire and North Northumberland Coast SAC and Isle of May SAC and harbour seal from the Firth of Tay and Eden Estuary SAC) whose construction phases overlap with the construction phase for the Proposed Development. Projects whose construction phase finishes in a year preceding the commencement of construction phase at the Proposed Development (2024) were screened in as the sequential piling at respective projects could lead to a longer duration of effect.
- **Injury/disturbance to marine mammals from elevated underwater noise during site investigation surveys (pre-construction phase, operation and maintenance phase)** – it is anticipated that the magnitude of the impacts will be of a similar scale to that described for the Proposed Development with the potential to experience disturbance by marine mammal receptors expected to be localised to within the boundaries of the respective projects. Therefore, the in-combination assessment has focussed only on site investigation surveys for those projects within the Firth of Forth and Tay region. Of these, very few projects have considered site-investigation surveys within the EIA. For pre-construction phase, where surveys are known to have been completed, this impact has been screened out of the in-combination assessment.
- **Injury/disturbance to marine mammals from elevated underwater noise during UXO clearance (pre-construction phase)** - the ZoI for UXO clearance can extend beyond the boundaries of other proposed offshore wind farms. Therefore, adopting a precautionary approach, the assessment has screened in projects within the regional marine mammal study area (harbour porpoise from the Southern North Sea SAC) and within the north-east of Scotland (bottlenose dolphin from Moray Firth SAC, grey seal from

Berwickshire and North Northumberland Coast SAC and Isle of May SAC and harbour seal from the Firth of Tay and Eden Estuary SAC) whose construction phases (which would include pre-construction UXO clearance) overlap with the construction phase for the Proposed Development. Note, projects with completed UXO clearance campaigns are screened out of the assessment (e.g. Seagreen 1A Project). Projects whose construction phase finishes in a year preceding the commencement of construction phase at the Proposed Development (2024) were screened in as the sequential UXO clearance at respective projects could lead to a longer duration of effect.

- **Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities (all phases)** – it is expected that each project will contribute to the increase of vessel traffic and hence to the amount of vessel noise in the environment during the construction, operation and maintenance and decommissioning phases. However, the potential for marine mammal receptors to experience disturbance would be expected to be localised to within the close vicinity of the respective projects and as such the assessment has focussed only on projects within the Firth of Forth and Tay region. However, where there is no effect-receptor pathway, projects have been screened out from in-combination assessment.
- **Changes in fish and shellfish communities affecting prey availability (all phases)** – potential in-combination effects on fish and shellfish assemblages, as identified in volume 2, chapter 9 of the Offshore EIA Report, may have indirect effects on marine mammals. For the purposes of the fish and shellfish ecology assessment of effects, in-combination effects have been assessed within a representative 20 km buffer of the Proposed Development fish and shellfish ecology study area. This 25 km buffer applies to all impacts considered in the assessment, except underwater noise, where a larger buffer of 100 km has been used to account for the larger ZoI of impacts. Therefore, only the projects considered in volume 2, chapter 9 of the Offshore EIA Report are considered in the assessment of in-combination indirect impacts due to changes in fish and shellfish communities affecting prey availability.

814 The assessment of in-combination effects with relevant projects has focussed on information available in the public domain (e.g. where the impact has been identified in the scoping study (Tier 3 projects) or the environmental statement (Tier 2 projects)). In this regard, where an impact has been identified and screened in, there is considered to be a potential for in-combination effects. Therefore, the impact will be considered further. Impacts scoped out from individual assessments of respective projects are not considered further.

Relevant plans and projects

815 The plans and projects set out in Table 7.5 have been considered within the assessment of other projects and plans with potential for in-combination effects.

Table 7.5: List of Other Developments with Potential for In-Combination Effects on Annex II Marine Mammal Features

Development	Status	Distance from Array Area (km)	Distance from Offshore Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development
Tier 1							
Offshore Wind Projects and Associated Cables							
No Tier 1 projects identified within the regional marine mammal study area.							
Tier 2							
Offshore Wind Projects and Associated Cables							
Seagreen 1	Under construction	5	35	Up to 1,075 MW (up to 114 wind turbines)	2020-2023	2024 onwards	Project operation and maintenance phase overlaps with Proposed Development construction and operation and maintenance phases
Seagreen 1A Project	Consented	5	36	Up to 36 wind turbines with no capacity limit	2023-2025	2026 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Neart na Gaoithe Offshore Wind	Under construction	16	15	Up to 450 MW (up to 75 wind turbines)	2020-2023	2024 onwards	Project operation and maintenance phase overlaps with Proposed Development construction and operation and maintenance phases
Inch Cape Offshore Wind Farm	Consented	19	39	Up to 1,000 MW (up to 72 wind turbines)	2023-2025	2026 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Blyth Demo Phase 2	Consented	102	97	Up to 58.4 MW (up to 5 floating wind turbines)	2023-2024	2025 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Moray West	Consented	203	229	Up to 950 MW (up to 85 wind turbines)	2023-2024	2025 onwards	Project operation and maintenance phase overlaps with Proposed Development construction and operation and maintenance phases
Dogger Bank Creyke Beck A	Under construction	236	240	Up to 1,200 MW (up to 200 wind turbines)	2022-2024	2025 onwards	Project operation and maintenance phase overlaps with Proposed Development construction and operation and maintenance phases
Dogger Bank Creyke Beck B	Under construction	213	218	Up to 1,200 MW (up to 200 wind turbines)	2022-2024	2025 onwards	Project operation and maintenance phase overlaps with Proposed Development construction and operation and maintenance phases
Dogger Bank Teesside A[9]	Under construction	241	246	Up to 1,400 MW	2022-2026	2027 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Sofia Offshore Wind Farm[6]	Under construction	241	246	Up to 1,400 MW	2022-2026	2027 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Hornsea Project Three	Consented	328	332	Up to 2400 MW	2023-2030	2031 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Hornsea Project Four	Submitted	258	260	Up to 2,600 MW	2024-2028	2029 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases

[9] As per the National Infrastructure Planning website, Dogger Bank Teesside A/Sofia Offshore Wind Farm (formerly Dogger Bank Teesside B) has been consented as one development. However, Dogger Bank Teesside A and Sofia Offshore Wind Farm provided separate Environmental Reports/Appraisals for increased hammer energy to support non-material change DCO applications and therefore the assessment of impacts on marine mammals will be considered independently. See more details in paragraph 417.

Development	Status	Distance from Array Area (km)	Distance from Offshore Export Cable Corridor (km)	Description of Development	Dates of Construction (If Applicable)	Dates of Operation (If Applicable)	Overlap with the Proposed Development
Oil and Gas Activities							
No oil and gas projects identified within the regional marine mammal study area.							
Aggregate Extraction							
No aggregate extraction projects identified within the regional marine mammal study area.							
Disposal Sites							
Eyemouth – FO0080	Operational	35	17	Dredged material disposal site	N/A	Ongoing	Project operation and maintenance phase overlaps with Proposed Development construction and operation and maintenance phases
Coastal Protection							
No coastal protection projects identified within the regional marine mammal study area.							
Subsea Cables (Telecommunications and Interlinks)							
Eastern link 1	Scoping	28	2	Subsea cable linking Scotland and north England	2023-2027	2028	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Eastern link 2	Scoping	14	21	Subsea cable linking Scotland and north England	2023-2027	2028	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Infrastructure							
No Infrastructure projects identified within the regional marine mammal study area.							
Ministry of Defence sites							
No MoD sites identified within the regional marine mammal study area.							
Tier 3							
Offshore Wind Projects and Associated Cables							
Forthwind Demonstration Project	Scoping	69	41	Up to 20 MW (1 wind turbine)	2024	2025 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Green Volt Floating Offshore Wind Farm	Scoping	150	185	Up to 480 MW (30 wind turbines)	2024-2026	2027 onwards	Project construction and operation and maintenance phases overlap with Proposed Development construction and operation and maintenance phases
Cambois connection	Pre-Application	N/A	N/A	Offshore export cable to meet the capacity of the Proposed Development	Q1 2028 – Q4 2031	Q4 2031	The construction and operation and maintenance phases of the Cambois connection overlap with the construction and operation and maintenance phases of the Proposed Development.

7.3 CONSTRUCTION AND DECOMMISSIONING

7.3.1 UNDERWATER NOISE

816 Increases in underwater noise associated with the construction (and decommissioning) of the Proposed Development have the potential to cause injury and disturbance to marine mammals. The assessment of impacts associated with underwater noise has been informed by subsea noise modelling, the scope of which was agreed through the Road Map process (see volume 3, appendix 10.2 of the Offshore EIA Report).

817 This section addresses the underwater noise effects associated with the construction and decommissioning phases of the Proposed Development. For each potential underwater noise effect, the nature of the effect is described, the source activities generating the effect and the potential changes to marine mammal receptors are outlined. Effects are categorised as permanent or temporary.

818 The subsequent sub-sections provide more information on each of these potential underwater noise effects and the sensitivity of the Annex II marine mammal features to these effects:

- a summary of the relevant components of the Proposed Development, outlined in the maximum design scenario (Table 7.10) and designed in measures (Table 7.11);
- an overview of the methodology/modelling/assessment undertaken to quantify and assess underwater noise effects on marine mammals (paragraph 819 *et seq*.); and
- an overview of relevant marine mammal information gathered to aid the assessment (paragraph 776 *et seq*.).

Assessment methodology

819 Marine mammals, particularly cetaceans, are capable of generating and detecting sound (Au *et al*., 1974; Bailey *et al*., 2010) and are dependent on sound for many aspects of their lives (i.e. prey identification; predator avoidance; communication and navigation). Increases in anthropogenic noise may consequently lead to a potential effect within the marine environment (Parsons *et al*., 2008; Bailey *et al*., 2010). Richardson *et al*. (1995) described four zones of noise influence which vary with the distance from the source, including: audibility (sound is detected); masking (interfere with detection of sounds and communication); responsiveness (behavioural or physiological response) and injury/hearing loss (tissue damage in the ear).

820 For this study, it is the zones of injury (auditory) and disturbance (i.e. responsiveness) that are of concern (there is insufficient scientific evidence to properly evaluate masking).

821 The following sub-sections (paragraph 822 *et seq*.) provide context for the effects of auditory injury and behavioural disturbance in the Annex II marine mammal species concerned and summarise the relevant thresholds for onset of effects and describe the evidence base used to derive them. Subsequent sections (paragraph 834 *et seq*.) outline the approach taken to the modelling and quantification of underwater noise effects on Annex II marine mammal species during construction and decommissioning.

Auditory injury in marine mammals

822 Auditory injury in marine mammals can occur as either a permanent threshold shift (PTS), where there is no hearing recovery in the animal, or as a temporary threshold shift (TTS), where an animal can recover from the tissue damage. The 'onset' of TTS is deemed to be where there is a temporary elevation in the hearing threshold by 6 dB and is "the minimum threshold shift clearly larger than any day to day or session to session variation in a subject's normal hearing ability", and which "is typically the minimum amount of threshold shift that can be differentiated in most experimental conditions" (Southall *et al*., 2007). Since it is considered unethical to conduct experiments measuring PTS in animals, the onset of PTS was extrapolated from early experiments on TTS growth rates in chinchillas (Henderson and Hamernick, 1986) and is conservatively considered to occur where there is 40 dB of TTS (Southall *et al*., 2007). Whether such shifts in hearing would lead to loss of fitness will depend on several factors including the frequency range of the shift and the duty cycle of impulsive sounds. For example, if a shift occurs within a frequency band that lies outside of the main hearing sensitivity of the receiving animal, there may be a 'notch' in this band but potentially no effect on the animal's ability to survive.

823 For the purposes of the assessment of potential injury, the emphasis is on PTS as the appropriate threshold due to the irreversible nature of the effect whereas TTS is temporary and reversible. A likely response of an animal exposed to noise levels that could induce TTS is to flee the ensonified area. It is therefore considered that there is also a behavioural response (disturbance) that overlaps with potential TTS ranges, and animals exposed to noise levels that have the potential to induce TTS are likely to actively avoid hearing damage by moving away from the ensonified area. Since derived thresholds for the onset of TTS are based on the smallest measurable shift in hearing, TTS thresholds are likely to be very precautionary and could result in overestimates of potential range of effect. In addition, the assumptions and limitations of subsea noise modelling (e.g. equal energy rule, reduced sound levels near the surface, conservative swim speeds, and use of impulsive sound thresholds at large ranges) also lead to a potential overestimation of range of effect. Notably, Hastie *et al*. (2019) found that during pile driving there were range dependant changes in signal characteristics with received sound losing its impulsive characteristics at ranges of several kilometres, especially beyond 10 km. For these reasons TTS is not considered a useful predictor of the potential impacts of underwater noise on marine mammals where ranges exceed more than c. 10 km and therefore, where this is the case (i.e. piling and UXO clearance) TTS is not included in the assessment in terms of injury. To supporting this reasoning a synthesis of the use of impulsive sound thresholds at large ranges is presented volume 3, appendix 10.1 of the Offshore EIA Report. Ranges for TTS were, however, modelled for completeness for all noise-related impacts and are presented in volume 3, appendix 10.1 of the Offshore EIA Report.

824 For marine mammals, injury thresholds are based on both linear (i.e. un-weighted) peak sound pressure levels (SPL_{pk}) and marine mammal hearing-weighted cumulative sound exposure level (SEL_{cum}). The SEL_{cum} takes account of the cumulative sound received by an animal within the ensonified area over the entire piling sequence and is weighted by marine mammal hearing groups based on similarities in known or expected hearing capabilities (Southall *et al*., 2007). Marine mammal hearing groups are described in the latest guidance (Southall *et al*., 2019) as follows:

- low frequency (LF) cetaceans (i.e. marine mammal species such as baleen whales with an estimated functional hearing range between 7 Hz and 35 kHz); minke whale is the marine mammal IEF in the LF cetacean group;
- high-frequency (HF) cetaceans (i.e. marine mammal species such as dolphins, toothed whales, beaked whales and bottlenose whales with an estimated functional hearing range between 150 Hz and 160 kHz). Bottlenose dolphin is the marine mammal IEFs in the HF cetacean group;
- very high-frequency (VHF) cetaceans (i.e. marine mammal species such as true porpoises, with an estimated functional hearing range between 275 Hz and 160 kHz). Harbour porpoise is the marine mammal IEF in the HF cetacean group; and
- pinnipeds in water (PW) (i.e. true seals with an estimated functional hearing range between 50 Hz and 86 kHz). Grey seal and harbour seal are the marine mammal IEFs in the PW group.

825 Injury criteria are proposed in Southall *et al*. (2019) for both impulsive and non-impulsive (continuous) sound and are summarised in Table 7.6 and Table 7.7.

Table 7.6: Summary of PTS Criteria for Impulsive and Non-Impulsive Noise (SEL Thresholds in dB re 1 µPa²s and peak SPL thresholds in dB re 1 µPa)

Hearing Group	Parameter	Impulsive	Non-impulsive
LF cetaceans (minke whale)	Peak SPL, unweighted	219	-
	SEL, LF weighted	183	199
HF cetaceans (bottlenose dolphin)	Peak SPL, unweighted	230	-
	SEL, HF weighted	185	198
VHF cetaceans (harbour porpoise)	Peak SPL, unweighted	202	-
	SEL, VHF weighted	155	173
Phocid carnivores in water (PCW) (grey and harbour seal)	Peak SPL, unweighted	218	-
	SEL, PW weighted	185	201

Table 7.7: Summary of TTS Criteria for Impulsive and Non-impulsive Noise (SEL Thresholds in dB re 1 µPa²s and peak SPL Thresholds in dB re 1 µPa)

Hearing Group	Parameter	Impulsive	Non-impulsive
LF cetaceans (minke whale)	Peak SPL, unweighted	213	-
	SEL, LF weighted	168	179
HF cetaceans (bottlenose dolphin)	Peak SPL, unweighted	224	-
	SEL, HF weighted	170	178
VHF cetaceans (harbour porpoise)	Peak SPL, unweighted	196	-
	SEL, VHF weighted	140	153
PCW (grey and harbour seal)	Peak SPL, unweighted	212	-
	SEL, PW weighted	170	181

826 To carry out exposure calculations (SEL_{cum} metric) the underwater noise modelling made a simplistic assumption that an animal would be exposed over a 24-hour period and that there would be no breaks in activity during this time. It was assumed that an animal would swim away from the noise source at the onset of activity at a constant rate and subsequently conservative species specific swim speeds were incorporated into the model (see Table 7.8) following agreement with statutory nature conservation bodies (swim speeds presented during Road Map Meeting 2 with no queries raised - see volume 3, appendix 10.3 of the Offshore EIA Report).

Table 7.8: Swim Speeds Assumed for Exposure Modelling (SEL_{cum}) for Marine Mammal IEFs

Species	Hearing group	Swim speed	Source reference
Harbour porpoise	VHF	1.5 m/s	Otani *et al.,* 2000
Harbour seal	PCW	1.8 m/s	Thompson, 2015
Grey seal	PCW	1.8 m/s	Thompson, 2015
Bottlenose dolphin	HF	1.52 m/s	Bailey and Thompson, 2010

Disturbance in marine mammals

827 Beyond the zone of injury, noise levels are such that they no longer result in physical injury but can result in disturbance to marine mammal behaviour. A marine mammal's response to disturbance will depend on the individual and the context; previous experience and acclimatisation will affect whether an individual exhibits an aversive response to noise, particularly in a historically noisy area. Typically, a threshold approach has been adopted in offshore wind farm assessments in the UK to quantify the scale of the potential effect. For example, the United States (US) National Marine Fisheries Service (NMFS, 2005) define strong disturbance in all marine mammals as "Level B harassment" and for impulsive noise suggests a threshold of 160 dB re 1 µPa (root mean square (rms)). This threshold meets the criteria defined by JNCC (2010a) as a 'non-trivial' (i.e. significant) disturbance and is equivalent to the Southall *et al*., (2007) severity score of five or more on the behavioural response scale. Beyond this threshold, the behavioural responses are likely to become less severe (e.g. minor changes in speed, direction and/or dive profile, modification of vocal behaviour and minor changes in respiratory rate (Southall *et al*., 2007)). The NMFS guidelines suggest a precautionary level of 140 dB re 1 µPa (rms) to indicate the onset of low-level marine mammal disturbance effects for all mammal groups for impulsive sound (NMFS, 2005), although this is not considered likely to lead to a 'significant' disturbance response.

828 More recently, to illustrate the variation in behavioural responses of marine mammals, Graham *et al*. (2017) used empirical evidence collected during piling at the BOWL (Moray Firth, Scotland) to demonstrate that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the source. The study showed a 100% probability of disturbance at an (un-weighted) SEL of 180 dB re 1 µPa²s, 50% at 155 dB re 1 µPa²s and dropping to approximately 0% at an SEL of 120 dB re 1 µPa²s. The dose response thresholds tie in with the NMFS (2005) criteria since a mild behavioural response is suggested to occur at a threshold of 140 dB re 1 µPa (rms) which is equivalent of 130 dB 1 µPa²s where a small response (c. 10% of animals) would occur according to the dose response. Dose response is an accepted approach to understanding the behavioural effects from piling and has been applied at other UK offshore wind farms (for example Seagreen Alpha/Bravo and Hornsea Project Three).

829 For the assessment of potential impacts of piling noise, subsea noise modelling was undertaken using the dose-response approach with SEL_{ss} contours modelled in 5 dB increments. For all other noise impacts, the simple threshold approach using the NMFS criteria (NMFS, 2005) was adopted. Disturbance criteria are presented in Table 7.9.

Table 7.9: Disturbance Criteria for Marine Mammals Used in Assessment

Effect	Non-Impulsive Threshold	Impulsive Threshold (Other than Piling)	Impulsive Threshold (Piling)
Mild disturbance (all marine mammals)	-	140 dB re 1µ Pa (rms)	Based on SEL 5 dB contours
Strong disturbance (all marine mammals)	120 dB re 1µ Pa (rms)	160 dB re 1µ Pa (rms)	Based on SEL 5 dB contours

830 In applying these criteria it is possible to provide quantification of the magnitude of effects with respect to the spatial extent of disturbance and subsequently the number of animals potentially affected. There is, however, a note of caution associated with this approach. Southall *et al*. (2021) highlights that the challenges for developing a comprehensive set of empirically derived criteria for such a diverse group of animals are significant. Extensive data gaps have been identified (e.g. measurements of the effects of elevated noise on baleen whales) which mean that extrapolation from other species has been necessary. Sounds that disturb one species may, however, be irrelevant or inaudible to other species since there are broad differences in hearing across the frequency spectrum for different marine mammal hearing groups. Variance in responses even within a species are well documented to be context and sound-type specific (Ellison *et al*., 2012; Southall *et al*., 2017). In addition, the potential interacting and cumulative effects of

multiple stressors (e.g. reduction in prey, noise and disturbance, contamination) is likely to influence the severity of responses (Lacy *et al*., 2017).

831 For these reasons, neither a threshold approach nor a dose-response function was provided in the original guidance (Southall *et al*., 2007) and subsequently the recent recommendations by Southall *et al*. (2021) also steer away from a single overarching approach. Instead, Southall *et al*. (2021) proposes a framework for developing probabilistic response functions for future studies. The paper suggests different contexts for characterising marine mammal responses for both free ranging and captive animals with distinctions made by sound sources (i.e. active sonar, seismic surveys, continuous/industrial noise and pile driving). Three parallel categories have been proposed within which a severity score from an acute (discrete) exposure can be allocated:

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

832 Marine mammals considered in this assessment vary biologically and therefore have different ecological requirements that may affect their sensitivity to disturbance. To illustrate this point we can compare the differences between the two seal species identified as key biological receptors in the baseline. Grey seals are capital breeders (foraging to build up stored fat reserves for lactation) and often make long foraging trips from haul-outs. In contrast, harbour seals are income breeders (feeding throughout the pupping season) and making shorter foraging trips from haul-outs.

833 In summary, Southall *et al* (2021) clearly highlights the caveats associated with simple, one-size-fits-all threshold approaches that could lead to errors in disturbance assessments. Although approach presented in paragraph 827 *et seq*. is based on the best scientific evidence currently available, the quantification of effects should the interpreted with caution.

Summary underwater noise modelling

Piling

834 Pile driving during the construction phase of the Proposed Development has the potential to result in elevated levels of underwater noise that are detectable by marine mammals above background levels and could result in injury or behavioural effects on Annex II marine mammal species. A detailed underwater noise modelling assessment has been carried out to investigate the potential for injury and behavioural effects on marine mammals as a result of piling (impulsive sounds), using the latest assessment criteria (see volume 3, appendix 10.1 of the Offshore EIA Report).

835 With respect to the SPL_{pk} metric, the soft start initiation (see Table 7.11) is the most relevant noise source and period, as this is the range at which animals may potentially experience injury from the initial strike of the hammer, after which point it is assumed that they will move away from the noise source. Secondly, injury ranges were predicted for marine mammals exposed to impulsive noise from multiple hammer strikes over a prolonged period (i.e. using the SEL_{cum} metric); the assumption being that a marine mammal exposed to lower noise levels over a prolonged period (as it moves away from the source) could experience auditory injury. The maximum injury ranges for each species have been provided with reference to the largest impact range from the dual criteria approach, and a proposed marine mammal mitigation zone has been determined on the basis of the largest range across all species.

836 Taking a precautionary approach, in line with SNCBs advice as discussed during Road Map Meetings (volume 3, appendix 10.3 of the Offshore EIA Report) and via Scoping Opinion (Marine Scotland, 2022), the subsea noise assessment considered a range of different conversion factors (the amount of hammer energy converted into received sound by marine mammal receptors): 1% constant, 4% reducing to 0.5% and 10% reducing to 1%.

837 A detailed study was undertaken reviewing noise modelling methodologies across different UK offshore wind farms and investigating energy conversion factors for determining sound source levels during piling. Published literature on energy conversion factors were explored together with available noise measurements taken during offshore wind farm construction and the results presented as an evidence-based, peer-reviewed report (volume 3, appendix 10.1, of the Offshore EIA Report). The study recommended that the most representative and precautionary conversion factor was 4% reducing to 0.5% as piling progresses. However, a sensitivity assessment was also undertaken to compare the results of noise modelling for the three different conversion factors requested by consultees (volume 3, appendix 10.1, annex B of the Offshore EIA Report). Subsequently, considering the evidence-base and the results of the sensitivity assessment, a precautionary approach was adopted for the marine mammal assessment of effects whereby both a conversion factor of 4% reducing to 0.5% and the 1% constant throughout the piling period has been taken forward to the quantitative assessment for marine mammals. As requested by consultees, a third conversion factor of 10% reducing to 1% was also quantified with respect to effects on marine mammal receptors, although not taken forward to the assessment of effects as it was determined to be overly conservative and therefore not realistic. Volume 3, appendix 10.5 of the Offshore EIA Report presents a comparison of the numbers of animals affected for all three conversion factors scenarios.

838 The scenarios modelled were based on the absolute maximum hammer energy (4,000 kJ) and a realistic maximum hammer energy (3,000 kJ). The assessment has been carried out at two locations on opposite sides of the Proposed Development array area, chosen to represent extremes of location. The bathymetry of the site is relatively flat, therefore the two locations were selected to represent the points closest and furthest away from the shoreline. These are represented by the indicative wind turbine foundation locations wind turbine 40 and wind turbine 135 (used in the assessment of underwater noise impacts for all species, except bottlenose dolphin, as these represent the largest area of impact) or wind turbine 1 and wind turbine 179 (used in the assessment of underwater noise impacts for bottlenose dolphin due to proximity to the areas of high coastal density, see volume 2, chapter 10 of the Offshore EIA Report).

839 For piling at wind turbines it is assumed that two vessels would pile concurrently, and two scenarios were modelled in this respect:

- separation distance of 1.78 km (minimum distance between foundations) would result in the greatest potential for injury since animals could be exposed to sound from both rigs at relatively high levels; and
- separation distance of c. 50 km (maximum separation distance between vessels) would result in the maximum area of disturbance since the overlap between disturbed areas would be smaller compared to vessels piling close together.

840 Using the equation below (see volume 3, appendix 10.1 of the Offshore EIA Report), a broadband source level value was evaluated for the noise emitted during impact pile driving operation in each operation window.

$$SEL = 120 + 10\ log_{10}\left(\frac{\beta E C_0 \rho}{4\pi}\right)$$

841 In this equation, β is the energy transmitted from the pile into the water column, E is the hammer energy employed in joules, C_0 is the speed of sound in the water column, and ρ is the density of the water. From the SEL result calculated using the equation above, source-level spectra can also be calculated for different third octave frequency bands.

842 Following a noise modelling workshop to test sensitivities of different scenarios, the piling campaign was developed with a low hammer energy and slow initiation phase in order to provide designed in measures

to reduce the potential risk of injury to marine mammal receptors. Four scenarios were investigated in the subsea noise modelling assessment and are summarised as follows:

- wind turbine foundations (piled jacket) maximum design scenario – up to 179 piled jacket foundations, with up to four legs per foundation and up to 2 x 5.5 m diameter piles per leg (1,432 piles) using an absolute maximum hammer energy of 4,000 kJ for the longest possible duration (up to ten hours);
- wind turbine foundations (piled jacket) realistic design scenario – up to 179 piled jacket foundations, with up to four legs per foundation and up to 2 x 5.5 m diameter piles per leg (1,432 piles) using a realistic average maximum hammer energy of 3,000 kJ for a realistic maximum duration (up to nine hours);
- OSP/Offshore convertor station platform foundations (jacket) maximum design scenario – using a maximum hammer energy of 4,000 kJ for a duration of up to eight hours; and
- OSP/Offshore convertor station platform foundations (jacket) realistic design scenario – using a maximum hammer energy of 3,000 kJ for a duration of up to seven hours.

843 The marine mammal assessment was based on the maximum design scenario with piling at a maximum energy of 4,000kJ for both wind turbine foundations and OSP/Offshore convertor station platform foundations. However, since piling is unlikely to reach and maintain the absolute maximum hammer energy of 4,000 kJ at all locations, results for a realistic design scenario were also provided for context using an average maximum hammer energy of 3,000 kJ for both foundations. There will be a maximum of two piling events at any one time and subsea noise modelling assumed concurrent piling at two wind turbine foundations as a maximum design scenario. This was due to the distances between wind turbines (i.e. maximum spatial separation) as well as the longer duration of piling at wind turbine foundations compared to OSP/Offshore convertor station platform foundations. Installation does not, however, preclude concurrent piling at a wind turbine foundation and OSP/Offshore convertor station platform foundation but this scenario is captured in the maximum design scenario case for concurrent piling at two wind turbine foundations. Results presented here are therefore for concurrent piling at two wind turbine foundations and single piling at wind turbine or OSP/maximum design scenario foundations.

844 A number of conservative assumptions were adopted in the subsea noise model that resulted in a precautionary assessment (volume 3, appendix 10.1 of the Offshore EIA Report). These are summarised here:

- the subsea noise modelling assumed that the maximum hammer energy would be reached and maintained for 195 minutes at all locations, whereas this is unlikely to be the case based on examples from other offshore wind farms For example, at the BOWL the mean actual hammer energy averages were considerably lower than the maximum adverse scenario assessed in the EIA Report and only six out of 86 asset locations reached maximum hammer energy (Beatrice, 2018);
- the soft start procedure simulated does not allow for short pauses in piling (e.g. for realignment) and therefore the modelled SEL_{cum} is likely to be an overestimate since, in reality, these pauses will reduce the noise exposure that animals experience whilst fleeing;
- the modelling assessment assumed that animals swim directly away from the noise source at constant and conservative average speeds based on published values (see volume 3, appendix 10.1 of the Offshore EIA Report). This is likely to lead to overestimates of the potential range of effect where animals exceed these speeds. For example, Otani *et al.* (2000) note that horizontal speed for harbour porpoise can be significantly faster than vertical speed and cite a maximum speed of 4.3 m/s. Similarly, Leatherwood *et al.* (1988) reported harbour porpoise swim speeds of approximately 6.2 m/s;
- the use of the SEL_{cum} metric is described as an equal energy rule where exposures of equal energy are assumed to produce the same noise-induced threshold shift regardless of how the energy is distributed over time. This means that for intermittent noise, such as piling, the equal-energy rule overestimates the effects since the quiet periods between noise exposures will allow some recovery of hearing compared to continuous noise;
- the model overestimates the noise exposure an animal receives since it does not account for any time that marine mammals spend at the surface and the reduced sound levels near the surface; and
- due to a combination of factors (e.g. dispersion of the waveform, multiple reflections from sea surface and seafloor, and molecular absorption of high frequency energy), impulsive sounds are likely to transition into non-impulsive sounds at distance from the sound source with empirical evidence suggesting such shifts in impulsivity could occur markedly within 10 km from the sound source (Hastie *et al*., 2019) (see volume 3, appendix 10.1 of the Offshore EIA Report). Since the precise range at which this transition occurs is unknown, noise models still adopt the impulsive thresholds at all ranges which is likely to lead to an overestimate of effect ranges at larger distances (tens of kilometres) from the sound source.

845 A final scenario was modelled to include the use of an Acoustic Deterrent Device (ADD) activated for a period of 30 minutes prior to initiation of piling to illustrate the potential efficacy of using this as a secondary mitigation (for more details see volume 2, chapter 10). The injury scenarios with and without use of ADDs were suggested by NatureScot in their 2020 Berwick Bank Scoping Advice on 07 October 2020. Therefore, additional noise modelling was undertaken to determine whether the potential for injury to marine mammals would be reduced through the application of ADDs.

Dose response

846 Empirical evidence from monitoring at offshore wind farms during construction suggests that pile driving is unlikely to lead to 100% avoidance of all individuals exposed, and that there will be a proportional decrease in avoidance at greater distances from the pile driving source (Brandt *et al*., 2011). This was demonstrated at Horns Rev Offshore Wind Farm, where 100% avoidance occurred in harbour porpoises at up to 4.8 km from the piles, whilst at greater distances (10 km plus) the proportion of animals displaced reduced to < 50% (Brandt *et al*., 2011). Similarly, Graham *et al*. (2019) used empirical evidence collected during piling at the BOWL (Moray Firth, Scotland) to demonstrate that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the noise source. Importantly, Graham *et al*. (2019) demonstrated that the response of harbour porpoise to piling diminished over the piling phase such that, for a given received noise level or at a given distance from the source, there were more detections of animals at the last piling location compared to the first piling location.

847 Similarly, a telemetry study undertaken by Russell *et al*. (2016) investigating the behaviour of tagged harbour seals during pile driving at the Lincs Offshore Wind Farm in the Wash found that there was a proportional response at different received noise levels. Dividing the study area into a 5 km x 5 km grid, the authors modelled SEL_{ss} levels and matched these to corresponding densities of harbour seals in the same grids during non-piling versus piling periods to show change in usage. The study found that there was a significant decrease during piling at predicted received SEL levels of between 142 dB and 151 dB re $1\mu Pa^2s$.

848 A dose response curve was applied to this assessment to determine the number of animals that may potentially display a behavioural response to received noise levels during piling. Unweighted sound exposure level single strike (SEL_{ss}) contours were plotted in 5 dB isopleths in decreasing increments from 180 dB to 120 dB re.$1\mu Pa^2s$ using the highest modelled received noise level for 4% reducing to 0.5% conversion factor and 1% constant conversion factor.

849 To adopt the most precautionary approach, the dose response contours were plotted in Geographical Information System (GIS) for all modelled locations and the location selected for assessment was the one whereby the contours covered the greatest spatial area, thereby representing the maximum adverse scenario. The areas within each 5 dB isopleth were calculated from the spatial GIS map and a proportional expected response, derived from the dose response curve for each isopleth area, was used to calculate the number of animals potentially disturbed. These numbers were subsequently summed across all isopleths to estimate the total number of animals disturbed during piling. The number of animals predicted to respond was based on species specific densities as agreed with statutory consultees (volume 2, chapter 10 of the Offshore EIA Report).

850 For harbour porpoise the dose-response curve was applied from the first location modelled as shown by Graham *et al*. (2017) where the probability of response approaches zero at c. 120 dB SEL_{ss}. In the absence of species-specific data for other cetacean species the same dose response curve was assumed to apply to all cetaceans in this assessment (see volume 2, chapter 10 of the Offshore EIA Report).

851 For harbour seal and grey seal the most appropriate dose response curve was derived from the Russell *et al*., (2017) study and has been previously applied to other Offshore Wind Farm assessments in the UK (e.g. Hornsea Project Three (GoBe, 2018a) and Seagreen Alpha/Bravo optimised design (Seagreen Wind Energy, 2018)). In this case the highest received level at which a response was detected was at 135 dB SEL_{ss} with a zero probability of response measured at 130 dB SEL_{ss} (see volume 2, chapter 10 of the Offshore EIA Report).

Conversion Factors

852 At the request of MS-LOT, a range of conversion factors - 1% constant, 4% reducing to 0.5% and 10% reducing to 1% - have been modelled with respect to how much of the hammer energy is converted into received sound. Based on a comprehensive peer-reviewed study, it was recommended that 4% reducing to 0.5% is most representative of a precautionary estimate of the conversion factor for the type of hammer to be used at the Proposed Development. A summary of the reasoning behind this conclusion is provided below with full detail given in the Subsea Noise Technical Report (see volume 3, appendix 10.1, Annex A of the Offshore EIA Report).

853 The study on conversion factors (volume 3, appendix 10.1, annex A of the Offshore EIA Report) found that theoretical values for representative conversion factors were likely to reach an upper limit of 1.5% for an above water hammer throughout a piling sequence with a conversion factor of 1% being typical throughout the majority of the piling (as estimated from in field measurements (e.g. Dahl and Reinhall, 2013)). The 1% constant conversion factor is therefore representative of this theoretical average and use of a constant conversion factor is typical of the approach adopted by previous UK offshore wind farm subsea noise assessments.

854 There are, however, likely to be differences in conversion factors depending on the type of hammer used. The use of a submersible hammer, as opposed to an above water hammer, can result in a conversion factor that varies with pile penetration depth. Since the piling at the Proposed Development is likely to involve a partially submersible hammer, the literature review explored the conversion factors that may be applicable in this situation. A key study cited in the review was by Lippert *et al.,* (2017) where both modelled and measured data were used to estimate a conversion factor of between 2% and 0.5% for a partially submersible hammer. In this study the modelled and measured data were strongly correlated suggesting that the estimated conversion factors were very representative. Nevertheless, it was recognised that for the Lippert *et al*. (2017) study a significant proportion of the pile was above water at the start of the piling sequence which could have reduced the apparent conversion factor compared to a situation where the pile starts just above the water line. Assuming that the energy radiated into the water is approximately proportional to the length of pile which is exposed to the water then the conversion factor at the start of piling from the Lippert study can be estimated to be approximately 3.5% (see volume 3, appendix 10.1, annex A of the Offshore EIA Report). Thus, the 4% conversion factor requested by SNCBs is considered to be close to, but more precautionary, than the empirically derived value based on the Lippert *et al.,* (2017) study.

855 The study on conversion factors (volume 3, appendix 10.1, annex A of the offshore EIA Report) found that a conversion factor of 10% was likely to be over precautionary and therefore more likely to lead to an overestimate of effect ranges, particularly considering the transition from impulsive to continuous noise over distance from the source. The 10% reducing conversion factor was based upon a study conducted at the BOWL for a fully submersible hammer which suggested that higher conversion factors were found for longer exposed lengths of pile towards the start of the piling and reduced to 1% as the pile penetrated further into the seabed (Thompson *et al.,* 2020). However, there were large discrepancies between the noise modelling and real-world propagation particularly at further distances from the pile. By reanalysing the data from BOWL it was determined that at closer distances, the modelled and measured levels were closer in value and suggested a conversion factor closer to 5% rather than the 10% cited in the study.

856 Acknowledging that the conversion factor of 10% reducing to 1% as unrealistic and likely to be over precautionary, the sensitivity assessment found that for the peak pressure metric (SPL_{pk}) the maximum injury ranges for all species were derived using the 1% conversion factor as opposed to the 4% reducing to 0.5% conversion factor. This is because the higher conversion rate for the 4% reducing to 0.5% conversion factor occurs when the hammer is at its lowest energy at the start of the piling sequence, so the highest estimated SPL_{pk} levels are later in the piling sequence once the conversion factor has reduced. In contrast, with a constant 1% conversion factor throughout the piling sequence, the SPL_{pk} ranges increase throughout the piling sequence with increasing hammer energy.

857 As previously, discounting the conversion factor of 10% reducing to 1% as over-precautionary for the cumulative exposure metric (SEL_{cum}), the maximum injury ranges for all species were derived using the 4% reducing to 0.5% conversion factor. Since the noise modelling for injury adopts a dual metric approach using both SPL_{pk} and SEL_{cum} the most precautionary approach was to assess the greatest injury range using either metric and considering both the 1% throughout the piling period, and 4% reducing to 0.5% conversion factor. The maximum injury ranges were predicted using the 1% conversion factor throughout the piling period and were based on the SPL_{pk} metric. The number of animals affected were subsequently estimated on this basis and differs by species hearing group. This was to ensure that, for mitigation purposes, the most precautionary approach was adopted.

858 In terms of behavioural effects, the 1% constant conversion factor was found to result in the highest SEL_{ss} at any point over the piling sequence compared to the 4% reducing to 0.5% conversion factor and therefore resulted in the largest potential effect area (see volume 2, chapter 10 of the Offshore EIA Report). The reason for this is that the maximum SEL for the 1% constant scenario is at the end of the piling sequence, which is when the hammer energy is maximum (i.e. up to 4,000 kJ) because for a constant conversion factor of 1% the SEL will increase with increasing hammer energy (see volume 2, chapter 10 of the Offshore EIA Report). This is not the case for the 4% reducing to 0.5% scenario as in this instance, the highest SEL occurs during initiation as the 4% conversion factor at this point leads to a higher SEL_{ss} than at any other point during the piling sequence (see volume 2, chapter 10 of the Offshore EIA Report). The SEL_{ss} is an unweighted metric and therefore there is no difference in modelled contours by marine mammal hearing group.

859 Although not considered as part of the assessment of effects for the reasons described in paragraph 855, for completeness the dose-response contours were also plotted for the 10% reducing to 1% conversion factor to allow estimates of the numbers of animals potentially disturbed by this scenario. The results are presented in volume 3, appendix 10.5 of the Offshore EIA Report.

Summary of iPCoD modelling

860 There is limited understanding of how behavioural disturbance and auditory injury affect survival and reproduction in individual marine mammals and consequently how this translates into effects at the population level. The iPCoD model was developed using a process of expert elicitation to determine how physiological and behavioural changes affect individual vital rates (i.e. the components of individual fitness that affect the probability of survival, production of offspring, growth rate and offspring survival).

861 Expert elicitation is a widely accepted process in conservation science whereby the opinions of many experts are combined when there is an urgent need for decisions to be made but a lack of empirical data with which to inform them. In the case of iPCoD, the marine mammal experts were asked for their opinion on how changes in hearing resulting from PTS and behavioural disturbance (equivalent to a score of 5* or higher on the 'behavioural severity scale' described by Southall *et al*. (2007)) associated with offshore

renewable energy developments affect calf and juvenile survival and the probability of giving birth (Harwood *et al*., 2014). Experts were asked to estimate values for two parameters which determine the shape of the relationships between the number of days of disturbance experienced by an individual and its vital rates, thus providing parameter values for functions that form part of the iPCoD model (Harwood *et al*., 2014).

862 The iPCoD model simulates the median population difference over time for a disturbed and an undisturbed population to provide comparison of the type of changes that could occur resulting from natural environmental variation, demographic stochasticity[10] and man-induced disturbance. The results are summarised in relation to the forecasted population size over time with forecasts made at certain timepoints (e.g. two, seven, 13, 19 and 25 years) after piling commences. In addition, the model calculates the ratio of the unimpacted to the impacted population size at these timepoints. A caveat of this model, however, is that the model does not account for density dependence and therefore the forecasts may be unrealistic as they assume that vital rates in the population will not alter as a result of density dependent factors (e.g. competition).

863 Whilst there are many limitations to this process, iPCoD was requested by statutory consultees as part of Road Map Meeting process as it represents the best available approach for the species considered in this assessment (volume 3, appendix 10.3 of the Offshore EIA Report). In addition, any uncertainties have been offset as far as possible by adopting a precautionary approach at all stages of the assessment from the maximum design parameters in the project envelope, conservatism in the subsea noise model and adoption of precautionary estimates to represent the densities of key species. Thus, the result from the iPCoD is considered to be inherently cautious and should be interpreted as such.

864 Given that Annex II marine mammals constituting the population of the designated site are a part of the wider populations, population modelling using iPCoD was carried out for MU populations from which individuals can be linked to respective SACs:

- Harbour porpoise (Annex II species of the Southern North Sea SAC) and North Sea MU;
- Bottlenose dolphin (Annex II species of the Moray Firth SAC) and Coastal East Scotland MU;
- Harbour seal (Annex II species of the Firth of Tay and Eden Estuary SAC) and East Scotland MU; and
- Grey seal (Annex II species of the Isle of May SAC and the Berwickshire and North Northumberland SAC) and East Scotland and North East Scotland MU.

Site investigation surveys

865 Several sonar-based survey types will potentially be used for the geophysical surveys, including multibeam echosounder (MBES), Side Scan Sonar (SSS), Single beam echo sounders (SBES) and sub-bottom sonar (SBS). The equipment likely to be used can typically work at a range of signal frequencies, depending on the distance to the bottom and the required resolution. The signal is highly directional, acts like a beam and is emitted in pulses. Sonar-based sources are considered as continuous (non-impulsive) because they generally compromise a single (or multiple discrete) frequency as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times. Unlike the sonar-based surveys, the ultra high resolution seismic (UHRS) is likely to utilise a sparker, which produces an impulsive, broadband source signal.

866 Source levels for borehole drilling ahead of standard penetration testing are in a range of 142 dB to 145 dB re 1 µPa re 1 m (rms). SEL measurements conducted during core penetration tests (CPTs) showed that it is characterised by broadband sound with levels measured generally 20 dB above the acoustic ocean noise floor (see volume 3, appendix 10.1 of the Offshore EIA Report). For the purpose of assessment of effects, these sources are considered as impulsive sounds. Measurements of a vibro-core test (Reiser *et al*., 2011) show underwater source sound pressure levels of approximately 187 dB re 1 µPa re 1 m (rms). The vibro-core sound is considered to be continuous (non-impulsive).

867 Full description of the source noise levels for geophysical and geotechnical survey activities is provided in volume 3, appendix 10.1 of the Offshore EIA Report.

UXO clearance

868 Although the clearance of UXO prior to commencement of construction using low order techniques is the preferred option, there is a small risk UXO clearance could result in high order detonation. High order detonation has the potential to generate some of the highest peak sound pressures of all anthropogenic underwater sound sources (von Benda-Beckman *et al*., 2015), and are considered a high energy, impulsive sound source. The potential impacts of this activity will depend on noise source characteristics, the receptor species, distance from the sound source and noise attenuation within the environment.

869 Subsea noise modelling for UXO clearance (both low order and high order detonation) has been undertaken using the methodology described in Soloway and Dahl (2014), which provides a simple relationship between distance from an explosion and the weight of the charge (or equivalent trinitrotoluene (TNT) weight). Since the charge is assumed to be freely standing in mid-water, unlike a UXO which would be resting on the seabed and could potentially be buried, degraded or subject to other significant attenuation, this estimation of the source level can be considered conservative. Marine mammal hearing weighted thresholds were compared by application of the frequency dependent weighting functions at each distance from the source. Based on findings presented in Robinson *et al*. (2020), noise modelling for low order techniques followed the same methodology as for high order detonation, with a smaller donor charge size. Full details of underwater noise modelling undertaken for UXO clearance is provided in volume 3, appendix 10.1 of the Offshore EIA Report.

870 Potential effects of underwater noise from high order UXO clearance on marine mammals include mortality, physical injury or auditory injury. The duration of effect for each UXO detonation is less than one second. Behavioural effects are therefore considered to be negligible in this context. TTS is presented as a temporary auditory injury but also represents a threshold for the onset of a fleeing response. Proposed Development specific underwater noise modelling was carried out using published and peer-reviewed criteria to determine the potential magnitude (range) of effect on marine mammal receptors. A project specific Marine Mammal Mitigation Plan (MMMP) will be developed in order to reduce the potential to experience injury and has been provided as a high-level draft at Application (volume 4, appendix 23) (Table 7.11).

871 It is anticipated that up to 70 UXOs are likely to be found within the Proposed Development array area and Proposed Development export cable corridor, however, only 14 of these will require clearance. The maximum design scenario is based on experience of UXO clearance at Seagreen Offshore Wind Farm (in close proximity to the Proposed Development). For Seagreen, of the 20 UXOs estimated to be present for the purposes of the marine mammal risk assessment (Seagreen Wind Energy, 2021), only four (20%) were

[10] Demographic stochasticity refers to variability in population growth rates arising from random differences among individuals in survival and reproduction.

found to require clearance within the proposed development site, one of which was relocated rather than cleared by high order techniques (SSE *pers. Comm.*). The estimate of 70 UXOs for Berwick Bank Offshore Wind Farm was extrapolated from the same study carried out for Seagreen (Ordtek, 2017; Ordtek, 2019) and therefore it is considered likely that the number of UXOs requiring disposal will be significantly less than assessed here (i.e. based on the same proportion cleared for Seagreen, there may only be 14 UXOs requiring clearance for the Proposed Development). The precise details and locations of potential UXOs is unknown at the time of Application. During the UXO clearance campaign at Seagreen Offshore Wind Farm the maximum UXO size identified was 250 kg NEQ. Given that Seagreen Offshore Wind Farm is located approximately 4 km from the Proposed Development array area, a similar maximum size of munition is expected to be encountered in the same region. Therefore, for the purposes of this assessment, it has been assumed that the maximum design scenario is UXO size up to 300 kg (see Table 7.10). The maximum frequency is up to two detonations within 24 hours. The clearance activities will be tide and weather dependant as detonations will take place during daylight hours and slack water only. The aim is to enable clearance of at least one UXO per tide, during daylight hours only.

872 Low order techniques will be applied as the intended methodology for clearance of UXO. The technique uses a single charge of up to 80 g Net Explosive Quantity (NEQ) which is placed in close proximity to the UXO to target a specific entry point. When detonated, a shaped charge penetrates the casing of the UXO to introduce a small, clinical plasma jet into the main explosive filling. The intention is to excite the explosive molecules within the main filling to generate enough pressure to burst the UXO casing, producing a deflagration of the main filling and neutralising the UXO. Recent controlled experiments showed low-order clearance using deflagration to result in a substantial reduction in acoustic output over traditional high-order methods, with SPL_{pk} and SEL_{cum} being typically significantly lower for the low order techniques of the same size munition, and with the acoustic output being proportional to the size of the shaped charge, rather than the size of the UXO itself (Robinson *et al*., 2020). Using this low-order clearance method, the probability of a low-order outcome is high; however, there is a small inherent risk with these clearance methods that the UXO will detonate or deflagrate violently. It is also possible that there will be residual explosive material remaining on the seabed following low order clearance. In this case, recovery will be performed, including the potential need of a small (500 g NEQ) 'clearing shot'.

873 There is a small risk that a low order clearance could result in high order detonation of UXO. In addition, some UXOs may be deemed to be too unstable to warrant a low order approach and therefore for safety reasons would need to be cleared using high order methods. At Neart na Gaoithe Offshore Wind Farm in the Firth of Forth, a total of 53 items of UXO required detonation and four of the 37 (c. 10%) monitored UXO clearance events resulted in a high order detonation, largely as a result of the age, condition and type of munition (Seagreen Wind Energy, 2021). Therefore the assessment of potential impacts due to the underwater noise during UXO clearance and subsequent secondary mitigation is based on the maximum design scenario of high order detonation and is presented in paragraph 961 *et seq*. Additional, secondary mitigation measures will be agreed with the statutory conservation bodies post-Application discussions, and included as a part of the MMMP to ensure that the potential to experience injury by marine mammals is reduced for all clearance activities.

Vessel use and other activities

874 A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals resulting from elevated underwater noise (non-impulsive sound), using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report). A conservative assumption has been made that all individual marine mammals will respond aversively to increases in vessel noise (i.e. that there is no intra or inter-specific variation or context-dependent differences). The distance over which effects may occur will however, vary according to the species, the ambient noise levels, hearing ability, vertical space use and behavioural response differences. SELs have been estimated for each vessel type based on 24 hours continuous operation, although it is important to note that it is highly unlikely that any marine mammal would stay at a stationary location or within a fixed radius of a vessel for 24 hours. Therefore, subsea noise modelling has been undertaken based on an animal swimming away from the source (or the source moving away from an animal) as outlined in Table 7.8

875 The assessment of impacts from elevated underwater noise due to vessel use and other activities is based on vessel and/or activity basis, considering the maximum injury/disturbance range as assessed in volume 3, appendix 10.1 of the Offshore EIA Report. However, several activities could potentially occur concurrently therefore ranges of effects may extend from several vessels/locations where the activity is carried out and potentially overlap.

Construction phase

876 Construction phase impacts related to underwater noise include injury and disturbance during piling, injury and disturbance during site investigation surveys, injury and disturbance during UXO clearance and disturbance due to vessel use and other activities. Each of these potential effects are described below:

- **Injury and disturbance from elevated underwater noise during piling** – pile driving of wind turbine wind turbine and OSP/Offshore convertor station platforms foundations during the construction phase has the potential to result in elevated levels of underwater noise that are detectable by marine mammals above background levels and could result in injurious or behavioural effects. While the source activity is temporary, injury to Annex II marine mammals has the potential to be both permanent or temporary. Behavioural effects are considered temporary. A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals as a result of piling (impulsive sounds), using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report), and is summarised in paragraph 881 *et seq*.
- **Injury and disturbance during site investigation surveys** – site investigation surveys during the pre-construction phase have the potential to cause direct or indirect effects (including injury or disturbance) on marine mammals. While the source activity is temporary, injury to Annex II marine mammals has the potential to be both permanent or temporary. Behavioural effects are considered temporary. A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals as a result of geophysical and geotechnical surveys, using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report), and is summarised in paragraph 945 *et seq*.
- **Injury and disturbance during UXO clearance** – underwater explosions generate some of the highest peak sound pressures of all anthropogenic underwater sound sources (von Benda-Beckman *et al*., 2015), and are considered a high energy, impulsive sound source. Potential effects of underwater noise from UXO detonations on marine mammals include mortality, physical injury or auditory injury. While the source activity is temporary, injury to Annex II marine mammals has the potential to be both permanent or temporary. Behavioural effects are considered temporary. A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals as a result of UXO detonation (impulsive sounds), using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report), and is summarised in paragraph 961 *et seq*.
- **Injury and disturbance due to vessel use and other activities** – increased vessel movement during the construction phase has the potential to result in a range of impacts on marine mammals such as avoidance behaviour or displacement and masking of vocalisations or changes in vocalisation rate. While the source activity is temporary, injury to Annex II marine mammals has the potential to be both permanent or temporary. Behavioural effects are considered temporary. An underwater noise modelling assessment has been carried out to investigate the potential for behavioural effects on marine mammals as a result of underwater noise from vessel use during construction, using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report), and is summarised in paragraph 988 *et seq*.

Decommissioning phase

877 During the decommissioning phase, there is potential for disturbance effects to Annex II marine mammal features due to vessel use and other activities:

- **Injury and disturbance due to vessel use and other activities** – vessel movement during the decommissioning phase has the potential to result in a range of impacts on marine mammals. While the source activity is temporary, injury to Annex II marine mammals has the potential to be both permanent or temporary. Behavioural effects are considered temporary. An underwater noise modelling assessment has been carried out to investigate the potential for behavioural effects on marine mammals as a result of underwater noise from vessel use during decommissioning, using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report), and is summarised in paragraph 988 *et seq*.

Maximum design scenario relevant to the assessment of adverse effects on integrity

878 The Maximum Design Scenario considered for the assessment of potential impacts on Annex II marine mammal features during construction and decommissioning from underwater noise are set out in Table 7.10.

Table 7.10: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Underwater Noise during Construction and Decommissioning

Potential Impact	Maximum Design Scenario	Justification
Injury and disturbance from elevated underwater noise during piling (fixed foundations)	**Construction Phase** • Wind turbines: – up to 179 piled jacket foundations, with up to 4 legs per foundation and up to 2 x 5.5 m diameter piles per leg (1,432 piles); – maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – up to 2 concurrent piling of wind turbine foundations with two vessels; – Minimum 950 m and maximum 49.43 km distance between concurrent piling events; – Up to 10 hours absolute maximum piling per pile (9 hours realistic maximum); – Total duration of piling = 12,888 hours (realistic maximum) to 14,320 hours (absolute maximum); and – Maximum piles installed within 24 hours (concurrent piling) = 5. • OSPs/Offshore convertor station platforms: – up to 8 jacket foundations with up to 6 legs per foundation and 4 x 3.0 m diameter piles per leg (192 piles) and up to 2 jacket foundations with up to 8 legs per foundation and 4 x 4.0 m diameter piles per leg (64 piles); – maximum hammer energy up to 4,000 kJ, with realistic maximum hammer energy of 3,000 kJ (based on average of up to 75% maximum hammer energy); – up to 8 hours absolute maximum (7 hours realistic maximum) piling per pile; – total duration of piling = 1,792 hours (realistic maximum) to 2,048 hours (absolute maximum); and – Maximum piles installed within 24 hours (based on single piling) = 3. The maximum scenario for concurrent piling is maximum of two piling events at any one time. Number of days when piling may occur within piling phase (OSPs/Offshore convertor station platforms and wind turbines) = 372 days. Total piling phase of 52 months over a construction phase of 96 months.	The largest hammer energy and the maximum spacing between concurrent piling vessels could lead to the largest area of ensonification at any one time. Minimum spacing between concurrent piling represents the highest risk of injury to animals. Note that the absolute maximum hammer energy is the maximum achieved at any one location whilst the 'realistic maximum' is taken as the average of the maximum energy likely to be achieved across all 179 locations (and is estimated as 75% of the maximum). The longest duration of piling at any location results in the greatest number of days when piling could occur. The maximum number of piles installed within 24 hours will result in the greatest impact over 24 hours. Maximum number of piles for wind turbines installed within 24 hours is based on the realistic maximum duration of piling and assuming up to 2 concurrent piling vessels for wind turbines and OSP/Offshore convertor station platform foundations, with an assumption that there will be a maximum of 2 piling events at any one time. Note that maximum design scenario assumes concurrent piling for wind turbine foundations as the maximum design scenario but it may occur as a combination of wind turbines and OSPs/Offshore convertor station platforms. Figures have been rounded to nearest whole number. The maximum number of days when piling occurs will result in the greatest potential impact. Total number of days when piling may occur is based on the total number of piles divided by the number of piles that can be installed within 24 hours for wind turbines and OSP/Offshore convertor station platforms. Duration of piling at wind turbines assumes 2 concurrent vessels. OSPs/Offshore convertor station platforms only assume a single vessel for pile installation. In total, a maximum of 2 piling vessels will be piling at any one time.
Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	**Pre-Construction phase** Geophysical site investigation activities include: • Multi-beam echo-sounder (MBES) (200 kHz to 400 kHz; 180-240 dB re 1 1µPa); • Sidescan Sonar (SSS) (200 kHz to 900 kHz; 190-245 dB re 1 1µPa); • Single Beam Echosounder (SBES) (200 kHz to 400 kHz; 180-240 dB re 1 1µPa); • Sub-Bottom Profiler (SBP) (0.5 kHz to 12 kHz chirp, 4 kHz pinger, 100 kHz pinger; 200-240 chirp dB re 1 1µPa, 200-235 pinger (both) dB re 1 1µPa.); • Ultra High Resolution Seismic (UHRS) (19.5 kHz to 33.5 kHz; 170-200 dB re 1 1µPa); and • magnetometer. Geotechnical site investigation activities include: • boreholes. • Cone penetration tests (CPTs). • vibrocores. Site investigation surveys will involve the use of up to 2 geophysical/geotechnical survey vessels and take place over a period of up to three months with up to 70 return trips.	Maximum range of geophysical and geotechnical activities likely to be undertaken using equipment typically employed for these types of surveys will result in the greatest potential impact.
Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	**Pre-Construction phase** • clearance of 14 UXOs within the Proposed Development array area or offshore export cable route; • maximum UXO size of up to 300 kg; • surveys will involve the use of up to 7 vessels on site at any one time with up to 30 vessel movements in total; • intention for low order clearance of all UXOs using low order techniques (subsonic combustion) with a single	Maximum number and maximum size of UXOs encountered in the project area based on UXO Hazard Assessment undertaken for Seagreen will result in the greatest potential impact. Donor charge is maximum required to initiate low order detonation.

Potential Impact	Maximum Design Scenario	Justification
	donor charge of up to 80 g net explosive quantity (NEQ) for each clearance event; • up to 500 g NEQ clearance shot for neutralisation of residual explosive material at each location; • small risk of potential for unintended consequence of low order techniques to result in high order detonation of UXO (approximately 10% of the total number of UXOs could result in high order detonation); and • up to two detonations within 24 hours. Clearance during daylight hours only.	Assumption of a clearance shot of up to 500 g at all locations although noting that this may not always be required.
Disturbance of marine mammals from elevated underwater noise due to vessel use and other activities	**Construction phase** Vessels used for a range of construction activities associated with site preparation, inter-array cables and offshore export cables, including boulder clearance, sand wave clearance, drilling and trenching; maximum vessels on site at any one time including: • up to 9 pre-installation boulder clearance vessels with up to 316 return trips throughout the construction phase. • up to 3 sand wave clearance vessels with up to 104 return trips over a throughout the construction phase. Vessels associated with site preparation, foundation installation, OSP/Offshore convertor station platform installation, inter-array cables, offshore export cables, and landfall works, with up to 11,484 vessel round trips over the construction phase; maximum vessels on site at any one time including: • up to 9 main installation vessels making up to 297 return trips. • up to 14 cargo barges making up to 194 return trips. • up to 9 support vessels making up to 714 return trips. • up to 22 tug/anchor handlers making up to 794 return trips. • up to 6 cable installation vessels making up to 36 return trips. • up to 22 guard vessels making up to 1,488 return trips. • up to 8 survey vessels making up to 464 return trips. • up to 14 crew transfer vessels (CTVs) making up to 3,342 return trips. • up to 10 scour/cable protection installation vessels making up to 3,390 return trips. • up to 20 resupply vessels making up to 245 return trips. Other activities: • up to 10% of piles are anticipated to require drilling at wind turbine foundations (144 piles) with a maximum drilling duration of 96 days; • up to 32 piles will require drilling at OSPs/Offshore convertor station platforms foundations with a maximum drilling duration of up to 39 days; and • Burial of 1,225 km of inter-array cables and 828 km of offshore export cable via jet trenching; along with cable laying and jack up rigs. Maximum offshore construction duration of up to 96 months. **Decommissioning Phase** Vessels used for a range of decommissioning activities such as removal of foundations, cables and cable protection. Noise from vessels assumed to be as per vessel activity described for construction phase above.	Maximum numbers of vessels on site at any one and largest numbers of round trips during each phase of the Proposed Development and broad range of vessel types, representative of vessels to be used during construction, operation and maintenance and decommissioning will result in the greatest potential impact. Range of other activities including maximum timescales (where available) during which activities are conducted.

Designed in measures relevant to the assessment of adverse effects on integrity

879 Designed in measures (and the associated commitments) of relevance to the assessments of potential impacts on Annex II marine mammal features from underwater noise during construction and decommissioning are set out in Table 7.11.

Table 7.11: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Marine Mammal Features from Underwater Noise during Construction and Decommissioning

Effect/Impact Pathway	Detail of Measure	Justification
Injury and disturbance from elevated underwater noise during piling (fixed foundations)	An outline MMMP (volume 4, appendix 23 of the Offshore EIA Report) will be consulted on with NatureScot and/or Marine Scotland Science (MSS), approved by MS-LOT and implemented prior to construction, as described in in volume 3, appendix 6.3. For the purpose of developing the MMMP, a mitigation zone will be defined based on the maximum predicted injury range from the dual metric noise modelling for any of the modelled scenarios (4,000 kJ for concurrent piling of wind turbines and, 4,000 kJ for single piling at wind turbine/OSP-Offshore convertor station platform) and across all marine mammal species. The MMMP will set out the designed in measures to apply in advance of and during piling activity.	The implementation of an approved MMMP will mitigate for the risk of physical or permanent auditory injury to marine mammals within a 'mitigation zone'. The potential to mitigate for injury was considered with respect to the largest potential injury zone across all species (2,319 m based on predictions of injury for minke whale using the 4% reducing to 0.5% conversion factor). The use of an approved MMMP will also minimise the potential for collision risk, or potential injury to, marine mammals. Measures such as visual and acoustic monitoring will be applied.
	Implementation of piling soft start and ramp up measures. During piling operations, soft starts will be used. This will involve the	This measure will minimise the risk of injury to marine mammal and fish species in the immediate vicinity of piling operations, allowing individuals to

Effect/Impact Pathway	Detail of Measure	Justification
	implementation of lower hammer energies (i.e. approximately 15% of the maximum hammer energy) at the beginning of the piling sequence before energy input is 'ramped up' (increased) over time to required higher levels.	flee the area before noise levels reach a level at which injury may occur. It is considered that compliance with these guidelines will, in most cases, reduce the risk of injury to marine mammals to negligible levels. More details about piling soft start and ramp up procedure are presented in MMMP (volume 4, appendix 23).
Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	A MMMP will also include geophysical surveys to ensure that appropriate measures are followed in line with JNCC guidance (JNCC, 2017).	The measures outlined in JNCC guidelines (JNCC, 2017) are designed to reduce the risk of injury to marine mammals during geophysical survey activities.
Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	Detonation of UXO using low order techniques.	Low order techniques will be adopted where practicable. Given the small risk that a low order could unintentionally arise in high order detonation, the MMMP will also include secondary mitigation to reduce the risk of injury from UXO clearance. Measures such as visual and acoustic monitoring will be applied.

Information to inform Appropriate Assessments

880 Results presented in this section refer to the assessment at species level for grey seal, harbour seal, harbour porpoise and bottlenose dolphin, as informed by volume 2, chapter 10 of the Offshore EIA Report. Assessment for these species as features of the designated sites is provided in section 7.6.

Injury and disturbance from elevated underwater noise during piling

Auditory injury

Grey seal and harbour seal

881 The maximum range for injury to harbour and grey seal was estimated as 118 m based on SPL_{pk} and using the 1% constant conversion factor (Table 7.12; see volume 3, appendix 10.5 of the Offshore EIA Report for estimates using a range of conversion factors). The ranges are low due to the soft-start initiation of piling (see Table 7.11) which is likely to reduce the probability of marine mammals being in proximity to piling activities on full power. Therefore, the spatial extent of PTS will be localised for all piling scenarios. Taking into account the most conservative scenario, maximum density for both species (based on mean at-sea seal usage from Carter *et al*. 2020), as well as concurrent piling of wind turbines at 4,000kJ, there will be less than one animal (of each species) that could be potentially injured within the maximum range of 150 m.

882 To reduce the potential of injury, designed in measures, involving visual and acoustic monitoring, will be adopted as part of a MMMP (see Table 7.11). Additionally, secondary mitigation will be applied in a form of ADDs to minimise residual risk of injury. Assuming conservative swim speeds, activation of an ADD for 30 minutes would deter grey seal and harbour seal beyond the maximum injury zone.

883 The total duration of piling is estimated at over 16,368 hours (wind turbines and OSPs/Offshore convertor station platforms) for the absolute maximum temporal scenario. Up to five piles per 24-hour period will be installed at wind turbine foundations (assuming concurrent piling with two vessels) and up to three piles will be installed per 24 hours at OSP/Offshore convertor station platform foundations (assuming a single piling vessel). It is anticipated that piling could occur for up to 372 days during construction of foundations (wind turbines and OSP/Offshore convertor station platforms). This will be intermittent over a 52-month piling phase within the total construction phase of 96 months (see Table 7.10).

884 Both species of seal typically live between 20 to 30 years with gestation lasting between ten to 11 months (SCOS, 2015; SCOS, 2018), thus the duration of piling could potentially overlap with a maximum of five breeding cycles. However, it is worth noting that piling will be intermittent and will occur over small timespan (372 days) within piling phase (52 months). Considering the above, the duration of the effect in the context of the life cycle of harbour and grey seal is classified as medium term.

Table 7.12: Summary of SPL_{pk} and SEL_{cum} Injury Ranges and Areas of Potential Effect for Harbour Seal and Grey Seal Due to Impact Piling for Wind Turbine and OSP/Offshore Convertor Station Platform Jacket Foundations (Absolute Maximum Hammer Energy) Using 1% Constant Conversion Factor

Threshold	Spatial Scale: Range of Effect (m)	Spatial Scale: Area of Effect (km^2)	Temporal Scale: Duration per Pile (hours)	Temporal Scale: Total Number of Piling Days
Wind turbine –4,000 kJ – Concurrent Piling with Two Vessels				
SPL_{pk} 202 dB re 1 µPa	118	0.044	10	286.4
SELcum 155 dB re 1 µPa2s	25	0.002		
Wind turbine/OSP – Offshore Convertor Station Platform - 4,000 kJ – Single Piling Vessel				
SPLpk 202 dB re 1 µPa	118	0.044	8	85.3
SELcum 155 dB re 1 µPa2s	N/E1	N/E1		

885 With designed in measures in place including soft start and an MMMP (see Table 7.11), the magnitude of the impact would result in a negligible risk of injury to harbour and grey seal as the scale of effects (range and number of animals potentially injured) is very small. Considering the duration of the impact, the risks (albeit negligible) could occur over a meaningful proportion of the lifespan of these species.

886 The impact (elevated underwater noise from piling) is predicted to be of local spatial extent, medium term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of injury from elevated underwater noise during piling on grey seal and harbour seal as features of respective designated sites is provided in section 7.6.

Harbour porpoise

887 The maximum range for injury to harbour porpoise was estimated as 449 m based on SPL_{pk} and using the 1% constant conversion factor (Table 7.13; see volume 3, appendix 10.5 of the Offshore EIA Report for estimates using a range of conversion factors). The effect range is based on SPL_{pk} for the maximum hammer energy but noting that during soft start initiation this range will be considerably smaller. The most conservative number of individuals that could be potentially injured within the maximum range of 449 m, based on the peak seasonal densities from site-specific survey data and concurrent piling of wind turbines at 4,000kJ, was estimated as less than one harbour porpoise.

888 To further reduce the potential for injury, designed in measures will be adopted as part of a MMMP (Table 7.11; see volume 4, appendix 23 of the Offshore EIA Report for more details). These measures will involve the use of visual and acoustic searches over a pre-defined mitigation zone. The 449 m falls within the standard JNCC mitigation zone of 500 m (JNCC, 2010a). There are, however, often difficulties in detecting marine mammals (particularly harbour porpoise) over large ranges (McGarry *et al*., 2017). Visual surveys

note that there is often a significant decline in detection rate with increasing sea state (Embling *et al*., 2010; Leaper *et al*., 2015). Secondary mitigation in the form of ADDs will be applied to further minimise any residual risk of injury. Assuming conservative swim speeds, activation of an ADD for 30 minutes would deter harbour porpoises beyond the maximum injury zone.

889 The total duration of piling is presented in paragraph 883. Harbour porpoise typically live between 12 and 24 years and give birth once a year (Fisher and Harrison, 1970). The duration of piling could potentially overlap with a maximum of five breeding cycles. However, it is worth noting that piling will be intermittent and will occur over small timespan (372 days) within the piling phase (52 months). The duration of the effect in the context of the life cycle of harbour porpoise is classified as medium term, as the risk could occur over a meaningful proportion of the lifespan of these species.

Table 7.13: Summary of SPL_{pk} and SEL_{cum} Injury Ranges and Areas of Effect for Harbour Porpoise due to Impact Piling for Wind Turbine and OSP/Offshore Convertor Station Platform Jacket Foundations (Absolute Maximum Hammer Energy) Using 1% Constant Conversion Factor

Scenario (4,000kJ)/Threshold	Spatial Scale		Temporal Scale	
	Range of Effect (m)	Area of Effect (km^2)	Duration Per Pile (hours)	Total Number of Piling Days
Concurrent Piling (Wind turbine)				
SPL_{pk} 202 dB re 1 µPa	449	0.633	10	286.4
SEL_{cum} 155 dB re 1 $µPa^2s$	201	0.127		
Single Piling (Wind turbine/OSP-Offshore Convertor Station Platform)				
SPL_{pk} 202 dB re 1 µPa	449	0.633	8	85.3
SEL_{cum} 155 dB re 1 $µPa^2s$	104/103	0.033		

890 With designed in measures in place, the magnitude of the impact would result in a low risk of injury as the scale of effects (range and number of animals potentially injured) is small. Considering the duration of the impact the risk (albeit very low) could occur over the medium term.

891 The impact (elevated underwater noise from piling) is predicted to be of local spatial extent, medium term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of injury from elevated underwater noise during piling on harbour porpoise as feature of designated site is provided in section 7.6.

Bottlenose dolphin

892 The maximum range for injury to bottlenose dolphin was estimated as 43 m based on SPL_{pk} and using the 1% constant CF (Table 7.14see volume 3, appendix 10.5 of the Offshore EIA Report for estimates using a range of CFs). Therefore, the spatial extent of PTS will be localised for all piling scenarios. Considering the most conservative scenario, which is the highest coastal bottlenose dolphin density (for outer Firth of Tay region, see volume 3, appendix 10.2 of the Offshore EIA Report) and full hammer energy, there will be less than one animal that could be potentially injured within the maximum range of 43 m.

893 It is worth noting that this injury range will not overlap with the Forth of Tay and coastal areas (2-20 m depth) where the highest density of bottlenose dolphins is encountered. To further reduce the potential to experience injury, designed in measures will be adopted as part of a MMMP (see volume 4, appendix 23 of the Offshore EIA Report). Additionally, secondary mitigation will be applied in the form of ADDs to minimise residual risk of injury. Assuming conservative swim speeds, activation of an ADD for 30 minutes would deter bottlenose dolphins beyond the maximum injury zone.

894 The total duration of piling is presented in paragraph 883. Bottlenose dolphin typically live between 20 and 30 years, females reproduce every three to six years. Given that gestation takes 12 months followed by calves suckling of 18 to 24 months, the duration of piling could potentially overlap with a maximum of two breeding cycles. However, it is worth noting that piling will be intermittent and will occur over small timespan (372 days) within the piling phase (52 months). Considering the above, the duration of the effect in the context of life cycle of bottlenose dolphin is classified as medium term.

Table 7.14: Summary of SPL_{pk} and SEL_{cum} Injury Ranges and Areas of Effect for Bottlenose Dolphin Due to Impact Piling for Wind Turbine and OSP/Offshore Convertor Station Platform Jacket Foundations (Absolute Maximum Hammer Energy) Using 1% Constant Conversion Factor

Scenario (4,000kJ)/Threshold	Spatial Scale		Temporal Scale	
	Range of Effect (m)	Area of Effect (km^2)	Duration per Pile (hours)	Total Number of Piling Days
Concurrent Piling (Wind turbine)				
SPL_{pk} 202 dB re 1 µPa	43	0.006	10	286.4
SEL_{cum} 155 dB re 1 $µPa^2s$	N/E[1]	N/E[1]		
Single Piling (Wind turbine/OSP- Offshore Convertor Station Platform)				
SPL_{pk} 202 dB re 1 µPa	43	0.006	8	85.3
SEL_{cum} 155 dB re 1 $µPa^2s$	N/E[1]	N/E[1]		

[1] N/E = Threshold not exceeded

895 With designed in measures in place including soft start and a MMMP (see volume 4, appendix 23 of the Offshore EIA Report)Table 7.11, the magnitude of the impact would result in a negligible risk of injury to bottlenose dolphin as the scale of effects (range and number of animals potentially injured) is very small. Considering the duration of the impact, the risk (albeit negligible) could occur over a meaningful proportion of the lifespan of these species and therefore is classed as medium term.

896 The impact (elevated underwater noise from piling) is predicted to be of local spatial extent, medium term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of injury from elevated underwater noise during piling on bottlenose dolphin as feature of designated site is provided in section 7.6.

Behavioural disturbance

897 The numbers of animals predicted to experience potential disturbance as a result of different piling scenarios is presented in this section (Table 7.15 to Table 7.18). Predictions are based on the assumptions of the dose response relationship described in paragraphs 848 *et seq*. using the SEL_{ss} metric. The estimated numbers of animals potentially disturbed are based on the maximum adverse piling scenario which describe the maximum potential impact for each species. This has been defined with reference to either the extent of the effect, or spatial overlap with abundance hotspots (e.g. areas near the coast).

898 Scientific literature suggests that inshore and offshore populations of bottlenose dolphins are often ecologically and genetically discrete (Hoelzel *et al*., 1998). Therefore, this assessment considered two separate populations of bottlenose dolphin; those distributed in coastal waters as well as offshore.

899 Assessment of magnitude for behavioural disturbance presented in this section is based on 1% constant conversion factor unless stated otherwise.

Grey seal

900 The magnitude of effects with respect to disturbance was initially estimated using two approaches. The first used the representative maximum species density value, derived from Carter *et al.* (2020) across Proposed Development array area and Proposed Development export cable corridor (see volume 3, appendix 10.2 of the Offshore EIA Report for more details) and, assuming uniform densities across the site, multiplied this value by the area of effect. The second estimate was achieved by overlaying the noise contours on the spatial at-sea density map provided by Carter *et al.* (2020) and summing the values for all cells where more than 50% of the cell lay within a contour. For the first approach the most precautionary estimate was derived from the largest area of effect (i.e. whichever location and scenario leads to the maximum area disturbed at any one time). For the second approach, the modelled location was more important as, where piling occurs closer to the coast, the areas of disturbance are more likely to overlap with hotspots where higher densities of grey seal have been predicted (see Figure 10.21 in volume 2, chapter 10 of the Offshore EIA Report).

901 Both approaches were explored to determine which would lead to the most precautionary assessment in terms of number of individuals disturbed. Given that the outermost 135 dB behavioural disturbance contours do not overlap with areas of density hotspots for this species (see Figure 10.21 in volume 2, chapter 10 of the Offshore EIA Report), the most precautionary values were derived using the largest areas of effect for the single and concurrent scenarios (see Figure 10.19 and Figure 10.11 in volume 2, chapter 10 of the Offshore EIA Report) multiplied by the maximum density estimate from Table 7.4. The application of this approach is considered to be precautionary, as realistically the density of grey seal will vary (as presented in Figure 10.21 to Figure 10.22 in volume 2, chapter 10 of the Offshore EIA Report, showing grey seal at-sea usage based on Carter *et al.* (2020) study), and therefore will not represent a mean value across the Proposed Development marine mammal study area.

902 Using the most precautionary approach, up to 1,358 animals were predicted to have the potential to be disturbed from concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.15). For comparison, the number of animals that could be potentially disturbed during the same piling scenario but using 4% reducing to 0.5% CF has been conservatively assessed as up to 935 grey seals (see volume 3, appendix 10.5 of the Offshore EIA Report for estimates using various conversion factor).

903 The maximum numbers presented in Table 7.15 are considered conservative as these are based on the mean at-sea usage estimates (1.2 animals per km^2) from Carter *et al*. (2020). If maximum numbers were compared with estimates of the number of potentially disturbed grey seals using the mean monthly (0.276 animals per km^2) or even the peak seasonal densities (0.321 animals per km^2), derived from the Proposed Development aerial digital survey data, these estimates would be shown to be highly precautionary. For example, based on the mean and peak densities from aerial data, the number of grey seals affected by possible disturbance for the maximum adverse scenario (concurrent piling at 4,000 kJ) would be 312 animals and 364 animals, respectively, compared to 1,358 animals estimated for mean at sea usage from Carter *et al.* (2020). Similarly, for the single piling at 4,000 kJ scenario, the estimates using the mean and peak densities from aerial data, would be 166 animals and 193 animals, respectively, compared to 720 animals using Carter *et al.* (2020) mean at-sea usage estimates.

904 Additionally, there is a number of conservative assumptions in the subsea noise model, as the maximum hammer energy of 4,000 kJ is unlikely to be reached at all piling locations (see paragraph 844 for more details It is therefore reasonable to consider the number of animals potentially disturbed could be based on estimates for a realistic average maximum hammer energy of 3,000 kJ (using 1% constant conversion factor; volume 3, appendix 10.5 of the Offshore EIA Report), where up to 1,095 animals could potentially be disturbed during concurrent piling at wind turbine foundations.

905 Grey seal could also be potentially disturbed within the zone of possible disturbance during single piling at a wind turbine or an OSP/Offshore convertor station platform at a maximum hammer energy of 4,000 kJ, with up to 705 animals affected (Table 7.15).

Table 7.15: Number of Grey Seals Predicted to be Disturbed within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios Using 1% Constant Conversion Factor

Scenario (4,000 kJ)	Number of Animals	
	Average	Maximum
Concurrent piling (wind turbine)	312	1,358
Single Piling (wind turbine/OSP-Offshore convertor station platform)	162	705

906 Two sites designated for grey seal are screened into the HRA Stage 2 Appropriate Assessment: the Berwickshire and North Northumberland Coast SAC and the Isle of May SAC. As water depth gets shallower closer to land, the outer behavioural disturbance contours (135 dB) overlap only slightly with coastal areas south of the Proposed Development and therefore there is a small overlap with northern part of the Berwickshire and North Northumberland Coast SAC. There is no direct overlap of the outer behavioural noise contours with Isle of May SAC, located approximately 40 km from the Proposed Development array area. However, as the outer behavioural disturbance contours extend towards Fife and Berwickshire coasts, it is assumed that some of the animals in the impacted area could be associated with both, Isle of May SAC and Berwickshire and North Northumberland Coast SAC. These sites support breeding populations of 5,900 and 1,000 individuals, respectively.

907 The level at which a measurable response is predicted to occur in seal species is at a maximum received noise level of SEL_{ss} 135 dB (≡ 145 dB_{rms}) which was predicted over a shorter range compared to the NMFS (2005) threshold for mild disturbance (140 dB_{rms} ≡ 130 dB SEL_{ss}). Animals exposed to lower noise levels in the outer disturbance contours are likely to experience mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement are unlikely to occur (Southall *et al*., 2021). Further discussion on the sensitivity of grey seal is provided in section 7.5 (with respect to survival, feeding and reproductive behaviours). For the purposes of assessment, it is considered that grey seal close to the coast could experience mild disturbance but that this is unlikely to lead to barrier effects (i.e. prevent animals from using the foraging grounds in waters along the coast, as animals are unlikely to be excluded from the area). However, when piling occurs, there is the potential for some animals to be temporarily deterred from the offshore areas. Animals would therefore need to find alternative foraging grounds and there may be an energetic cost associated with longer foraging trips.

908 As previously described in paragraph 884, the duration of piling could potentially affect grey seal over a maximum of five breeding cycles. The magnitude of the impact could also result in a small but measurable alteration to the distribution of marine mammals during piling only (372 days over 52 months).

909 Given that grey seal individuals from the Berwickshire and North Northumberland Coast SAC are linked with the wider ES plus NE MUs population, population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of effects. Results of the iPCoD modelling for grey seal against the wider MU population showed that the median of the ratio of the impacted population to the unimpacted population was 100% at 25 years regardless of the conversion factor scenario assessed (1% constant, 4% reducing to 0.5% or 10% reducing to 1% conversion factors). Very small differences in population size over time between the impacted and unimpacted population fall within the natural variance of the population (see volume 3, appendix 10.4 of the Offshore EIA Report). Therefore, it was considered that there is no potential for the long-term effects on this species within wider population as a result of underwater noise from piling (see volume 3, appendix 10.4 of the Offshore EIA Report for more details).

910 The impact is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of

disturbance from elevated underwater noise during piling on grey seal as feature of designated sites is provided in section 7.6.

Harbour seal

911 As previously described in paragraph 900 *et seq.,* there were two main approaches used to calculate the magnitude of effects with the potential to cause disturbance to marine mammals. As with grey seal, the approach using the uniformly distributed maximum density estimate (Table 7.4) multiplied by the largest predicted areas of effect for single/concurrent piling (as presented in Figure 10.19 and Figure 10.11, volume 2, chapter 10 of the Offshore EIA Report) resulted in the most precautionary assessment. To reiterate, this is a precautionary approach, as realistically the density of harbour seal will vary (as presented in Figure 10.17 to Figure 10.18 of volume 2, chapter 10 of the Offshore EIA Report, showing harbour seal at-sea usage based on Carter *et al.* (2020) study), and therefore will not represent a mean value across the Proposed Development marine mammal study area.

912 Up to three animals were predicted to experience potential disturbance from concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.16). For comparison, the number of animals that could be potentially disturbed during the same piling scenario but using 4% reducing to 0.5% conversion factor has been conservatively assessed as up to two harbour seals (volume 3, appendix 10.5 of the Offshore EIA Report for estimates using various conversion factor).

913 The maximum numbers of harbour seal individuals that could be potentially disturbed are considered to be conservative as they are based on the most precautionary density values (0.002 animals per km^2) taken from Carter *et al*. (2020). As described in more detail in volume 3, appendix 10.2 of the Offshore EIA Report, the average density of harbour seal within the Proposed Development array area based on Carter *et al*. (2020) is 0.0001 individuals per km^2. If maximum numbers were compared with estimates based on this average density, the number of harbour seal affected by possible disturbance during concurrent piling at 4,000 kJ) would be less than one animal, compared to less than three based on maximum densities.

914 It is reasonable to consider that disturbance could be predicted by a realistic average maximum hammer energy of 3,000 kJ (see paragraph 904 for more details), where up to two animals could potentially be disturbed during concurrent piling at wind turbine foundations (volume 3, appendix 10.5 of the Offshore EIA Report).

915 Harbour seal could also be potentially disturbed within the zone of possible disturbance during single piling at a wind turbine or an OSP/Offshore convertor station platform at a maximum hammer energy of 4,000 kJ (see volume 2, chapter 10 of the Offshore EIA Report), with up to two animals affected (Table 7.16).

Table 7.16: Number of Harbour Seals Predicted to be Disturbed Within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios Using 1% Constant Conversion Factor

Scenario (4,000 kJ)	Number of Animals	
	Average	Maximum
Concurrent piling (wind turbine)	<1	<3
Single piling (wind turbine/OSP-Offshore convertor station platform)	<1	<2

916 A single site designated for harbour seal was screened into the Stage 2 Appropriate Assessment: the Firth of Tay and Eden Estuary SAC. The behavioural disturbance contours during piling at location closest to the shore do not reach the coastal areas where the highest density of harbour seal is encountered (see Figure 10.17 in volume 2, chapter 10 of the Offshore EIA Report). There will be no overlap of noise disturbance contours with Firth of Tay and Eden Estuary SAC (located approximately 47 km from the Proposed Development array area) or any of the haul-out sites designated for harbour seals. However, given that the outer behavioural disturbance contours (135dB for seals) extend towards the coast, there is a potential that some of the animals within the impacted area may be associated with the Firth of Tay and Eden Estuary SAC (see volume 3, appendix 10.2 of the Offshore EIA Report for more details).

917 The potential for barrier effects (i.e. the ability to move between key areas such as haul-out sites and foraging areas offshore) is considered for both concurrent and single piling scenarios. The level at which a measurable response is predicted to occur in seal species is at a maximum received noise level of SEL_{ss} 135 dB (= 145 dB_{rms}) which was predicted over a shorter range compared to the NMFS (2005) threshold for mild disturbance (140 dB_{rms} = 130 dB_{ss}). Animals exposed to lower noise levels in the outer disturbance contours are likely to experience mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement, are unlikely to occur (Southall *et al*., (2021). Further discussion on the sensitivity of harbour seal is provided in section 7.5 (with respect to survival, feeding and reproductive behaviours) but for the purposes of assessment, it is considered that harbour seal close to the coast could experience mild disturbance but that this is unlikely to lead to barrier effects (i.e. preventing animals from using the foraging grounds in waters along the coast), as animals are unlikely to be excluded from the coastal areas. However, when piling occurs, these is a potential for some animals to be temporarily deterred from the offshore areas. Animals would therefore need to find alternative foraging grounds and there may be an energetic cost associated with longer foraging trips.

918 As previously described in paragraph 889, the duration of piling could potentially affect harbour seal over a maximum of five breeding cycles. The magnitude of the impact could also result in a small but measurable alteration to the distribution of marine mammals during piling only (372 days over 52 month piling phase) and may affect the fecundity of some individuals over the medium term.

919 Given that harbour seal individuals from the Firth of Tay and Eden Estuary SAC are linked with the wider ES MU population, population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of effects. Results of the iPCoD modelling for harbour seal against the wider MU population showed that the median of the ratio of the impacted population to the unimpacted population was 100% at 25 years regardless of the conversion factor scenario assessed (1% constant, 4% reducing to 0.5% or 10% reducing to 1% conversion factors). Very small differences in population size over time between the impacted and unimpacted population fall within the natural variance of the population (see volume 3, appendix 10.4 of the Offshore EIA Report). Therefore, it was considered that there is no potential for the long-term effects on this species within wider population as a result of underwater noise from piling (see volume 3, appendix 10.4 of the Offshore EIA Report for more details). These results are not in agreement with findings of Hanson *et al*. (2017), who suggested that the continuation of current decline trend in the Firth of Tay and Eden Estuary SAC could result in the species disappearing from this area within next 20 years. The reason for this discrepancy is that the revised demographic parameters to inform iPCoD models (Sinclair *et al.,* 2020) indicate that with inclusion of the Firth of Forth counts, the total East Scotland MU counts appear to be relatively stable and that counts in the Northeast England have increased.

920 The impact is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of disturbance from elevated underwater noise during piling on harbour seal as feature of designated site is provided in section 7.6.

Harbour porpoise

921 Up to 2,822 harbour porpoise (based on seasonal peak density) are predicted to experience potential disturbance from concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.17). For comparison, the number of animals that could be potentially disturbed during the same piling scenario but using a 4% reducing to 0.5% conversion factor has been conservatively assessed as up to 2,090 harbour porpoises (see volume 3, appendix 10.5 of the Offshore EIA Report for estimates using a range of conversion factors).

922 The estimated numbers of individuals potentially impacted are based on conservative densities. Although the distribution of harbour porpoise across the Proposed Development marine mammal study area was found to be uneven (see volume 3, appendix 10.2 of the Offshore EIA Report for more details), it was assumed that the peak seasonal density of 0.826 animals per km^2 is uniformly distributed within all noise contours to provide a precautionary assessment. Comparison of the estimated number of harbour porpoise potentially disturbed using the mean monthly density derived from the Proposed Development aerial digital survey data (0.299 animals per km^2) or using the modelled density estimate for SCANS III for this area (0.599 animals per km^2) demonstrates that the peak seasonal density estimates generate highly precautionary results. For example, based on the mean monthly density from aerial data or SCANS III data, the number of harbour porpoise affected by possible disturbance for the maximum adverse scenario (concurrent piling at 4,000 kJ) would be 1,021 animals or 2,047 animals respectively compared to 2,822 animals using peak seasonal density.

923 It is reasonable to consider that disturbance could be predicted by a realistic average maximum hammer energy of 3,000 kJ (see paragraph 904 for more details), where up to 2,378 animals have the potential to experience disturbance.

924 Harbour porpoise could also be potentially disturbed within the zone of possible disturbance during single piling at a wind turbine or an OSP/Offshore convertor station platform at a maximum hammer energy of 4,000 kJ, with up to 1,754 animals affected based on the seasonal peak density (using 1% constant conversion factor, Table 7.17).

Table 7.17: Number of Harbour Porpoises Predicted to be Disturbed Within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios[11]

Scenario (4,000 kJ)	Number of Animals	
	Average	Maximum
Concurrent piling (wind turbine)	1,021	2,822
Single piling (wind turbine/OSP-Offshore convertor station platform)	635	1,754

925 A single site designated for harbour porpoise was screened into the Stage 2 Appropriate Assessment: the Southern North Sea SAC. The Southern North Sea SAC is located 146 km from the Proposed Development array area. There is no potential for overlap of noise disturbance contours with this designated site. Given that harbour porpoise can travel over large distances, there is a possibility that a small number of individuals from the SAC population may be occasionally present within the disturbance contours. The population of the Southern North Sea SAC is estimated at between 20,237 and 41,538 individuals (see section 5.1.2 of appendix 10.2 of the Offshore EIA Report for more details).

926 As previously described in paragraph 889, the duration of piling could potentially affect harbour porpoise over a maximum of five breeding cycles. The magnitude of the impact could also result in a small but measurable alteration to the distribution of marine mammals during piling only (372 days over 52 months) and may affect the fecundity of some individuals over the medium term.

927 Given that harbour porpoise individuals from the Southern North Sea SAC are linked with the wider North Sea MU population, population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of effects. Results of the iPCoD modelling for harbour porpoise against the wider MU population showed that the median of the ratio of the impacted population to the unimpacted population was 99.9% at 25 years regardless of the conversion factor scenario assessed (1% constant, 4% reducing to 0.5% or 10% reducing to 1% conversion factors). Small differences in population size over time between the impacted and unimpacted population falls within the natural variance of the population (see volume 3, appendix 10.4 of the Offshore EIA Report). Therefore, it was considered that there is no potential for the long-term effects on this species (see volume 3, appendix 10.4 of the Offshore EIA Report for more details) within wider MU population. This was also the case when considered against the SCANS III Block R as a vulnerable subpopulation (see volume 3, appendix 10.4 of the Offshore EIA Report for more details).

928 The impact (elevated underwater noise from piling) is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of disturbance from elevated underwater noise during piling on harbour porpoise as feature of designated site is provided in section 7.6.

Bottlenose dolphin

929 Given that bottlenose dolphin distribution may be coastal or offshore, a dual approach has been taken to estimate the number of animals potentially disturbed. The noise contours predicted to result from piling were overlaid with 2 m to 20 m depth contours and the number of animals potentially disturbed within those areas was calculated. Estimates were based on the area of overlap and an average density of 0.197 animals per km^2 from Peterhead to Farne Islands. This is with the exception of the outer Firth of Tay, where the density is higher with 0.294 animals per km^2 (see Figure 10.13 in volume 2, chapter 10 of the Offshore EIA Report). For the purpose of this assessment it has been assumed that density of 0.294 animals per km^2 is uniformly distributed within the 2 m to 20 m depth contour of outer Firth of Tay. This approach is based on the assumption that half of the CES MU population is present within the Firth of Tay and adjacent waters and therefore this approach is highly precautionary. Given that both densities, 0.197 and 0.294 animals per km^2, were obtained from coastal distribution studies, the number of bottlenose dolphins potentially disturbed during piling in offshore areas was calculated using densities from SCANS III Block R data with 0.0298 animals per km^2 (Table 7.3).

930 The outermost noise contours predicted from the maximum hammer energy of 4,000 kJ reach the coastal areas (see Figure 10.14 in volume 2, chapter 10 of the Offshore EIA Report) and therefore overlap with the key distribution of bottlenose dolphin. Up to five animals are predicted to have the potential to experience disturbance from concurrent piling in coastal waters. For comparison, the number of animals that could potentially be disturbed during the same piling scenario but using 4% reducing to 0.5% conversion factor has been conservatively assessed as up to four bottlenose dolphins (volume 3, appendix 10.5 of the Offshore EIA Report for estimates using a range of conversion factors).

931 It is reasonable to consider that disturbance could be predicted by a realistic average maximum hammer energy of 3,000 kJ (see paragraph 904 for more details), where up to four animals could potentially be disturbed during concurrent piling at wind turbine foundations (volume 3, appendix 10.5 of the Offshore EIA Report).

[11] Average Number is Based on the Monthly Average Density whilst Maximum is Based on the Seasonal Peak Density Using 1% Constant CF

932 Coastal bottlenose dolphin could also be potentially disturbed during single piling at a wind turbine or an OSP/Offshore convertor station platform, with up to four animals affected for the 4,000 kJ hammer energy (Table 7.18).

933 Since the outer contours reach areas occupied by the coastal bottlenose dolphin population, the potential for barrier effects (e.g. restricting animals from moving along the coast), must also be considered for both concurrent and single piling scenarios. Received noise levels within the 2 m to 20 m depth contour are predicted to reach maximum SEL_{ss} levels of 130 dB. This is equivalent to the outer limit of the US National Marine Fisheries Service threshold (140 dB_{rms}) for mild disturbance (NMFS, 2005) and therefore likely to elicit less severe disturbance reactions compared to higher received levels of 150 dB SEL_{ss} (=160 dB_{rms} for strong disturbance).

934 According to the behavioural response severity matrix suggested by Southall *et al*. (2021) low level disturbance (scoring between 0 to 3 on 0 to 9 scale) could lead to mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement are unlikely to occur. Further discussion on the sensitivity of bottlenose dolphin is provided in section 7.5 (with respect to survival, feeding and reproductive behaviours) but for the purposes of assessing magnitude, it is considered that up to four or five animals from the coastal population (depending on the scenario, Table 7.18) could experience mild disturbance but that this is unlikely to lead to barrier effects as animals are unlikely to be excluded from the coastal areas.

935 Potential effects on the offshore bottlenose dolphin population were also assessed. During concurrent piling at maximum 4,000 kJ hammer energy, up to 102 individuals occurring in offshore waters have the potential to experience disturbance (Table 7.18). This equates to 5.29 % of the SCANS III Block R estimated abundance. Estimates for 4,000 kJ hammer energy are shown to be precautionary if compared with estimates based on concurrent piling at a realistic average maximum hammer energy of 3,000 kJ, where up to 86 animals could potentially be disturbed (4.46% of the SCANS III Block R estimated abundance; volume 3, appendix 10.5 of the Offshore EIA Report). For the single piling scenario with a hammer energy of 4,000 kJ, up to 64 individuals have the potential to experience disturbance offshore, which equates to 3.29% of the SCANS III Block R estimated abundance (Table 7.18).

Table 7.18: Number of Bottlenose Dolphins Predicted to be Disturbed within Unweighted SEL_{ss} Noise Contours as a Result of Different Piling Scenarios Using 1% Constant Conversion Factor

Scenario (4,000 kJ)	Number of Animals	
	Coastal	Offshore
Concurrent piling (wind turbine)	5	102
Single piling (wind turbine/OSP-Offshore convertor station platform)	4	64

936 The maximum numbers presented in Table 7.18 are considered to be conservative as these are based on highly precautionary coastal and offshore density estimates (Table 7.4). As described in more detail in volume 3, appendix 10.1 of the Offshore EIA Report, bottlenose dolphins were recorded in low numbers during the Proposed Development aerial digital surveys and only on two occasions within the 24-month survey period (encounter rate varied between 0.0005 individuals per km in October 2019 and 0.0024 individuals per km in April 2021). Considering the above, the estimated number of bottlenose dolphins with the potential to be disturbed, especially in offshore waters, should be interpreted with caution as this is likely to be an overestimate.

937 The Moray Firth SAC designated for protection of bottlenose dolphin is located approximately 167 km from the Proposed Development array area. There is no potential for overlap of noise disturbance contours with this designated site, however, noise contours have the potential to overlap with the main distributional range of its population. It is important to note that recent studies have shown that although the numbers of bottlenose dolphin using the Moray Firth SAC appear to be stable, the proportion of the population using these waters has declined due to overall increase in population size and expansion of range along the eastern coast (in southern direction, for more details see volume 3, appendix 10.2 of the Offshore EIA Report).

938 As previously described in paragraph 894, the duration of piling could potentially affect bottlenose dolphin over a maximum of three breeding cycles. The magnitude of the impact could also result in a small but measurable alteration to the distribution of marine mammals during piling only (372 days over 52 months) and may affect the fecundity of some individuals over the medium term.

939 Given that bottlenose dolphin individuals from the Moray Firth SAC are functionally linked with the wider Coastal East Scotland population, population modelling was carried out to explore the potential of disturbance during piling to affect the population trajectory over time and provide additional certainty in the predictions of the assessment of effects. Results of the iPCoD modelling for bottlenose dolphin against the wider MU population showed that the median counterfactual of population size was 100% for all three scenarios (1% constant, 4% reducing to 0.5% or 10% reducing to 1% conversion factors). Very small differences in population size over time between the impacted and unimpacted population fall within the natural variance of the population (see volume 3, appendix 10.4 of the Offshore EIA Report). Therefore, it was considered that there is no potential for the long-term effects on this species within the wider MU population (see volume 3, appendix 10.4 of the Offshore EIA Report for more details).

940 The impact is predicted to be of regional spatial extent, medium term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of disturbance from elevated underwater noise during piling on bottlenose dolphin as feature of designated site is provided in section 7.6.

Secondary Mitigation and Residual Effect

941 Due to the potential to experience injury to marine mammals, secondary mitigation will be applied in the form of an ADD to deter animals from the area of impact. This is due to the inherent uncertainties in applying the standard measures (visual and acoustic approaches), for example, problems with detecting animals in high sea states or low visibility due to adverse weather conditions.

942 ADDs have commonly been used in marine mammal mitigation at UK offshore wind farms to deter animals from potential injury zones prior to the start of piling. The JNCC (2010a) draft guidance for piling mitigation recommends their use, particularly in respect of periods of low visibility or at night to allow 24-hour working. With a number of research projects on ADDs commissioned via the Offshore Renewables Joint Industry Programme (ORJIP), the use of ADDs for mitigation at offshore wind farms has gained momentum. Indeed, for the BOWL, the use of ADDs was accepted by the regulators (Marine Scotland) to be applied pre-piling as it was thought to be more effective at reducing the potential for injury to marine mammals compared to standard designed in measures (marine mammal observers and PAM) which, as mentioned previously, have limitations with respect to effective detection over distance (Parsons et al., 2009; Wright and Cosentino, 2015).

943 There are various ADDs available with different sound source characteristics (see McGarry *et al*., 2020) and a suitable device will be selected based on the key species requiring mitigation. The selected device will typically be deployed from the piling vessel and activated for a pre-determined duration to allow animals sufficient time to move away from the sound source whilst also minimising the additional noise introduced into the marine environment. The type of ADD and approach to mitigation (including activation time and procedure) are included in the MMMP (see volume 4, appendix 23 of the Offshore EIA Report).

944 Noise modelling was carried out to determine the potential efficacy of using ADDs to deter marine mammals from the injury zone (see volume 3, appendix 10.1 of the Offshore EIA Report). The results suggest that the use of an ADD for a duration of 30 minutes before the piling commences would further reduce the potential to experience injury to marine mammal receptors. For example, the maximum injury zones for species based on SPLpk metric for piling of the wind turbines and OSP/Offshore convertor station platform foundations at a maximum hammer energy of 4,000 kJ using 1% constant conversion factor are shown in Table 7.19. Assuming conservative swim speeds, it was demonstrated that activation of an ADD for 30 minutes would deter all animals beyond the maximum injury zone (Table 7.19). This corroborates findings of other studies that reported that ADDs deter different marine mammals over several hundreds of metres or indeed several kilometres from the source (reviewed in McGarry *et al*., 2020).

Table 7.19: Summary of Peak Pressure Injury Ranges for Marine Mammals Due to Single Piling of Wind turbine and OSP/Offshore Convertor Station Platform at 4,000 kJ Hammer Energy Using 1% Constant Conversion Factor, Showing Whether the Individual Can Flee the Injury Range During the 30 Minutes of ADD Activation

Species	Threshold (Unweighted Peak)	Injury Range	Swim Speed (m/s)	Swim Distance (m)	Flee?
Bottlenose dolphin	PTS – 230 dB re 1 µPa (pk)	43	1.52	2,736	Yes
Harbour porpoise	PTS – 202 dB re 1 µPa (pk)	449	1.5	2,700	Yes
Harbour seal Grey seal	PTS – 218 dB re 1 µPa (pk)	118	1.8	3,240	Yes

Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys

945 Several sonar-based survey types will potentially be used for the geophysical surveys, including MBES, SSS, SBES and SBS. The equipment likely to be used can typically work at a range of signal frequencies, depending on the distance to the bottom and the required resolution. The signal is highly directional, acts like a beam and is emitted in pulses. Sonar-based sources are considered as continuous (non-impulsive) because they generally compromise a single (or multiple discrete) frequency as opposed to a broadband signal with high kurtosis, high peak pressures and rapid rise times. Unlike the sonar-based surveys, the UHRS is likely to utilise a sparker, which produces an impulsive, broadband source signal.

946 Source levels for borehole drilling ahead of standard penetration testing are in a range of 142 dB to 145 dB re 1 µPa re 1 m (rms). SEL measurements conducted during core penetration tests (CPTs) showed that it is characterised by broadband sound with levels measured generally 20 dB above the acoustic ocean noise floor (volume 3, appendix 10.1 of the Offshore EIA Report). For the purpose of this assessment, these sources are considered as impulsive sounds. Measurements of a vibro-core test (Reiser, 2011) show underwater source sound pressure levels of approximately 187 dB re 1 µPa re 1 m (rms). The vibro-core sound is considered to be continuous (non-impulsive).

947 Full description of the source noise levels for geophysical and geotechnical survey activities is provided in volume 3, appendix 10.1 of the Offshore EIA Report.

Auditory injury

948 Potential impacts of site investigation surveys will depend on the characteristic of the activity, frequency bands and water depth. The impact ranges presented in this section are rounded to the nearest 5 m. It should be noted that, for the sonar-based surveys, many of the injury ranges are limited to approximately 65 m as this is the approximate water depth in the area. Sonar based systems have very strong directivity which effectively means that there is only potential for injury when a marine mammal is directly underneath the sound source. Once the animal moves outside of the main beam, there is no potential for injury. This section provides estimated ranges for injury of Annex II marine mammals in the construction phase of the Proposed Development.

949 The noise modelling assessment showed that ranges within which there is a risk of PTS occurring to Annex II marine mammals as a result of geophysical investigation activities (based on comparison to Southall *et al*. (2019) SEL thresholds) are relatively low (Table 7.20). For harbour porpoise PTS could occur out to 360 m during sub-bottom profiler surveys. However, impact ranges within which PTS could occur are smaller for other marine mammal species at maximum of 65 m.

Table 7.20: Potential PTS Impact Ranges (m) for Annex II Marine Mammals During the Geophysical Site Investigation Surveys

Threshold	PTS Impact Ranges (m) Harbour Porpoise	Bottlenose Dolphin	Seal Species
Multi-Beam Echosounder (MBES)			
180-240 dB re 1 µPa re 1 m (rms)	70	65	40
Sidescan Sonar (SSS)			
190-245 dB re 1 µPa re 1 m (rms)	100	65	65
Single Beam Echosounder (SBES)			
180-400 dB re 1 µPa re 1 m (rms)	65	65	65
Sub-Bottom Profiler (SBP)			
200-240 dB re 1 µPa re 1 m (rms)	360	65	65
Ultra-High-Resolution Seismic (UHRS)			
170-200 dB re 1 µPa re 1 m (rms)	15	N/E[1]	N/E[1]

[1] N/E = Threshold Not Exceeded

950 With respect to the ranges within which there is a risk of PTS occurring to marine mammals as a result of geotechnical investigation activities, PTS threshold was not exceeded for almost all Annex II marine mammal species, except harbour porpoise (Table 7.21). PTS is only expected to occur during cone penetration test, out to a maximum of 60 m for harbour porpoise.

Table 7.21: Potential PTS Impact Ranges (m) for Annex II Marine Mammals During the Geotechnical Site Investigation Surveys

Threshold	PTS Impact Ranges (m) Harbour porpoise	Bottlenose Dolphin	Seal Species
Borehole Drilling			
142–145 dB re 1 µPa rms @ 1 m	N/E[1]	N/E[1]	N/E[1]
Core Penetration Test (CPT)			

189 dB re 1 µPa^{2s} re 1 m (rms)	60	N/E[1]	N/E[1]
Vibro-Coring			
223 dB re 1 µPa^{2s} re 1 m (based on 1 hr operation for single core sample)	5	N/E[1]	N/E[1]

[1] N/E = Threshold Not Exceeded

951 The number of Annex II marine mammals potentially affected within the modelled ranges for PTS were estimated using the most up to date species-specific density estimates (Table 7.4). Where ranges for density estimates have been applied (harbour porpoise, bottlenose dolphin, grey seal and harbour seal), numbers of animals affected have been based on the maximum density value as a precautionary approach. It should be noted that since sonar-based systems have strong directivity, there is only potential for injury when marine mammal is directly underneath the sound source.

952 Due to low impact ranges, for all marine mammal species, there is the potential for less than one animal to experience PTS (and no animals where the threshold is not exceeded) as a result of geophysical and geotechnical site investigation surveys. The site-investigation surveys are considered to be short term as they will take place over up to a period of up to three months. Standard designed in mitigation measures to reduce the risk of injury to marine mammals will be implemented for the geophysical surveys (JNCC, 2017). With such measures in place the risk during construction and decommissioning is deemed to be negligible.

953 Site investigation surveys will also involve the use of up to two geophysical/geotechnical survey vessels with up to 70 round trips. Noise impacts associated with vessel movements are identified in paragraph 988 *et seq.*

954 The impact of site investigation surveys leading to PTS is predicted to be of very local spatial extent, short-term duration, intermittent and whilst the impact will occur during piling only, the effect of PTS will irreversible. It is predicted that the impact will affect the receptor directly. The assessment of the effect of injury from elevated underwater noise during site investigation surveys on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

Behavioural disturbance

955 The estimated maximum ranges for onset of disturbance are based on exceeding the 120 dB re 1 µPa (rms) threshold applicable for all marine mammals, noting that this threshold is for 'mild disturbance' and therefore is not likely to result in displacement of animals. Additionally, Russell *et al*. (2017) study reported the highest received level at which a response was detected by seals at 135 dB SEL_{ss} with a zero probability of response measured at 130 dB SEL_{ss}. The disturbance ranges as a result of geophysical and geotechnical site-investigation surveys (Table 7.22) will be higher than those presented for PTS. Most of the predicted ranges are within 100s of metres, however, the largest distance over which the disturbance could occur is out to approximately 7.5 km during vibro-coring.

Table 7.22: Potential Disturbance Ranges for Marine Mammals During the Geophysical and Geotechnical Site Investigation Surveys

	Disturbance Ranges (m)							
	MBES	**SSS**	**SBES**	**SBP**	**UHRS**	**Borehole**	**CPT**	**Vibro-coring**
All species	865	675	735	2,045	585	20	1,500 (mild)	7,459

956 The number of marine mammals potentially affected within the modelled ranges for behavioural response (disturbance) are estimated using the most up to date species specific density estimates (see Table 7.4) and are presented in Table 7.23. Where ranges for density estimates have been applied (harbour porpoise, grey seal and harbour seal), numbers of animals affected have been based on the maximum density value as a precautionary approach. Number of bottlenose dolphins potentially disturbed has been assessed based on the density for offshore populations.

Table 7.23: Number of Animals Potentially Disturbed Due to the Geophysical and Geotechnical Site Investigation Surveys

Threshold	Estimated Number of Animals with the Potential to be Disturbed			
	Harbour porpoise	**Bottlenose dolphin**	**Harbour seal**	**Grey seal**
MBES				
180-240 dB re 1 µPa re 1 m	2	<1	<1	3
SSS				
190-245 dB re 1 µPa re 1 m	1	<1	<1	2
SBES				
180-400 dB re 1 µPa re 1 m	1	<1	<1	2
SBP				
200-240 dB re 1 µPa re 1 m	11	<1	<1	16
UHRS				
170-200 dB re 1 µPa re 1 m	1	<1	<1	1
Borehole Drilling				
142–145 dB re 1 µPa rms @ 1 m	<1	<1	<1	<1
CPT				
189 dB re 1 µPa^{2s} re 1 m	*6*	<1	<1	8
Vibrocoring				
223 dB re 1 µPa^{2s} re 1 m	144	5	1	210

957 The data presented in Table 7.23 are considered to be conservative, especially for harbour porpoise as the number of animals likely to be disturbed is based on the peak seasonal density estimates from the Proposed Development aerial digital survey data during spring months. If these numbers were compared with estimates of the number of harbour porpoise potentially affected using the mean monthly density derived from the Proposed Development aerial digital survey data (0.299 animals per km^2) or using the modelled density estimate for SCANS III for this area (0.599 animals per km^2) these estimates would be shown to be highly precautionary. For example, based on the mean monthly density from aerial data or SCANS III data, the number of harbour porpoise affected by possible disturbance during vibro-core testing, would be 52 animals or 105 animals, respectively, compared to 144 animals estimated for peak seasonal density estimates. The same applies to the grey seal, where the numbers of potentially disturbed animals (based on Carter *et al.,* 2020) were shown to be precautionary compared with estimates of the number of grey seal using the mean monthly or seasonal peak densities derived from the Proposed Development aerial digital survey data (0.276 animals per km^2 and 0.321 animals per km^2). For example, based on the mean monthly and seasonal peak density from aerial data, the number of grey seal affected by possible disturbance during vibro-core testing, would be 48 animals and 56 animals, respectively, compared to 210 animals estimated Carter *et al*. (2020) mean at sea usage.

958 Number of bottlenose dolphins that could be exposed to potential disturbance (Table 7.23) relate to their offshore populations. Given that the vibro-core sampling locations are currently unknown and coastal distribution of bottlenose dolphin is spatially limited, any quantitative assessment of the disturbance to

coastal populations would be an overestimation. All geotechnical and geophysical surveys will be very short duration (up to three months) and animals are expected to recover quickly after cessation of the survey activities. The magnitude of the impact could result in a negligible alteration to the distribution of marine mammals.

959 The impact of site investigation surveys leading to behavioural effects is predicted to be of local spatial extent, medium term duration, intermittent and the effect of behavioural disturbance is of high reversibility (animals returning to baseline levels soon after surveys have ceased). It is predicted that the impact will affect the receptor directly. The assessment of the effect of disturbance from elevated underwater noise during site investigation surveys on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

Secondary Mitigation and Residual Effect

960 The PTS thresholds are not exceeded for most surveys and for most species. This is with the exception of cone penetration testing where the PTS range is so small (60 m predicted for harbour porpoise only) that it is considered that animals are likely to be deterred beyond this range (i.e. out to 300 m) by the vessel noise itself (see Table 7.35). Additionally, as a part of designed in measures (Table 7.11), Standard JNCC (2017) mitigation will be adhered to for the geophysical surveys which will involve the use of marine mammal observers/PAM monitoring of a standard 500 m mitigation zone for a period of no < 30 minutes prior to the start of surveys (Table 7.11). No secondary marine mammal mitigation is considered necessary because there is no residual risk of injury in the absence of further mitigation (beyond the designed in measures outlined above and in Table 7.11).

Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance

Auditory injury

961 An explosive mass of 300 kg (maximum design scenario due to high order detonation; see Table 7.10) yielded the largest potential PTS ranges for all species, with the greatest effect ranges seen for harbour porpoise (Table 7.24). As described in paragraph 873, there is just a small (10%) chance that low order detonation could result in a high order detonation event. Therefore, whilst this assessment considers the most likely scenario to be based on a detonation of 0.08 kg donor change (maximum size of donor charge used for low order techniques) and a detonation of 0.5 kg clearance shot (maximum size of clearing shot to neutralise any residual explosive material (Table 7.25), the assessment considers both high order and low order techniques for the purposes of mitigation. With regard to UXO detonation (low order techniques as well as high order events), due to a combination of physical properties of high frequency energy, the sound is unlikely to still be impulsive in character once it has propagated more than a few kilometres (see volume 3, appendix 10.1 of the Offshore EIA Report). The NMFS (2018) guidance suggested an estimate of 3 km for transition from impulsive to continuous (although this was not subsequently presented in the later guidance (Southall *et al.*, 2019). For other impulsive noise sources (pile driving and airguns) Hastie *et al.,* (2019) suggests that some measures of impulsiveness change markedly within c. 10 km of the source. Therefore, great caution should be used when interpreting any results with predicted injury ranges in the order of tens of kilometres as the impact ranges are likely to be significantly lower than predicted.

Table 7.24: Potential PTS Impact Ranges for Marine Mammals Due to UXO High Order Detonation

Threshold	PTS Impact Ranges (m)		
	Harbour Porpoise	Bottlenose Dolphin	Seal Species
Charge Size 300 kg			
SPL Peak	10,630	615	2,085
SEL (Weighted)	3,805	150	790

Table 7.25: Potential PTS Impact Ranges for Marine Mammals Due to Low Order Techniques

Threshold	PTS Impact Ranges (m)		
	Harbour Porpoise	Bottlenose Dolphin	Seal Species
Charge Size 0.08 kg			
SPL Peak	685	40	135
SEL (Weighted)	310	5	15
Charge Size 0.5 kg			
SPL Peak	1,265	75	250
SEL (Weighted)	650	5	40

962 The subsea noise assessment found that the maximum injury (PTS) range estimated for harbour porpoise using the SPL_{pk} metric is 685 m for the detonation of charge size of 0.08 kg and 1,260 m for the detonation of 0.5 kg clearance shot (Table 7.25). Conservatively, the number of individuals that could be potentially injured, based on the peak seasonal densities from site-specific survey data, was estimated as one and four harbour porpoises for 685 m and 1,265 m respectively (Table 7.26).

963 The subsea noise assessment found that the maximum injury (PTS) range estimated for bottlenose dolphin using the SPL_{pk} metric is 40 m for the detonation of charge size of 0.08 kg and 75 m for the detonation of 0.5 kg clearance shot (Table 7.25). Conservatively, the number of bottlenose dolphins that could be potentially injured within the maximum range of 75 m, based on the peak densities in the outer Firth of Tay from the probability of occurrence model (Arso Civil *et al*., 2019), was estimated as less than one individual (Table 7.26).

964 Both seal species (harbour and grey seal) could experience potential injury at the maximum range of 135 m due to detonation of charge size of 0.08 kg and 250 m due to detonation of 0.5 kg clearance shot (Table 7.25). Taking into account the most conservative scenario, maximum density for both species (based on mean at-sea seal usage from Carter *et al*. (2020)), there will be less than one animal of each species that could be potentially injured within the maximum range of 250 m (Table 7.26).

Table 7.26: Number of Animals with the Potential to Experience PTS due to Low Order Techniques

Threshold	Estimated Number of Animals with the Potential to be Disturbed		
	Harbour Porpoise	Bottlenose Dolphin	Seal Species
Charge Size 0.08 kg			
SPL Peak	1	<1	<1
SEL (Weighted)	<1	<1	<1
Charge Size 0.5 kg			
SPL Peak	4	<1	<1
SEL (Weighted)	1	<1	<1

965 As discussed previously, whilst the preferred approach is to clear UXOs using low order techniques, this assessment also presents the number of animals potentially injured by high order detonation (Table 7.27).

966 Harbour porpoise is likely to be the most sensitive species to potential injury from high order UXO clearance. The subsea noise assessment found that the maximum injury (PTS) range estimated for harbour porpoise using the SPL_{pk} metric is 10,630 m for the high order detonation of charge size of 300 kg (Table 7.24). Conservatively, the number of harbour porpoise that could be potentially injured during each high order detonation of UXO is greater (up to 293 individuals) compared with other species. The second most sensitive marine mammal that could be affected by the high order UXO clearance event is grey seal with up to 16 animals with the potential to be injured during each high order detonation of the UXO. Less than one individual has the potential to be injured for all other species considered in the assessment (Table 7.27).

967 To reduce the potential of experiencing injury, designed in measures will be adopted as part of a MMMP (see Table 7.11). However, mitigation zones of c. 10 km are considerably larger than the standard 1,000 m mitigation zone recommended for UXO clearance (JNCC, 2010b) and there are often difficulties in detecting marine mammals (particularly harbour porpoise) over such large ranges (McGarry *et al*., 2017). Visual surveys note that there is often a significant decline in detection rate with increasing sea state (Embling *et al*., 2010; Leaper *et al*., 2015). Therefore, additional mitigation will be applied in the form of soft start charges and ADDs to minimise residual risk of injury and the assessment of effects therefore considers the deployment of these as a secondary mitigation measure.

Table 7.27: Number of Animals with the Potential to Experience PTS due to High Order Detonation

Threshold	Estimated Number of Animals with the Potential to be Affected			
	Harbour Porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal
Charge Size 300 kg				
SPL Peak	293	<1	<1	16
SEL (Weighted)	38	<1	<1	2

968 Due to the small numbers of marine mammals potentially injured from low order techniques (Table 7.26) the magnitude of the impact could result in a negligible alteration to the distribution of marine mammals. For low order techniques the impact of PTS is predicted to be of local spatial extent, very short-term duration, intermittent and of low reversibility. It is predicted that the impact will affect the receptor directly.

969 In comparison, larger numbers of marine mammal could potentially be injured by high order detonation which could lead to a minor alteration in the distribution of marine mammals. For high order detonation the impact of PTS is predicted to be of local to regional spatial extent, very short-term duration, intermittent and the effect of injury is of low reversibility. It is predicted that the impact will affect the receptor directly. Only a small proportion (c. 10% of the UXO) are considered likely to result in high order detonation.

970 A MMMP will be developed for the purpose of mitigating the risk of auditory injury (PTS) to marine mammals from the proposed UXO clearance activities at the Proposed Development. Mitigation suggested in volume 2, chapter 10 of the Offshore EIA Report is considered to be sufficient to deter most animals (Table 7.28), however there may be a residual effect for harbour porpoise for the 300 kg UXO size, as the maximum predicted PTS impact range for this species is larger than deterrence distance. It is expected that small, nominal number of animals could be exposed to PTS threshold. More information about secondary mitigation measures and residual effect is provided in paragraph 978 *et seq*. The assessment of the effect of PTS from elevated underwater noise during UXO clearance on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6

Table 7.28: Recommended ADD Duration for High Order UXO Clearance and Sizes, and Associated Displacement Distance

UXO Size	Minimum ADD Duration Prior to Mitigation	Displacement Distance (m)		
		Harbour Porpoise	Bottlenose Dolphin	Seals
Up to 3 kg	22 min	1,980	2,006	2,376
Up to 6.5 kg	30 min	2,700	2,736	3,240
Up to 15 kg	40 min	3,600	3,648	4,320
Up to 50 kg	60 min	5,400	5,472	6,480
Up to 300 kg	60 min plus soft start charges for 20 minutes	7,200	7,296	8.640

TTS

971 A second threshold assessed was the onset of TTS where the resulting effect would be a potential temporary loss in hearing. Whilst similar ecological functions would be inhibited in the short term due to TTS, these are reversible on recovery of the animal's hearing and therefore not considered likely to lead to any long-term effects on the individual. The onset of TTS also corresponds to a 'fleeing response' as this is the threshold at which animals are likely to flee from the ensonified area. Thus, the onset of TTS reflects the threshold at which behavioural displacement could occur. As previously described in paragraph 961, the sound is unlikely to be impulsive in character once it has propagated more than a few kilometres. It is particularly important when interpreting results for TTS with impact ranges of up to 51 km as these are likely to be significantly lower than predicted. As before, the assessment of TTS will consider a most likely scenario of the detonation of a 0.08 kg donor change (maximum size of donor charge used for low order techniques) and the detonation of a 0.5 kg clearance shot (maximum size of clearing shot to neutralise any residual explosive material). Due to the potential for a low order detonation technique to result in a high order detonation (as per paragraph 873) the assessment also considers high order detonation of 300 kg UXO munition size.

Table 7.29: Potential TTS Impact Ranges for Marine Mammals Due to Low Order Techniques

Threshold	Potential TTS Impact Ranges (m)		
	Harbour Porpoise	Bottlenose Dolphin	Seal Species
Charge Size 0.08kg			
SPL Peak	1,265	75	250
SEL (Weighted)	2,015	40	210
Charge Size 0.5 kg			
SPL Peak	2,325	135	455
SEL (Weighted)	3,110	95	505

Table 7.30: Number of Animals with the Potential to Experience TTS Due to Low Order Techniques

Threshold	Estimated Number of Animals with the Potential to be Affected			
	Harbour Porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal
Charge Size 0.08kg				
SPL Peak	4	<1	<1	<1
SEL (Weighted)	11	<1	<1	<1
Charge Size 0.5 kg				
SPL Peak	14	<1	<1	1
SEL (Weighted)	25	<1	<1	1

972 The subsea noise assessment found that temporary hearing impairment and behavioural displacement from the area (TTS) may affect harbour porpoise at a maximum range of 2,015 m for the detonation of charge size of 0.08 kg and 3,110 m for the detonation of 0.5 kg clearance shot. Up to 11 animals have the potential to be affected by TTS due to the low order techniques (charge size of 0.08 kg) and up to 25 animals have the potential to experience TTS from the detonation of 0.5 kg clearance shot (Table 7.31).

973 The subsea noise assessment found that temporary hearing impairment and behavioural displacement from the area (TTS) may affect bottlenose dolphin at a maximum range of 75 m for the detonation of charge size of 0.08 kg and 135 m for the detonation of 0.5 kg clearance shot. The maximum range of 135 m is only slightly larger when compared to PTS (75 m) and therefore less than one animal has the potential to be affected by TTS (Table 7.31).

974 The subsea noise assessment found that temporary hearing impairment and behavioural displacement from the area (TTS) may affect harbour and grey seal at a maximum range of 250 m for the low order techniques (charge size of 0.08 kg) and 505 m for the detonation of 0.5 kg clearance shot. Less than one harbour seal and one grey seal have the potential to be affected by TTS due to the detonation of charge size of 0.08 kg as well as the detonation of 0.5 kg clearance shot (Table 7.31).

Table 7.31: Number of Animals with the Potential to Experience TTS due to Low Order Techniques

Threshold	Estimated Number of Animals with the Potential to be Affected			
	Harbour Porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal
Charge Size 0.08kg				
SPL Peak	4	<1	<1	<1
SEL (Weighted)	11	<1	<1	<1
Charge Size 0.5 kg				
SPL Peak	14	<1	<1	1
SEL (Weighted)	25	<1	<1	1

975 High order detonation has the potential to impact animals over larger ranges when compared to low order techniques. The maximum range for TTS across all Annex II marine mammals was for harbour porpoise with the maximum range of 19,590 m due to high order detonation of charge size of 300 kg (Table 7.32). Seals are also anticipated to experience TTS across relatively large range of up to 6,430 m as a result of detonation of charge size of 300 kg.

Table 7.32: Potential TTS Impact Ranges (m) for Marine Mammals Due to High Order Detonation

Threshold	TTS Impact Ranges (m)		
	Harbour Porpoise	Bottlenose Dolphin	Seal Species
Charge Size 300 kg			
SPL Peak	19,590	1,130	3,840
SEL (Weighted)	8,900	1,137	6,430

976 Due to relatively large ranges of potential impacts presented in, up to 995 harbour porpoises have the potential to be affected by TTS due to detonation of the 300 kg charge size (Table 7.33). Taking into account the most conservative scenario, up to 156 grey seals could potentially experience TTS due to the high order detonation of charge size of 300 kg. As described previously, the duration of effect is very short-lived and since TTS is a temporary hearing impairment, animals are likely to fully recover from the effects.

Table 7.33: Number of Animals with the Potential to Experience TTS due to High Order Detonation

Threshold	Estimated Number of Animals with the Potential to be Affected			
	Harbour Porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal
Charge Size 300 kg				
SPL Peak	995	<1	<1	56
SEL (Weighted)	205	<1	<1	156

977 The impact of TTS for low order techniques is predicted to be of local spatial extent, very short term duration, intermittent and high reversibility. The impact of TTS high order detonation is predicted to be of regional spatial extent, very short-term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of TTS from elevated underwater noise during UXO clearance on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6

Secondary Mitigation and Residual Effect

978 Additional mitigation will be applied to reduce the potential for injury occurring during UXO clearance. As previously described in paragraph 873 *et seq.*, low order techniques will be applied as the intended methodology for clearance of UXO, however there is a small risk that a low order clearance could result in high order detonation of UXO (as per paragraph 873, approximately 10% of the total number of UXOs could result in high order detonation). The mitigation has been therefore tailored based on the size of the UXO and high order detonation scenario. A range of UXO munitions sizes have been considered for purpose of determining effective mitigation measure, up to a maximum scenario of a UXO size of 300 kg. This approach follows a similar strategy to what was done for Seagreen EPS Risk Assessment and MMMP (Seagreen Wind Energy Ltd, 2021).

979 A MMMP will be developed for the purpose of mitigating the risk of auditory injury (PTS) to marine mammals from the proposed UXO clearance activities at the Proposed Development. As previously mentioned, an approach used in Seagreen EPS Risk Assessment and MMMP (Seagreen Wind Energy Ltd, 2021) has been followed for the Proposed Development. The MMMP will be provided as a stand-alone document, however this section provides an overview of the procedures prior to making conclusions on the potential for residual effects.

980 The designed in measures included as a part of the MMMP (Table 7.11) are in line with JNCC guidelines for minimising the risk of injury to marine mammals from using explosives (JNCC, 2010b). Details of ADD use and soft-start charges application are specific for each of the anticipated UXO sizes. A flow-chart, originally presented in Figure 2 of Seagreen EPS Risk Assessment and MMMP (Seagreen Wind Energy Ltd, 2021), has been used to inform the mitigation procedures. Prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information, including an evaluation of the most appropriate measures to employ particularly with respect to emerging evidence on the use of scare charges as the most widely applied approach alongside ADDs. During Road Map Meeting 4 stakeholders were informed that appropriate mitigation measures will be agreed via consultation as a part of a UXO specific MMMP and this will include consideration of the efficacy of noise abatement measures.

981 The approach to mitigating injury to marine mammals involves the monitoring of a 1 km radius mitigation zone. Monitoring will be carried out by suitably qualified and experienced personnel within a mitigation team, comprising two dedicated marine mammal observers and one dedicated PAM operator. The purpose of this monitoring is to ensure that the mitigation zone is clear of marine mammals prior to detonation.

982 Given that there is a potential to experience auditory injury by harbour porpoise at a greater range than can be mitigated by monitoring of the 1 km mitigation zone alone (Table 7.24), an ADD will be deployed for a pre-determined length of time to deter marine mammals to a greater distance prior to any detonation. The assessment of effects provided above in paragraph 961 et seq. determine the auditory injury range based on high order detonation of a 300 kg UXO. At the time of writing, the number and size of the UXOs within the Proposed Development array area and the Proposed Development export cable corridor are unknown and therefore, the mitigation has been designed for a range of UXO munitions sizes so that the most appropriate approach can be applied to balance the risk of injury from UXO detonation with any additional noise introduced into the marine environment as deterrent measures. The assumption is that the animals swim in a straight line away from the ADD at a speed agreed in consultation with NatureScot and MSS for the Proposed Development. Swim speeds are summarised in Table 7.8 along with the source papers for the assumptions. Therefore, the duration of the application of the ADD prior to UXO detonation will determine whether the animal can move out of the injury zone prior to UXO detonation (Table 7.34).

983 Activation of an ADD will commence within the 60 minutes pre-detonation search, providing no marine mammals have been observed within the mitigation zone for a minimum of 20 minutes. Summaries provided in this paragraph refer to harbour porpoise only, however, deterrence distances are provided for all marine mammal IEFs in Table 7.34. Based on the UXO clearance flow chart (Seagreen Wind Energy Ltd, 2021), for UXO size up to 3 kg, the required time of ADD activation is 22 minutes and this is expected to displace harbour porpoise to 1,980 m range (Table 7.34). If UXO size of up 6.5 kg is identified during the survey, then ADD will be activated for 30 minutes and this is expected to deter harbour porpoise to 2,700 m. For UXO mass charge of up to 15 kg, the required time of ADD activation is 40 minutes and this is expected to displace harbour porpoise to 3,600 m range, respectively. For larger UXO sizes up to 50 kg, an ADD will be activated for 60 minutes and this is expected to deter harbour porpoise to 5,400 m.

984 For UXO sizes up to 300 kg, to reduce the risk of PTS, there is a need to deter animals from larger ranges that cannot be achieved using an ADD alone. Therefore, following an ADD activation period of 60 minutes, a 'soft start' will be undertaken, using a sequence of small explosive charges, detonated at five minutes intervals, over a total of 20 minutes (Table 7.34). It is expected that 80 minutes of combined ADD/soft start procedure will displace harbour porpoise to range of 7,200 m. Whilst this mitigation is considered to be sufficient to deter most animals, there may be a residual effect for harbour porpoise for this largest UXO size, as the maximum predicted PTS impact range for this species was 10,630 m (Table 7.24).

Table 7.34: Recommended ADD Duration for High Order UXO Clearance and Sizes, and Associated Displacement Distance

UXO Size	Minimum ADD Duration prior to Mitigation	Displacement Distance (m)		
		Harbour Porpoise	Bottlenose Dolphin	Seals
Up to 3 kg	22 min	1,980	2,006	2,376
Up to 6.5 kg	30 min	2,700	2,736	3,240
Up to 15 kg	40 min	3,600	3,648	4,320
Up to 50 kg	60 min	5,400	5,472	6,480
Up to 300 kg	60 min plus soft start charges for 20 minutes	7,200	7,296	8.640

985 The analysis presented in Table 7.34 suggests that for UXO sizes of up to 300 kg, pre-detonation search and use of ADD will be sufficient to reduce the potential of experiencing PTS by bottlenose dolphin, harbour seal and grey seal to negligible. Harbour porpoises could potentially experience an auditory injury at distances that cannot be fully mitigated by application of ADD and soft start charges. The maximum mitigation zone has been assessed as 7,200 m and PTS range for this species has been modelled as 10,630 m. To assess the residual effect, the average and maximum number of animals that may potentially be present within an area of 192 km^2 (difference between the area across which effects could be mitigated and area of effect) could be calculated using harbour porpoise density range (Table 7.4). However, this approach is considered likely to lead to an overestimate and may result in unrealistic predictions for the numbers of animals potentially injured. For example, for highly impulsive sounds such as piling, at ranges from the source in the order of tens of kilometres, the sound changes from being impulsive in character to being non-impulsive. At even greater ranges, the sound will not only be non-impulsive but can be characterised as being continuous (i.e. each pulse will merge into the next one). As presented in volume 3, appendix 10.1, annex D of the Offshore EIA Report, assessment of transition range is an area of ongoing research but it is considered that any predicted injury ranges in the tens of kilometres are almost certainly an overly precautionary interpretation of existing criteria (Southall et al., 2021).

986 There is also a likelihood that the range over which the animals are anticipated to be displaced during 60 minutes of ADD plus application of soft start charges (Table 7.34) is underestimated. Firstly, strong and far-reaching responses to an ADD have been recorded by Thompson et al. (2020) at approximately 10 km to the ADD source. Moreover, to assess the range of 7,200 m, an average harbour porpoise swim speed has been applied (i.e. 1.5 m/s). Various scientific papers provided significantly faster speeds with a maximum speed of 4.3 m/s and 6.2 m/s cited by Otani et al. (2000) and Leatherwood et al. (1988), respectively.

987 For harbour porpoise, it is expected that small numbers of animals could be exposed to potential PTS. Given that details about UXO clearance technique to be used and charge sizes will not be available until after the consent is granted (pre-construction phase, following UXO survey), it is not possible to quantify the effects of UXO detonations and therefore the residual number of animals is not presented within this document. At a later stage, when details about UXO sizes and specific clearance techniques to be used become available, it will be possible to provide detailed assessment and tailor the mitigation to specific UXO sizes and species to reduce the risk of injury. Therefore, prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information for the UXO clearance works. Appropriate mitigation measures will be agreed with stakeholders as a part of a UXO specific MMMP. It is therefore anticipated that following the application of secondary mitigation measures following receipt of more detail regarding size and number of UXO, the risk of injury will be reduced to low.

Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities

Auditory injury

988 During the construction phase of the Proposed Development, the increased levels of vessel activity will contribute to the total underwater noise levels. The maximum design scenario for construction activities associated with site preparation and inter-array and offshore export cables is up to 316 return trips of up to nine boulder clearance vessels and 104 return trips of up to three sand wave clearance vessels, throughout the construction phase. Additionally, vessel movements associated with other activities such as foundation and OSP/Offshore convertor station platform installation, will contribute to a maximum scenario of up to 11,484 vessel round trips over the construction phase. Vessel types will include main installation vessels, cargo barges, support vessels, tug/anchor handlers, guard vessels and others (see Table 7.10 for full list of construction vessels and volume 3, appendix 10.1 of the Offshore EIA Report for SPLs associated with each vessel type). Whilst this will lead to an uplift in vessel activity, the movements will be limited to within the Proposed Development array area and Proposed Development export cable corridor and will follow existing shipping routes to/from the ports.

989 The main drivers influencing the magnitude of the impact are vessel type, speed and ambient noise levels (Wilson *et al.*, 2007). Based on information presented in volume 2, chapter 13 of the Offshore EIA Report, baseline levels of vessel traffic in the Proposed Development marine mammal study area are relatively high. An average of 14 vessels per day were recorded within a 10 nm buffer around the Proposed Development array area (hereinafter Proposed Development shipping and navigation study area) over a 14-day survey period in August 2022. The vessel traffic surveys also showed an average of three to four vessels intersecting the Proposed Development array area per day, over summer. Throughout the season, a maximum of 25 vessels were recorded within the Proposed Development array shipping and navigation study area over one day. For the winter survey period (January 2021), there was an average of 16 unique vessels per day recorded within the Proposed Development array area shipping and navigation study area. As described in the Navigational Risk Assessment (NRA) (volume 3, appendix 13.1 of the Offshore EIA Report), occasional vessel traffic movements associated with jack-ups, semi-submersibles and other platforms also occur in the region.

990 Other noise generating activities for the Proposed Development will include drilled piling, with a maximum of 176 piles over the period of 135 days (Table 7.10). Rotatory drilling is non-impulsive in character and the source sound levels associated with this activity have been based on pile drilling for the Oyster 800 project. The other noise sources potentially active during the construction phase are related to cable installation (i.e., trenching and cable laying activities), and their related operations such as the jack-up rigs. See volume 3, appendix 10.1 of the Offshore EIA Report for more information about SELs associated with above construction activities.

991 The noise modelling results indicate that ranges (within which there is a risk of PTS occurring to marine mammals as a result of elevated underwater noise due to vessel use) are either not exceeded or relatively low (Table 7.35). The maximum range within which the PTS could occur across all species has been estimated for harbour porpoise at 525 m for a rock placement vessel (Table 7.35).

Table 7.35: Vessels Involved in the Construction of the Proposed Development and Estimated Potential PTS Ranges for Marine Mammals

Threshold	Range of Effect (m)		
	Harbour porpoise	Bottlenose Dolphin	Seal Species
Installation vessel, construction vessel	280	10	N/E
Rock placement vessel	525	15	5
Anchor handling vessel, survey vessel, support vessels	N/E	N/E	N/E
Misc. small vessel (e.g. tugs, vessels carrying remotely operated vessels (ROVs), crew transfer vessels, dive boats, barges and rigid inflatable boats (RIBs)	N/E	N/E	N/E
Excavator, Backhoe dredger, pipe laying, geophysical survey vessel, jack up vessel	N/E	N/E	N/E

N/E = Not Exceeded

992 Of the other noise-producing activities cable laying is most likely to result in PTS compared to drilling, trenching and jack-up rigging (Table 7.36). As before, the modelled effect ranges for cable laying suggest that harbour porpoise is the most sensitive species with PTS predicted up to 525 m of the source (Table 7.36). The same activity is likely to result in a PTS to bottlenose dolphin within 15 m from the source and to seal species within only 5 m from the source. The jack-up rig has the potential to result in PTS to harbour porpoise within 5 m from the source. For all other activities and for all other species, the thresholds for PTS will not be exceeded as a result of underwater noise during construction activities.

Table 7.36: Estimated PTS Ranges for Marine Mammals During Other Activities

Threshold	Range of Effect (m)		
	Harbour porpoise	Bottlenose Dolphin	Seal Species
Drilled Piling (SEL 160 dB re 1 μPa^2s)	N/E	N/E	N/E
Cable Trenching	N/E	N/E	N/E
Cable laying	525	15	5
Jack-up rig	5	N/E	N/E

993 The number of marine mammals potentially affected within the modelled ranges for PTS from vessels (Table 7.35) and other activities (Table 7.36), were calculated and found to be less than one individual for all species. Whist the numbers of animals likely to be affected at any one time are extremely low, the maximum duration of the offshore construction phase is up to six years.

994 The impact is predicted to be of local spatial extent, medium term duration, intermittent and the effect of PTS on sensitive receptors is of low reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effects of injury from elevated underwater noise due to vessel use and other activities on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

Behavioural disturbance

995 Disturbance from vessel noise is likely to occur only where vessel noise associated with the construction of the Proposed Development exceeds the background ambient noise level. As discussed in paragraph 988 *et seq.*, the Proposed Development is located in a relatively busy shipping area and therefore background noise levels are likely to be relatively high.

996 A detailed underwater noise modelling assessment has been carried out to investigate the potential for behavioural effects on marine mammals resulting from increased vessel noise and other activities. The estimated ranges within which there is a potential for disturbance to marine mammals along with number

of animals with the potential to be disturbed are presented in Table 7.37 based on the most precautionary species-specific density estimates (Table 7.3) with offshore density estimates applied for bottlenose dolphin. Estimated impact ranges and numbers of animals potentially are presented for different vessel types in isolation. It is likely that during construction, operation and maintenance and decommissioning phases, there will be a number of different types of vessels present within the Proposed Development marine mammal study area at the same time. However, given that the exact type, numbers and distances between vessels are unknown at this stage, the cumulative ranges were not quantified. Therefore the discussion presented in this section is based on the maximum scenario for a single vessel at any given time. Installation and construction vessels as well as rock placement vessels result in the greatest modelled disturbance out to 4,320 m for all marine mammal species. Similar ranges for behavioural effects are predicted to occur due to underwater noise from cable laying activities with disturbance ranges of 4,389 m. In comparison, vessels such as excavator, backhoe dredger, pipe laying, geophysical survey vessel and jack up vessel as well as jack-up rig were predicted to result in disturbance ranges out to 300 m.

Table 7.37: Estimated Disturbance Ranges for Marine Mammals and Number of Animals Potentially Disturbed as a Result of Vessels and Other Activities

Threshold	Estimated Number of Animals with the Potential to be Disturbed				
	Disturbance Range (m)	Harbour Porpoise	Bottlenose Dolphin (Offshore)	Harbour Seal	Grey Seal
Vessels					
Installation vessel, construction vessel ((Dynamic Positioning)	4,320	48	<2	<1	70
Rock placement vessel	4,320	48	<2	<1	70
Anchor handling vessel, Survey vessel, Support vessels	2,980	23	<1	<1	33
Misc. small vessel	1,100	3	<1	<1	5
Excavator, Backhoe dredger, Pipe laying, Geophysical survey vessel, jack up vessel	300	<1	<1	<1	<1
Other Activities					
Drilled Piling (SEL 160 dB re 1 μPa^2s)	1,900	9	<1	<1	14
Cable Trenching	2,580	17	<1	0	25
Cable laying	4,389	50	<2	0	73
Jack-up rig	300	<1	<1	<1	<1

997 As discussed previously in paragraph 874, there is likely to be a proportionate response of animals within the modelled contours (i.e. not all animals will be disturbed to the same extent). The life history of an individual and the context will also influence the likelihood of an individual to exhibit an aversive response to noise.

998 Grey seal is likely to be the most sensitive species to disturbance from vessel traffic. The second most sensitive marine mammal is harbour porpoise. The numbers of animals with the potential to be disturbed (as presented in Table 7.37) are considered to be highly conservative, especially for harbour porpoise and grey seal, as these estimates were based on the peak seasonal densities from the Proposed Development aerial digital survey data during spring months and maximum density based on at-sea mean usage maps (Carter *et al*., 2020), respectively.

999 Activities with the largest disturbance ranges, including installation, construction, rock placement and cable laying vessels, will be operating at distances from the outer Firth of Tay (the highest bottlenose dolphin densities) and are unlikely to affect coastal bottlenose dolphin populations. Therefore, bottlenose dolphins that could be exposed to potential disturbance (Table 7.37) would belong to offshore population.

1000 The impact is predicted to be of local spatial extent, medium term duration, intermittent and the effect of behavioural disturbance is of high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of behavioural disturbance from elevated underwater noise due to vessel use and other activities on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

7.3.2 CHANGES IN PREY AVAILABILITY

1001 Potential changes to the fish assemblages during the construction and decommissioning phases of the Proposed Development, as identified in volume 2, chapter 9 of the Offshore EIA Report, may have indirect effects on marine mammals, as assessed in volume 2, chapter 10 of the Offshore EIA Report.

1002 This section addresses the effects due to changes in prey availability associated with the construction and decommissioning phases of the proposed project. For each type of underwater noise effect, the nature of the effect is described, the source activities generating the effect and the potential changes to marine mammal receptors are outlined. Effects are categorised as permanent or temporary.

1003 The subsequent sub-sections provide more information on each of these underwater noise effects and the sensitivity of the Annex II marine mammal features to these effects:

- a summary of the relevant components of the Proposed Development, outlined in the maximum design scenario (Table 7.38) and designed in measures;
- an overview of the methodology/modelling/assessment undertaken to quantify and assess effects due to changes in prey availability on marine mammals; and
- an overview of relevant marine mammal information gathered to aid the assessment (paragraph 1021 *et seq*.).

1004 Potential effects on fish assemblages during the construction, operation and maintenance and decommissioning phases of the Proposed Development, as identified in volume 2, chapter 9 of the Offshore EIA Report, may have indirect effects on marine mammals. The assessment includes temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, injury and/or disturbance from underwater noise and vibration, EMF, as well as colonisation of foundations, scour protection and cable protection.

1005 The key prey species for marine mammals include sandeel, gadoids (e.g. cod *Gadus morhua*, haddock *Melanogrammus aeglefinus*, whiting *Merlangius merlangus*), clupeids (herring), plaice *Pleuronectes platessa*, flatfish and mackerel. These prey species have been identified as being of regional importance within the Proposed Development fish and shellfish ecology study area (see volume 2, chapter 9 of the Offshore EIA Report). For example, there are important spawning grounds for cod, herring, plaice, sandeel, whiting and sprat within the Proposed Development array area and Proposed Development export cable corridor. Consequently, adverse effects on fish receptors may have indirect adverse effects on marine mammal receptors.

Construction phase

1006 Potential impacts on marine mammal prey species during the construction phase have been assessed in volume 2, chapter 9 of the Offshore EIA Report using the appropriate maximum design scenarios for these receptors. Construction impacts include temporary subtidal habitat loss/disturbance, long term subtidal habitat loss, injury and/or disturbance to fish and shellfish from underwater noise and vibration and increased SSCs and associated sediment deposition.

Decommissioning phase

1007 Potential impacts on marine mammal prey species during the decommissioning phase have been assessed in volume 2, chapter 9 of the Offshore EIA Report using the appropriate maximum design scenarios for these receptors. These impacts include temporary subtidal habitat loss/disturbance, long term subtidal habitat loss and increased SSCs and associated sediment deposition.

Maximum design scenario relevant to the assessment of adverse effects on integrity

1008 The Maximum Design Scenario considered for the assessment of potential impacts on Annex II marine mammal features from changes in prey availability during construction and decommissioning are set out in Table 7.38 below.

Table 7.38: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Changes in Prey Availability during Construction and Decommissioning

Potential Impact	Phase[12]			Maximum Design Scenario	Justification
	C	O	D		
Changes in fish and shellfish communities affecting prey availability[13]	✓	✓	✓	**Construction Phase** • up to 113,974,700 m^2 of temporary subtidal habitat loss/disturbance due to: • use of jack-up vessels during foundation installation, with up to 4 jack-up events per wind turbine and 4 jack-up events per OSP/Offshore convertor station platform; • installation of up to 1,225 km of inter-array cables, up to 94 km of interconnector cable, up to 872 km of offshore export cables with seabed disturbance width of: up to 25 m for sand wave clearance, up to 25 m for boulder clearance and up to 15 m for cable burial; • sand wave clearance for up to 20% of the Proposed Development export cable corridor length, up to 30% of inter-array cables and OSPs/Offshore convertor station platform interconnector cables; • boulder clearance for up to 20% of offshore export cable length, inter-array cables and OSPs/Offshore convertor station platforms interconnector cables; • anchor placement; • offshore export cables installation at the landfall via trenchless burial techniques; • up to eight exit punches out, each 20 m x 5 m, for removal of up to eight cables from the landfall; and • clearance of up to 14 UXO. Other impacts on fish and shellfish communities include: • increased SSCs and associated deposition from construction activities, such as drilling of 179 foundations, installation of up to 1,225 km of inter-array and up to 872 km of offshore export cables; • injury and/or disturbance to fish and shellfish from underwater noise and vibration as a result of the clearance of up to 14 UXOs and installation of 179 offshore wind turbines and up to 10 OSPs/Offshore convertor station platform; and • up to 7,798,856 m^2 of long term habitat loss due to presence of wind turbine and OSPs/Offshore convertor station platform foundations as well as cable protection for cable crossing. Maximum duration of the offshore construction phase is up to 96 months. Total piling phase of up to 372 days. **Decommissioning Phase** • up to 34,571,200 m^2 temporary subtidal habitat loss/disturbance due to: use of jack up vessels during decommissioning of wind turbine and OSPs/Offshore convertor station platform foundations; complete removal of inter-array, interconnector and offshore export cables; anchor placement during cable decommissioning; • increased SSCs and associated sediment deposition from: cutting and removal of piled jacket foundations and decommissioning of inter-array, interconnector and offshore export cables; and	Maximum design scenarios described for fish and shellfish receptors (volume 2, chapter 9 of the Offshore EIA Report) will result in the greatest potential impact.

[12] Impacts with a potential to occur during: C = Construction, O = Operation and maintenance, D = Decommissioning

[13] As presented in maximum design scenario table for the assessment of potential impacts on fish and shellfish ecology (see Table 9.15, volume 2, chapter 9).

Potential Impact	Phase[12] C	O	D	Maximum Design Scenario	Justification
				• up to 7,562,609 m² permanent subtidal habitat loss due to complete removal of cable protection and scour protection for inter-array, OSPs/Offshore convertor station platform interconnector and offshore export cables.	

Designed in measures relevant to the assessment of adverse effects on integrity

1009 There are no designed in measures of relevance to the assessments of potential effects on Annex II marine mammal features from changes to prey availability during construction and decommissioning.

Information to inform appropriate assessments

1010 The installation of infrastructure within the Proposed Development may lead to temporary subtidal habitat loss/disturbance as a result of a range of activities including use of jack-up vessels during foundation installation, installation of inter-array, interconnector and offshore export cables and associated seabed preparation, and anchor placements associated with these activities. There is the potential for temporary habitat loss/disturbance to affect up to 113,974,700 m² of seabed during the construction phase, which equates to 9.7% of the Proposed Development area, representing a relatively small proportion of the Proposed Development fish and shellfish ecology study area. Habitat loss/disturbance could potentially affect spawning, nursery or feeding grounds of fish and shellfish receptors. Due to the highly localised nature of the effects (i.e. spatially restricted to within the Proposed Development array area and Proposed Development export cable corridor) and the small proportion of habitats affected as a proportion of the northern North Sea fish and shellfish ecology study area and medium term duration, temporary habitat loss/disturbance during the construction phase was assessed as being of low risk to fish and shellfish communities.

1011 As suggested in volume 2, chapter 9 of the Offshore EIA Report, only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase with areas starting to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic infaunal species from the sediment (see volume 2, chapter 8 of the Offshore EIA Report), potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works. Most fish and shellfish receptors found within the Proposed Development fish and shellfish ecology study area are deemed to be of low vulnerability, high recoverability and local to international importance and therefore sensitivity of these receptors was considered to be low. However, sensitivity of some species has been assessed as medium, including larger crustacea (e.g. *Nephrops*, European lobster *Homarus gammarus*) and sandeel.

1012 The presence of infrastructure within the Proposed Development, including foundations and associated scour protection, cable protection, OSP/Offshore convertor station platform interconnector and offshore export cables will result in long term habitat loss of up to 7,798,856 m². Many species of fish and shellfish are reliant upon the presence of suitable sediment/habitat for their survival and therefore seabed habitats removed by installation of the infrastructure will reduce the area available for foraging, spawning and nursing. However, the area that will be impacted represents a very low proportion of the available habitat (0.7% of the Proposed Development fish and shellfish ecology study area). Moreover, as presented in more detail in volume 2, chapter 9 of the Offshore EIA Report, there is scientific evidence that presence of offshore wind farms is associated with an increase in density of soft sediment-associated fish species and of species associated with hard substrate. The sensitivity of fish and shellfish receptors ranged from low to medium with the majority of fish receptors deemed to be of low vulnerability, high recoverability and local to international importance.

1013 An increase in SSC and associated sediment deposition as a result of the installation of all wind turbines and offshore substation foundations and the installation of inter-array, interconnector and offshore export cables may result in short-term avoidance of affected areas by fish and shellfish. The maximum design scenario assessed in volume 2, chapter 9 of the Offshore EIA Report assumed all wind turbine and offshore substation foundations will be installed by drilling 5.5 m diameter piles and installation of inter-array cables through jet-trenching. Modelling of SSCs associated with the foundation installation showed the plume related directly to the sediment releases was < 5 mg/l and this drops to lower levels within a very short distance, typically < 500 m. Modelling of SSC for installation of inter-array and offshore export cables indicated concentrations of up to 500 mg/l and between 50 mg/l and 500 mg/l, respectively. Adult fish have high mobility and may show avoidance behaviour in areas of high sedimentation, however, there may be impacts on the hatching success of fish and shellfish larvae and consequential effects on the viability of spawning stocks due to limited mobility. Spawning grounds for sandeel overlap with the Proposed Development fish and shellfish ecology study area; eggs of these species are attached to the seabed for couple of weeks before hatching. Sandeel eggs are known to be tolerant to sediment deposition due to the nature of re-suspension and deposition within their natural high energy environment, therefore it is very likely that the effect on sandeel spawning populations will be limited. Herring spawning grounds are also found within the Proposed Development fish and shellfish ecology study area, however, herring eggs are tolerant of very high levels of SSC. Additionally, elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. It has been assessed that the impact of SSC and associated sediment deposition is likely to be localised, short term and intermittent.

1014 There is the potential for underwater noise and vibration during construction pile-driving to result in injury and/or disturbance to fish and shellfish communities (see volume 2, chapter 9 of the Offshore EIA Report). For SPL_{pk} and the maximum design scenario assessed (installation of one 5.5 m diameter pile with absolute maximum hammer energy of 4,000 kJ) in volume 2, chapter 9 of the Offshore EIA Report, the maximum recoverable injury range is estimated at 138 m to 228 m from the piling location. The potential for mortality or mortal injury to fish eggs would also occur at distances of up to 228 m. However, this is considered to be highly conservative due to the implementation of soft starts during piling operations which will allow fish to move away from the areas of highest noise levels, before the received noise reaches a level that would cause an injury. As such, the maximum injury ranges predicted for soft start initiation (i.e. of the order of tens of meters) are likely to be more realistic. For SEL_{cum}, subsea noise modelling showed that TTS, from which animals will recover, was predicted to occur out to a maximum distance of 4,161 m for single piling scenario at 4,000 kJ. The potential onset of behavioural effects (such as elicitation of a startle response, disruption of feeding, or avoidance of an area) may occur to ranges of approximately 17 km to 23 km. A qualitative assessment of behavioural effects in fish to underwater noise suggested, however, that responses will differ depending on the sensitivity of the species and the presence/absence of a swim bladder. For the least sensitive species (e.g. flatfish), the risk of behavioural effects is moderate to high in the nearfield (tens of metres) and intermediate field (i.e. hundreds of metres). For more sensitive species (e.g. herring, gadoids, sprat etc.) behavioural effects may occur further away from the source (i.e. over several kilometres or more from the source).

1015 With respect to indirect effects on marine mammals, no additional indirect effects other than those assessed for injury and disturbance to marine mammals as a result of elevated underwater noise during

piling (see paragraph 881 *et seq.*) have been predicted. This is because if prey were to be disturbed from an area as a result of underwater noise, it is assumed that marine mammals would be disturbed from the same or greater area, and so any changes to the distribution of prey resources would not affect marine mammals as they would already be disturbed from the same (or larger) area.

1016 On the basis of the assessments presented in volume 2, chapter 9 of the Offshore EIA Report, no significant adverse effects have been predicted to occur to fish and shellfish species (marine mammal prey) as a result of the construction of the Proposed Development.

1017 Decommissioning activities such as use of jack-up vessels during foundation removal, removal of inter-array, interconnector and offshore export cables, and associated anchor placements may result in temporary habitat loss/disturbance of up to 34,571,200 m^2. The impact is predicted to be of localised extent and affect only a small proportion of this total area at any one time during the decommissioning phase.

1018 Decommissioning of infrastructure will lead to increases in SSC and associated sediment deposition. The maximum design scenario is represented by the cutting and removal of piled jacket foundations at seabed level and removal of inter-array, OSP/Offshore convertor station platform interconnector and offshore export cables by jet dredging mobilising material from a 0.5 m deep and 2 m wide trench.

1019 Leaving infrastructure, such as the scour protection associated with wind turbine and OSP/Offshore convertor station platform foundations and cable protection associated with array, OSP/Offshore convertor station platform interconnector and offshore export cables, *in situ* after decommissioning will result in permanent habitat loss with a maximum design scenario of up to 7,562,609 m^2. An overview of potential impacts to fish and shellfish receptors and sensitivity conclusions were previously presented in paragraph 1012 *et seq*.

1020 The impact on marine mammals is therefore predicted to be of local spatial extent, medium term duration, intermittent and of high reversibility. The assessment of the effect of changes in fish and shellfish communities affecting prey availability on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

Relevant information of Annex II marine mammals

1021 Marine mammals exploit a range of different prey items and can forage widely, sometimes covering extensive distances. Given that the impacts of construction to prey resources will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat in the northern North Sea. Marine mammals occurring within this small impact area also have the potential to be directly affected as a result of impacts such as injury and disturbance from elevated underwater noise during piling and it is likely that the effects to prey resources (e.g. behavioural displacement) will occur over a similar, or lesser, extent and duration as those for marine mammals. There would, therefore, be no additional displacement of marine mammals as a result of any changes in prey resources during construction, as they would already be potentially disturbed as a result of underwater noise during piling. In addition, as prey resources are displaced from the areas of potential impact, marine mammals are likely to follow in order to exploit these resources.

1022 Following placement on the seabed, submerged parts of the wind turbines provide hard substrate for the colonisation by high diversity and biomass in the flora and fauna. Faecal deposits of dominant communities of suspension feeders are likely to alter the surrounding seafloor communities by locally increasing food availability (Degraer *et al*., 2020). Higher trophic levels, such as fish and marine mammals, are likely to profit from locally increased food availability and/or shelter and therefore have the potential to be attracted to forage within offshore wind farm array area. However, still relatively little is known about the distribution and diversity of marine mammals around offshore anthropogenic structures. Species such as harbour porpoise, minke whale, white-beaked dolphin, harbour seal and grey seal were frequently recorded around offshore oil and gas structures (Todd *et al*., 2016; Delefosse *et al*., 2018; Lindeboom *et al*., 2011). Acoustic results from a T-POD measurement within a Dutch wind farm found that relatively more harbour porpoises are found in the wind farm area compared to the two reference areas (Scheidat *et al*., 2011; Lindeboom *et al*., 2011). Authors of this study concluded that this effect is directly linked to the presence of the wind farm due to increased food availability as well as the exclusion of fisheries and reduced vessel traffic in the wind farm (shelter effect). Russell *et al.* (2014) monitored the movements of tagged harbour seals within two active wind farms in the North Sea and demonstrated that animals commonly showed grid-like movement patterns which strongly suggested that the structures were used for foraging. During research on a Danish wind farm, no statistical differences were detected in the presence of harbour porpoises between inside and outside the wind farm (Diederichs *et al*., 2008). Diederichs *et al*. (2008) suggested, however, that a small increase in detections during the night at hydrophones deployed in close proximity to single wind turbines may indicate increased foraging behaviour near the monopiles. Whilst there is some mounting evidence of potential benefits of man-made structures in marine environment (Birchenough and Degrae, 2020), the statistical significance in EIA terms of such benefits and details about trophic interactions in the vicinity of artificial structures and their influence on ecological connectivity remain largely unknown (Petersen and Malm, 2007; Inger *et al*., 2009; Rouse *et al.,* 2020, McLean *et al.,* 2022; Elliott and Birchenough, 2022).

Grey seal

1023 Along the Scottish coast, grey seals exhibit an offshore foraging behaviour (Damseaux *et al*., 2021). Grey seal has a selective diet, mostly comprising flatfish and sandeel. A study on the diet of grey seals in Scottish waters found that 50% of prey items were plaice and sole *Solea solea* and 46% of prey items were sandeel (Damseaux *et al*., 2021). Hammond *et al*. (2001) corroborated this finding and highlighted sandeel as an important prey item for grey seals in Scottish waters where they account for approximately 50% of the diet. Gosch (2017) reported that there are significant regional and temporal differences in the diet of grey seal. Seals in shallow waters show a preference for demersal and groundfish species such as cephalopods and flatfish, whilst seals foraging in deeper waters, over sandy substrates, will target pelagic and bentho pelagic species such as blue whiting *Micromesistius poutassou* and sandeel (Gosch, 2017).

1024 Grey seals tend to forage in the open sea, returning to land regularly to haul out. Foraging trips can be wide-ranging, however, tracking studies have shown that most foraging is likely to occur within 100km of a haul out site (SCOS, 2018). Grey seal are deemed to be of low vulnerability, high recoverability and overall low sensitivity.

Harbour seal

1025 Harbour seals are central place foragers, requiring haul-out sites on land for resting, moulting and breeding, and dispersing from these sites to forage at sea. In order to reduce time and energy searching for prey, animals are likely to travel directly to areas of previously or predictably high foraging success (Bailey *et al.,* 2014). Harbour seals tend to stay within 50 km of the coast, although most foraging trips are over shorter ranges (Russell and McConnell, 2014; supported by tagging studies in SCOS, 2018). Since females need to regularly return to their pups at the haul-out site, they may be more limited in foraging distance. Because of the constraint on their foraging range, particularly during the breeding season, harbour seals may be particularly vulnerable to changes in prey abundance (Bailey *et al.*, 2014).

1026 Harbour seals are generalist feeders and their diet varies both seasonally and from region to region (Hammond *et al.*, 2001). The analysis of stable isotopic composition and concentration of Hg and Se ions in blood of harbour seals from the North Sea demonstrated that harbour seal diet comprised 30% juvenile cod, 29% plaice and 23% monkfish as well as European hake and haddock (Damseaux *et al*., 2021).

1027 There may be an energetic cost associated with increased travelling and harbour seal may be particularly vulnerable to this effect as individuals typically forage close to haul out sites (i.e. within nearest 50 km). Despite this, if animals do have to travel further to alternative foraging grounds, the impacts are expected to be short-term in nature and reversible. It is expected that all harbour seals would be able to tolerate the effect without any impact on reproduction and survival rates and would be able to return to previous activities once the impact had ceased. Harbour seal are deemed to be of low vulnerability, high recoverability and overall low sensitivity.

Harbour porpoise

1028 Harbour porpoise has a higher metabolic rate than dolphins and therefore need to feed more frequently and consume more prey per unit body weight, in order to maintain their body temperature and other energy needs (Rojano-Doñate *et al*., 2018). For this reason, porpoise may be highly susceptible to changes in the abundance of prey species or disturbance from foraging areas. Harbour porpoise feed on a wide range of fish species, but mainly small shoaling species from demersal or pelagic habitats (Santos and Pierce, 2003; Aarfjord, 1995). There are regional and seasonal differences in diet; interannual variation depending on the availability of prey species and ontogenetic variation (adults and juveniles), with juveniles targeting smaller species such as gobies (*Gobiidae*) or smaller individuals of the same prey species targeted by adults (Santos and Pierce, 2003). A harbour porpoise's field metabolic rate remains stable over seasonally changing water temperatures. Heat loss is deemed to be managed via cyclical fluctuations in energy intake to build up a blubber layer that offsets the extra cost of thermoregulation during winter (Rojano-Doñate *et al*., 2018). Ransijn *et al.* (2019) produced energy maps for various harbour porpoise prey species and found that the energy available in the North Sea is highest during the summer and the main energic contributions were from sandeel and whiting *Merlangius merlangus*. During the winter season European sprat *Sprattus sprattus* and Atlantic herring *Clupea harengus* also contributed to the overall energy density (Ransijn *et al.,* 2019). This study corroborated findings of previous harbour porpoise off the east coast of Scotland which reported that sandeel is the dominant prey item during summer (Santos *et al*., 2004).

1029 Harbour porpoise regularly forage around tidal races, overfalls, and upwelling zones during the ebb phase of the tide (Pierpoint, 2008). Embling *et al.* (2010) analysed results of dedicated surveys conducted in the southern Inner Hebrides and found that maximum tidal current is the best environmental explanation of persistent harbour porpoise abundance, although in contrast to other studies, they found that densities were higher in areas of low current. Although harbour porpoise generally hunts alone or in small groups, this species is often seen in larger aggregations of 50 or more individuals, either associated with food concentrations or seasonal migrations. Within these loose aggregations, segregation may occur, with females travelling with their calves and yearlings, and immature animals of each sex being segregated into groups.

1030 The fish and shellfish communities found within the fish and shellfish ecology study area (see chapter 9) are characteristic of the fish and shellfish assemblages in the northern North Sea. It is therefore reasonable to assume that, due to the highly mobile nature of marine mammals, there will be similar prey resources available in the wider area. There may be an energetic cost associated with increased travelling and harbour porpoise may be particularly vulnerable to this effect. Harbour porpoise has a high metabolic rate and only a limited energy storage capacity, which limits their ability to buffer against diminished food. Despite this, if animals do have to travel further to alternative foraging grounds, the impacts are expected to be short term in nature and reversible. It is expected that all marine mammal receptors would be able to tolerate the effect without any impact on reproduction and survival rates and would be able to return to previous activities once the impact had ceased. Harbour porpoise are deemed to be of low vulnerability, high recoverability and overall low sensitivity.

Bottlenose dolphin

1031 There is variation in the patterns of habitat use of bottlenose dolphin, even within a population, and generally the distribution of this species is influenced by factors such as tidal state, weather conditions, resource availability, life cycle stage, or season (Hastie *et al.,* 2004). Typical prey items in Scottish waters include cod *Gadus morhua*, saithe *Pollachius virens*, whiting, salmon *Salmo salar* and haddock *Melanogrammus aeglefinus* (Santos *et al.,* 2001).

1032 There is a seasonal pattern of a higher intensity of bottlenose dolphin movement from the Tay estuary and adjacent waters to the Moray Firth SAC in early summer months, and from the Moray Firth SAC to the Tay estuary and adjacent waters in late summer. These are anticipated to be driven by environmental and biological factors (Arso Civil *et al.,* 2021). Wilson *et al*. (1997) and Hastie *et al*. (2004) reported that these two areas share topographically distinct characteristics with increased observations of dolphins foraging. Seasonal changes in prey presence over variable temporal scales throughout the year may therefore enable dolphins to exploit these areas within their range at different times.

1033 Bottlenose dolphin are deemed to be of low vulnerability, high recoverability and overall low sensitivity.

7.4 OPERATION AND MAINTENANCE

7.4.1 UNDERWATER NOISE

1034 Increases in underwater noise associated with the operation and maintenance of the Proposed Development have the potential to cause injury and disturbance to marine mammals. Underwater noise assessment of effects of has been informed by subsea noise modelling, the scope of which was agreed through the Road Map process (volume 3, appendix 10.2 of the Offshore EIA Report).

1035 This section addresses the underwater noise effects associated with the operation and maintenance phase of the proposed project. For each type of underwater noise effect, the nature of the effect is described, the source activities generating the effect and the potential changes to marine mammal receptors are outlined. Effects are categorised as permanent or temporary.

1036 The subsequent sub-sections provide more information on each of these underwater noise effects and the sensitivity of the Annex II marine mammal features to these effects:

- a summary of the relevant components of the Proposed Development, outlined in the maximum design scenario (Table 7.39) and designed in measures (Table 7.40);
- an overview of the methodology/modelling/assessment undertaken to quantify and assess underwater noise effects on marine mammals; and
- an overview of relevant marine mammal information gathered to aid the assessment.

Maximum design scenario relevant to the assessment of adverse effects on integrity

1037 The maximum design scenarios considered for the assessment of potential impacts on Annex II marine mammal features from underwater noise during the operation and maintenance phases are set out in Table 7.39.

Table 7.39: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Underwater Noise during Operation and Maintenance

Parameter	Source-Receptor Pathways	Justification
Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	Routine geophysical surveys of wind turbine foundations, estimated to occur every six months for first two years and annually thereafter (approximately 37 surveys over the 35 year life cycle of the Proposed Development). It is assumed that approximately 10% of the inter-array cable length will require inspections each year (more if issues are found). Offshore export cables surveyed annually.	Maximum range of geophysical and geotechnical activities likely to be undertaken using equipment typically employed for these types of surveys.
Disturbance of marine mammals from elevated underwater noise due to vessel use and other activities	Vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth, replacement of access ladders, and geophysical surveys; maximum vessels on site at any one time including: • up to 4 CTVs making up to 832 return trips per year. • up to 1 jack up vessel making up to 2 return trips per year. • up to 2 support vessels making up to 26 return trips per year. • up to 1 cable repair vessel making up to 5 return trips per operational lifetime. • up to 2 service operations vessels (SOV, daughter craft) making up to 4 movements within Proposed Development array area per day; • up to 1 cable survey vessel making 1 return trip per year; and • up to 1 excavator/backhoe dredger making up to 5 return trips over operational lifetime.	Maximum numbers of vessels on site at any one and largest numbers of round trips during each phase of development and broad range of vessel types representative of vessels to be used during operation and maintenance. Range of other activities including maximum timescales (where available) during which activities are conducted.

Designed in measures relevant to the assessment of adverse effects on integrity

1038 Designed in measures (and the associated commitments) of relevance to the assessments of potential impacts on Annex II marine mammal features from underwater noise during operation and maintenance are set out in Table 7.40.

Table 7.40: Designed in Measures Relevant to the Assessment of Adverse Effects on Integrity on European Sites Designated for Annex II Marine Mammal Features from Underwater Noise During Operation and Maintenance

Effect/Impact Pathway	Detail of Measure	Justification
Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	A MMMP will include geophysical surveys to ensure that appropriate measures are followed in line with JNCC guidance (JNCC, 2017).	The measures outlined in JNCC guidelines (JNCC, 2017) are designed to reduce the risk of injury to marine mammals during geophysical survey activities.

Site investigation surveys

1039 Site investigation surveys during the operation and maintenance phase have the potential to cause direct or indirect effects (including injury or disturbance) on Annex II marine mammals. A detailed underwater noise modelling assessment has been carried out to investigate the potential for injurious and behavioural effects on marine mammals as a result of geophysical and geotechnical surveys, using the latest criteria (volume 3, appendix 10.1 of the Offshore EIA Report), which is drawn upon in the appropriate assessments presented below.

1040 The maximum design scenario comprises of routine geophysical surveys estimated to occur every six months for first two years and annually thereafter. This equates to up to 37 surveys over the 35-year life cycle of Proposed Development (Table 7.39).

Auditory injury and behavioural disturbance

1041 Vessel use during the operation and maintenance phase of the Proposed Development may lead to injury and/or disturbance to marine mammals. The maximum design scenario is for up to 2,323 vessel round trips per year over the operational lifetime of the Project. Vessel types which will be required during the operation and maintenance phase include those used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth, replacement of access ladders, and geophysical surveys (Table 7.39).

1042 An overview of potential impacts from auditory injury due to elevated underwater noise during geophysical site investigation surveys is described in paragraph 945 *et seq.* for the construction phase and has not been reiterated here for the operation and maintenance phase. Similarly, the magnitude of potential impacts for behavioural disturbance to marine mammals is described in paragraph 955 *et seq.* The magnitude of the impact of underwater noise from geophysical surveys during operation and maintenance phase could result in a negligible alteration to the distribution of marine mammals. Surveys are anticipated to be short-term in nature (weeks to a few months) and occur intermittently over the operation and maintenance phase.

1043 With designed in measures implemented for the geophysical surveys, the impact is predicted to be of local to regional spatial extent, short-term duration, intermittent and low reversibility (PTS) or high reversibility (behaviour). It is predicted that the impact will affect the receptor directly. The assessment of the effect of underwater noise due to site investigation surveys on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

Vessel use and other activities

1044 The uplift in vessel activity during the operation and maintenance is considered to be relatively small in the context of the baseline levels of vessel traffic in the Proposed Development marine mammal study area described in paragraphs 989 *et seq.* Presence of the operational wind farm may divert some of the shipping routes and therefore, current traffic within the Proposed Development array area, which is not associated with Proposed Development, is likely to be reduced. The extent of that change cannot be quantified at the time of writing, however, it is anticipated this reduction will be ultimately counterbalanced by presence of maintenance vessels. Vessel movements will be within the Proposed Development array area and Proposed Development export cable corridor and will follow existing shipping routes to/from the ports. In addition, Codes of Conduct will be issued to all project vessel operators.

1045 The size and noise outputs from vessels during the operation and maintenance phase will be similar to those used in the construction phase and therefore will result in a similar maximum design spatial scenario

(paragraph 988 *et seq*.). However, the number of vessel round trips and their frequency is much lower for the operation and maintenance phase compared to the construction phase.

Auditory injury

1046 An overview of potential impacts for auditory injury to marine mammals from elevated underwater noise due to vessel use and other activities is described in paragraph 988 *et seq*. for the construction phase with effect ranges presented in Table 7.35 and Table 7.36 and have not been reiterated here for the operation and maintenance phase. The impact is predicted to be of local spatial extent, long term duration, intermittent and low reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of injury from underwater noise due to site investigation surveys on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

Behavioural disturbance

1047 An overview of potential impacts for behavioural disturbance to marine mammals from elevated underwater noise due to vessel use and other activities is described in paragraph 995 *et seq*. for the construction phase with impact ranges presented in Table 7.37 and have not been reiterated here for the operation and maintenance phase. The impact is predicted to be of local spatial extent, long term duration, intermittent and high reversibility. It is predicted that the impact will affect the receptor directly. The assessment of the effect of behavioural disturbance from underwater noise due to site investigation surveys on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

7.4.2 CHANGES IN PREY AVAILABILITY

1048 Potential impacts on marine mammal prey species during the operation and maintenance phase have been assessed in volume 2, chapter 9 of the Offshore EIA Report using the appropriate maximum design scenarios for these receptors. These impacts include temporary subtidal habitat loss/disturbance, long-term subtidal habitat loss, increased SSC and associated sediment deposition, EMF from subsea electrical cabling and colonisation of foundations, scour protection and cable protection and the findings are summarised here.

Maximum design scenario relevant to the assessment of adverse effects on integrity

1049 The maximum design scenarios considered for the assessment of potential impacts on Annex II marine mammal features from changes in prey availability during the operation and maintenance phase are set out in Table 7.41 below.

Table 7.41: Maximum Design Scenarios Considered for the Assessment of Potential Impacts on Annex II Marine Mammal Features from Changes in Prey Availability During Operation and Maintenance

Potential Impact	Maximum Design Scenario	Justification
Changes in fish and shellfish communities affecting prey availability	• up to 989,000 m^2 temporary subtidal habitat loss/disturbance due to: major component replacements for wind turbines and OSP/Offshore convertor station platforms; inter-array, interconnector and offshore export cable repair/reburial events; • increased SSCs and associated sediment deposition from cable repair/reburial events; • up to 7,798,856 m^2 of long term subtidal habitat loss due to presence of: wind turbines on suction caisson foundations and 10 OSP/Offshore convertor station platforms on jacket foundations with associated scour protection; cable protection associated with inter-array, interconnector and offshore export cables; cable protection for cable crossings; • EMF from subsea electrical cabling due to presence of inter-array and offshore export cables; • colonisation of foundations, scour protection and cable protection leading to long term habitat creation of up to 10,198,971 m^2; and • EMF from presence of up to 1,225 km of 66 kV inter-array cables and up to 872 km of 275 kV HVAC offshore export cables.	Maximum adverse scenarios described for fish receptors.

Designed in measures relevant to the assessment of adverse effects on integrity

1050 There are no designed in measures of relevance to the assessments of potential effects on Annex II marine mammal features from changes to prey availability during operation and maintenance.

Information to inform Appropriate Assessments

1051 There is the potential for up to 989,000 m^2 of temporary habitat loss/disturbance during the operation and maintenance phase as a result of the use of jack-up vessels during any component replacement activities and during any inter-array, OSP/Offshore convertor station platform interconnector and offshore export cable repair activities. These impacts will be similar to those identified for temporary habitat loss/disturbance the construction phase (as discussed in paragraph 1010) and will be highly restricted to the immediate vicinity of these operations.

1052 The presence of infrastructure within the Proposed Development, will result in long term habitat loss of up to 7,798,856 m^2 during the operation and maintenance phase (0.7% of the Proposed Development fish and shellfish ecology study area). An overview of potential impacts to fish and shellfish receptors and sensitivity conclusions were previously presented in paragraph 1012 for construction phase and will not be reiterated here for operation and maintenance phase.

1053 Increased SSC could occur as a result of repair or remedial burial activities during the operation and maintenance phase. The maximum design scenario assessed in volume 2, chapter 9 of the Offshore EIA Report for increased SSC and associated deposition is for the repair of cables of up to 30,000 m in length and reburial of cables of up to 10,000 m in length for inter-array cables; and repair of cables of up to 4,000 m in length and reburial of cables of up to 4,000 m in length for offshore export cables, using similar methods as those for cable installation activities (e.g. jet-trenching), undertaken at intervals over the 35 years operation and maintenance phase. The assessment in volume 2, chapter 9 of the Offshore EIA

Report considered that any suspended sediments and associated deposition will be of the same magnitude, or lower as for construction.

1054 The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. Species for which there is evidence of a response to electrical and/or magnetic fields include elasmobranchs (sharks, skates and rays), river lamprey *Lampetra fluviatilis,* sea lamprey *Petromyzon marinus*, European eel *Anguilla ecommis*, plaice and Atlantic salmon *Salmo salar* (Gill *et al*., 2005, CSA, 2019). A range of their life functions is supported by either electric or magnetic sense, including detection of prey, predator avoidance, social or reproductive behaviours, orientation, homing, and navigation (Gill *et al*., 2005; Normandeau *et al*., 2011). The range over which species can detect EMF will be very localised to within a few centimetres of the buried cable, with rapid decay of the EMF with increasing distance.

1055 Artificial structures introduced to the marine environment, such as wind turbine foundations and scour/cable protection, provide hard substrate for settlement of various organisms, including small crustaceans and polychaete worms. These communities can provide a valuable food source for fish species and therefore, hard substrate habitat is likely to be colonised within days after construction by demersal and semi-pelagic species. The maximum design scenario assessed in volume 2, chapter 9 of the Offshore EIA Report assumes up to 10,198,971 m^2 of habitat created due to the installation of jacket foundations, associated scour protection and cable protection associated with inter-array cables, OSP/Offshore convertor station platform interconnector cables and offshore export cables. The dominant natural substrate character (e.g. soft sediment or hard rocky seabed) will determine the number of new species found on the introduced vertical hard surface and associated scour protection. When placed on a soft seabed, most of the colonising fish tend to be associated with hard bottom habitats, thus the overall diversity of the area is expected to increase. If infrastructure is introduced to the area of rocky substrates, few species will be added to the area, but the increase in total hard substrate could sustain higher abundance (Andersson *et al*., 2009).

1056 The impact on marine mammals is predicted to be of local spatial extent, long-term duration, continuous and the effect on marine mammals is of high reversibility. The assessment of the effect of changes in fish and shellfish communities affecting prey availability on grey seal, harbour seal, harbour porpoise and bottlenose dolphin as features of relevant designated sites is provided in section 7.6.

7.5 RELEVANT INFORMATION ON ANNEX II MARINE MAMMALS

7.5.1 SENSITIVITY TO AUDITORY INJURY

Elevated underwater noise during piling and vessel activity/other activities

Grey seal and harbour seal

1057 Seals are less dependent on hearing for foraging than cetacean species, but may rely on sound for communication and predator avoidance (e.g. Deecke *et al*., 2002). Seals detect swimming fish with their vibrissae (Shulte-Pelkum *et al*., 2007) but, in certain conditions, they may also listen to sounds produced by vocalising fish in order to hunt for prey. Thus, the ecological consequences of a noise induced threshold shift in seals are a reduction in fitness, reproductive output and longevity (Kastelein *et al*., 2018a). Hastie *et al*., (2015) reported that, based on calculations of SEL of tagged harbour seals during the construction of the Lincs Offshore Wind Farm (Greater Wash, UK), at least half of the tagged seals would have received sound levels from pile driving that exceeded auditory injury thresholds for pinnipeds (PTS). However, population estimates indicated that the relevant population trend is increasing and therefore, although there are many other ecological factors that will influence the population health, this indicated that predicted levels of PTS did not affect a sufficient number of individuals to cause a decrease in the population trajectory (Hastie *et al*., 2015). Hastie *et al*. (2015), however, noted that due to paucity of data on effects of sound on seal hearing, the exposure criteria used are intentionally conservative and therefore predicted numbers of individuals likely to be affected by PTS would also have been highly conservative.

1058 There is some evidence of noise-induced PTS in harbour seals, with the first confirmed report of PTS following a known acoustic exposure event in a marine mammal (Reichmuth *et al.,* 2019). The underwater hearing sensitivity of a trained harbour seal was evaluated before and immediately following exposure to 4.1 kHz tonal fatiguing stimulus, and rather than the expected pattern of TTS onset and growth, an abrupt threshold shift of > 47 dB was observed half an octave above the exposure frequency. While hearing at 4.1 kHz recovered within 48 h, there was a permanent threshold shift of at least 8 dB at 5.8 kHz, and hearing loss was evident for more than ten years.

1059 Despite the uncertainty in the ecological effects of PTS on seals, seals rely on hearing much less than cetaceans and therefore would exhibit some tolerance (i.e. the effect is unlikely to cause a change in either reproduction or survival rates). In addition, it has been proposed that seals may be able to self-mitigate (i.e. reduce their hearing sensitivity in the presence of loud sounds in order to reduce their perceived SPL) (Kastelein *et al*., 2018a). Although this evidence suggests a lower sensitivity of pinnipeds to PTS, based on uncertainties a precautionary approach has been taken.

1060 The telemetry data confirmed connectivity between Firth of Tay and Eden Estuary SAC, designated for harbour seal, and the Proposed Development marine mammal study area. The population of harbour seal is mostly concentrated within the Firth of Tay and Eden Estuary SAC and Firth of Forth, however the population within the Tay SAC is continuing to decline without indication of recovery within last 20 years (see volume 3, appendix 10.2 of the Offshore EIA Report for more information). Population modelling work conducted for the Firth of Tay and Eden Estuary SAC population has concluded that if this declining trend continues, the population may become extinct within the next 20 years (Hanson *et al*., 2017). Although it is unknown what is the reason for this decline, this population is deemed sensitive to any additional anthropogenic disturbance, especially during the breeding season (spring and summer). No population trajectory is available for Firth of Forth, although sporadic counts in the area indicate that the decline is localised within the SAC and may not represent the trends in the overall MU population (SCOS, 2020; Sinclair *et al.,* 2020). As outlined in paragraph 1026 *et seq*., harbour seals are generalist feeders and can forage on variety of species, usually within 50 km from the coast. Individuals may be particularly sensitive to anthropogenic disturbance or changes in prey distribution especially during breeding season.

1061 Grey seal and harbour seals, IEFs of international value, are deemed to be of medium vulnerability and low recoverability. The sensitivity of the receptor to PTS from elevated underwater noise during piling, vessel activity and other activities is therefore, considered to be high.

Harbour porpoise

1062 Scientific understanding of the biological effects of threshold shifts is limited to the results of controlled exposure studies on small numbers of captive animals (reviewed in Finneran 2015) where TTS are experimentally induced (since it is unethical to induce PTS in animals) and thresholds for PTS extrapolated using TTS growth rates.

1063 Studies of auditory injury in relation to a typical piling sequence have suggested that hearing impairment as a result of exposure to piling noise is likely to occur where the source frequencies overlap the range of peak sensitivity for the receptor species rather than across the whole frequency hearing spectrum (Kastelein *et al.,* 2013). Kastelein *et al.* (2013) demonstrated experimentally that for simulated piling noise (broadband spectrum), harbour porpoise's hearing around 125 kHz (the key frequency for echolocation)

was not affected. Instead, a measurable threshold shift in hearing was induced at frequencies of 4 kHz to 8 kHz, although the magnitude of the hearing shift was relatively small (2.3 dB to 3.6 dB at 4 kHz to 8 kHz) due to the lower received SELs at these frequencies. This was due to most of the energy from the simulated piling occurring in lower frequencies (Kastelein *et al*., 2013). Subsequently, Kastelein *et al*. (2017) confirmed sensitivity declined sharply above 125 kHz. The susceptibility of harbour porpoise to threshold shifts was further corroborated in a series of studies measuring temporary shifts in hearing in harbour porpoise at high amplitude frequencies of 0.5 kHz to 88.4 kHz. Here the greatest shift in mean TTS occurred at 0.5 kHz, which is very close to the lower bound of porpoise hearing (Kastelein *et al.,* 2021). Hearing always recovered within 60 minutes after the fatiguing sound stopped.

1064 In addition to the frequency characteristics of the source, the duty cycle of fatiguing sounds is also likely to affect the magnitude of a hearing shift. Kastelein *et al*. (2014) suggested that hearing may recover to some extent during inter-pulse intervals. Similarly, Finneran (2015) highlighted that whilst a threshold shift can accumulate across multiple exposures, the resulting shift will be less than the shift from a single, continuous exposure with the same total SEL.

1065 There is some evidence of self-mitigation by cetaceans to minimise exposure to sound. The animal can change the orientation of its head so that sound levels reaching the ears are reduced, or it can suppress hearing sensitivity by one or more neurophysiological auditory response control mechanisms in the middle ear, inner ear, and/or central nervous system. Kastelein *et al.* (2020) highlighted the lack reproducibility of TTS in a harbour porpoise after exposure to repeated airgun sounds and suggested the discrepancies may be due to self-mitigation.

1066 Extrapolating the results from captive bred studies to how animals may respond in the natural environment should, however, be treated with caution as it is not possible to exactly replicate natural environmental conditions. In addition, the small number of test subjects would not account for intraspecific differences (i.e. differences between individuals) or interspecific differences (i.e. extrapolating to other species) in response. However, based on our current understanding, since PTS is a permanent and irreversible hearing impairment it is expected that harbour porpoise is sensitive to this effect as the loss of hearing would affect key life functions (e.g. communication, predator detection, foraging, mating and maternal fitness) and could lead to a change in an animal's health (if chronic) or vital rates (if acute) (Erbe *et al*., 2018). Morell *et al*. (2021) showed the first case of presumptive noise-induced hearing loss, based on inner ear analysis in a free-ranging harbour porpoise. Subject to the limitations of available empirical evidence a potential consequence of a disruption in key life functions is that the health of impacted animals would deteriorate and potentially lead to reduced birth rate in females and mortality of individuals (Costa, 2012).

1067 Given the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication in all cetaceans, harbour porpoise, an IEF of international value, is deemed to be of high vulnerability and low recoverability. The sensitivity of the receptor to PTS from elevated underwater noise during piling, vessel activity and other activities is therefore, considered to be high.

Bottlenose dolphin

1068 Individual dolphins experiencing PTS would suffer a biological effect that could impact the animal's health and vital rates (Erbe *et al*., 2018). Bottlenose dolphin is classed as high-frequency cetaceans (Southall *et al*., 2019). There are frequency-specific differences in the onset and growth of a noise-induced threshold shift in relation to the characteristics of the noise source and hearing sensitivity of the receiving species. For example, exposure of two captive bottlenose dolphins to an impulsive noise source between 3 kHz and 80 kHz found that there was increased susceptibility to auditory fatigue between frequencies of 10 to 30 kHz (Finneran and Schlundt, 2013). The SEL_{cum} threshold incorporates hearing sensitivities of marine mammals and the magnitude of effects were considerably smaller compared to the very high frequency (e.g. harbour porpoise) and low frequency (e.g. minke whale) species, highlighting that high frequency species are less sensitive to the frequency components of the piling noise signal. The assessment considered the irreversibility of the effects (i.e. as noted for harbour porpoise) and importance of sound for echolocation, foraging and communication in small, toothed cetaceans.

1069 Given the uncertainty surrounding the effects of PTS on survival and reproduction and the importance of sound for echolocation, foraging and communication in all cetaceans, bottlenose dolphin, IEF of international value, is deemed to be of high vulnerability and low recoverability. The sensitivity of the receptor to PTS from elevated underwater noise during piling, vessel activity and other activities is therefore, considered to be high.

Elevated underwater noise as a result of site-investigation surveys

Grey seal, harbour seal, harbour porpoise, bottlenose dolphin

1070 For geotechnical surveys, injury to marine mammals is unlikely to occur beyond a few tens of metres (i.e. up to 60 m for harbour porpoise) and noise from vessels themselves is likely to deter marine mammals beyond this range. The maximum range for PTS from geophysical surveys (SBP) is 360 m. Sills *et al*. (2020) evaluated TTS onset levels for impulsive noise in seals following exposure to underwater noise from a seismic air gun and found transient shifts in hearing thresholds at 400 Hz were apparent following exposure to four to ten consecutive pulses (SEL_{cum} 191 dB – 195 dB re 1 μPa^2s; 167 dB – 171 dB re 1 μPa^2s with frequency weighting for phocid carnivores in water).

1071 Marine mammals, which are IEFs of international value, are deemed to be of medium vulnerability and low recoverability. The sensitivity of the receptor to PTS from elevated underwater noise during site investigation surveys is therefore, considered to be high.

Elevated underwater noise as a result of UXO clearance

Grey seal, harbour seal, harbour porpoise, bottlenose dolphin

1072 The acoustical properties of explosives are characterised by a short shock wave, comprising a sharp rise in pressure followed by an exponential decay with a time constant of a few hundred microseconds (see volume 3, appendix 10.1 of the Offshore EIA Report). The interactions of the shock and acoustic waves create a complex pattern in shallow water, and this was investigated further by Von Benda-Beckmann *et al*. (2015). As harbour porpoises have high sensitivity to noise, impacts on these species are most often assessed in a scientific literature.

1073 Von Benda-Beckmann *et al*. (2015) investigated the range of effects of explosives on harbour porpoise in the southern North Sea. The study measured SEL and peak overpressure (in kPa) at distances up to 2 km from the explosions of seven aerial bombs detonated at approximately 26 m to 28 m depth, on a sandy substrate. Six bombs had a charge mass of 263 kg (580 lb) and one had a charge mass of 121 kg (267 lb). The study looked at the potential for injury to occur as an ear trauma caused by the blast wave at a peak overpressure of 172 kPa (190 dB re. 1µPa). Furthermore, the potential for noise-induced PTS to occur was based on a threshold of 190 dB re. $1\mu Pa^2s$ (PTS 'very likely to occur') and an onset threshold of 179 dB re. $1\mu Pa^2s$ (SEL) (PTS 'increasingly likely to occur') (Lucke *et al*. (2009) criteria). The results suggested that the largest distance at which a risk of ear trauma could occur was at 500 m and that noise-induced PTS was likely to occur greater than the 2 km range that was measured during the study since the SEL recorded at this distance was 191 dB re. $1\mu Pa^2s$ (i.e. 1 dB above the 'very likely to occur' threshold).

1074 In the same study Von Benda-Beckmann *et al*. (2015) modelled possible effect ranges for 210 explosions (of up to 1,000 kg charge mass) that had been logged by the Royal Netherland Navy (RNLN) and the Royal Netherlands Meteorological Institute (RNMI) over a two year period (2010 and 2011). Using the empirical measurements of SEL out to 2 km to validate the model (described above in paragraph 1073), the authors found that the effect distances ranged between hundreds of metres to just over 10 km (for charges ranging from 10 kg up to 1,000 kg). Near the surface, where porpoises are known to spend a large proportion of time (e.g. 55% based on Teilmann *et al*., 2007) the SELs were predicted to be lower with effect distances for the onset of PTS just below 5 km. The authors caveat these results as, whilst the model could provide a reasonable estimate of the SEL within 2 km (since the empirical measurements were made out to this point), estimates above this distance required further validation since the uncorrected model systematically overestimated SEL. Salomons *et al*. (2021) analysed the sound measurements performed near two detonations of UXO (charge masses of 325 kg and 140 kg). From the weighted SEL values and threshold levels from Southall *et al*. (2019), a PTS effect distance in the range 2.5 km – 4 km has been derived (Salomons *et al*., 2021).

1075 By comparing experimental data and model predictions, Salomons *et al*. (2021) found thar harbour porpoises are at risk of permanent hearing loss at distances of several kilometres from large explosives, (i.e. distance between 2 km and 6 km based on 140 kg and 325 kg charge masses). Following clearance of ground mines in the Baltic Sea in 2019, 24 harbour porpoises were found dead in the period after those clearing events along the coastline (Siebert *et al*., 2022). The post-mortem examination found that in ten cases the cause of death was associated with a blast injury, however the charge masses of the explosives in this study are unknown (Siebert *et al*., 2022).

1076 Not much is known about sensitivity of bottlenose dolphin to blasting. However, during a clearance of relatively small explosive (35 kg charge) at an important feeding area for a resident community of bottlenose dolphin in Portugal, acoustic pressure levels in excess of 170 dB e 1µPa were measured. Despite pressure levels being 60 dB higher than ambient noise, no adverse effects were recorded in the behaviour or appearance of resident community (Santos *et al*., 2010). Nonetheless, other studies reported that external injuries consistent with inner ear damage have been found in dolphins subjected to explosives, with little change in surface animal behaviour near blast areas (Ketten, 1993).

1077 Robinson *et al*. (2020) described a controlled field experiment and compared the sound produced by high-order detonations with a low-order disposal method (i.e. deflagration). He found that using low order techniques offers a substantial reduction in acoustic output over traditional high-order methods, with the peak SPL_{pk} and SEL_{cum} observed being typically > 20 dB lower for the deflagration of the same sized munition (a reduction factor of just over ten in SPL_{pk} and 100 in acoustic energy). The study also reported that the acoustic output depends on the size of the shaped charge, rather than the size of the UXO itself. Considering the above, compared to high-order methods, Robinson *et al*. (2020) provided the evidence that low order techniques offers the potential for greatly reduced acoustic noise exposure of marine mammals.

1078 The sensitivity of the receptors to the injury from impulsive underwater noise has been described previously for piling and is presented in paragraphs 1057 to 1061.

1079 All marine mammals, which are IEFs of international value, are deemed to be of high vulnerability and low recoverability. The sensitivity of the receptor to PTS from elevated underwater noise during UXCO clearance is therefore, considered to be high.

7.5.2 SENSITIVITY TO BEHAVIOURAL DISTURBANCE

Elevated underwater noise during piling

1080 Studies have shown that acoustic disturbance to marine mammals may lead to the interruption of normal behaviours (such as feeding or breeding) and avoidance, leading to displacement from the area and exclusion from critical habitats (Goold, 1996; Weller *et al.,* 2002; Castellote *et al*., 2010, 2012). Noise may also cause stress which in turn can lead to a depressed immune function and reduced reproductive success (Anderson *et al*., 2011; De Soto *et al*., 2013). The extent to which an animal will be behaviourally affected, however, is very much context-dependent and varies both inter- and intra-specifically. A summary of known behavioural sensitivities of different species to underwater noise from piling at other wind farm sites is provided in paragraph 1088 *et seq.,* noting that the conclusions drawn are subject to the limitations of extrapolating results from one project to another.

Grey seal and harbour seal

1081 Strong disturbance could result in displacement of seals from an area. Whilst mild disturbance has the potential to disturb individuals, this constitutes only slight changes in behaviour, such as changes in swimming speed or direction, and is unlikely to result in population-level effects. Although there are likely to be alternative foraging sites for both harbour seal and grey seal, barrier effects as a result of installation of monopiles could either prevent seals from travelling to forage from haul-out sites or force seals (particularly harbour seal) to travel greater distances than is usual during periods of piling.

1082 A study of the movements of tagged harbour seals during piling at the Lincs Offshore Wind Farm in the Greater Wash showed significant avoidance of the wind farm by harbour seals (Russell *et al*., 2016). Within this study, seal abundance significantly reduced over a distance of up to 25 km from the piling activity and there was a 19 to 23% decrease in usage within this effect range. However, the displacement was limited to pile driving activity only, with seals returning rapidly to baseline levels of activity within two hours of cessation of the piling (Russell *et al.,* 2016).

1083 Hastie *et al*. (2021) recently demonstrated that anthropogenic noise can influence foraging decisions in seals and such decisions were consistent with a risk/profit balancing approach. The study measured the relative influence of perceived risk of a sound (silence, pile driving, and a tidal wind turbine) and prey patch quality (low density versus high density), in grey seals in an experimental pool environment. Foraging success was highest under silence, but under tidal wind turbine and pile driving treatments success was similar at the high-density prey patch but significantly reduced under the low-density prey patch. Therefore, avoidance rates were dependent on the quality of the prey patch as well as the perceived risk from the anthropogenic noise.

1084 Recorded reactions of tracked grey seals to pile driving during construction of the Luchterduinen wind farm in 2014 and Gemini wind farm in 2015 have been diverse, and have ranged from altered surfacing and diving behaviour, changes in swimming direction, or coming to a halt (Aarts *et al*., 2018). In some cases, however, no apparent changes in diving behaviour or movement were observed (Aarts *et al*., 2018). Similar to the conclusions drawn by Hastie *et al*., (2021) the study at the Luchterduinen and Gemini wind farms suggested animals were balancing risk with profit. Whilst approximately half of the tracked seals were absent from the pile-driving area all together, this may because animals were drawn to other more profitable areas as opposed to active avoidance of the noise, although a small sample size (n=36 animals) means that no firm conclusions could be reached. It was notable that, in some cases, seals exposed to pile-driving at distances shorter than 30 km returned to the same area on subsequent trips. This suggests that the incentive to go to the area was stronger than potential deterrence effect of underwater noise from pile driving in some seals.

1085 Barrier effects and altered behaviour could affect the ability of phocid seals to accumulate the energy reserves prior to both reproduction and lactation (Sparling *et al.,* 2006). Female seals exhibit clear patterns of increased foraging effort (including increased diving behaviour) towards the start of the breeding season as a strategy to maximise energy allocation to reproduction. Especially during the third trimester of pregnancy, grey seals accumulate reserves of subcutaneous blubber which they use to synthesize milk during lactation (Hall *et al.,* 2001). They may be most vulnerable to reduced foraging during this period, as maternal energy storage is extremely important to offspring survival and female fitness (Mellish *et al.,* 1999; Hall *et al.,* 2001). Therefore, potential exclusion from foraging grounds during this time has the potential to affect reproduction rates and probability of survival.

1086 Phocid seals may be vulnerable to disturbance during the lactation period also, although the extent to which this occurs depends on their breeding strategy. Changes in behaviour could have a particular impact on harbour seal - an income breeder - during lactating periods (June to August), when female harbour seals spend much of their time in the water with their pups, and foraging is more restricted than during other periods (Thompson and Härkönen, 2008). Consequences of disturbance may include reduced fecundity, reduced fitness, and reduced reproductive success. Although harbour seal may be able to avoid the disturbed area and forage elsewhere, there may be an energetic cost to having to move greater distances to find food, and therefore there may be a potential effect on reproductive success of some individuals. For grey seal - a capital breeder - the lactation period lasts around 17 days (Sparling *et al.,* 2006) during which time the females remain mostly on shore, fasting. As grey seal females do not forage often during lactation, it is expected that they may exhibit some tolerance to disturbance and the effect is less likely to cause a change in both reproduction and survival rates during lactation compared to harbour seal. Note, however, that following lactation female grey seals return to the water and must forage extensively to build up lost energy reserves.

1087 Grey seal and harbour seals, IEFs of international value, are deemed to be of medium vulnerability and high recoverability. The sensitivity of the receptor to disturbance as a result of elevated underwater noise during piling is therefore, considered to be medium.

Harbour porpoise

1088 Harbour porpoise, as a small cetacean species, is vulnerable to heat loss through radiation and conduction. As a species with a high metabolic requirement, it needs to forage frequently to lay down sufficient fat reserves for insulation. A study of six, non-lactating, harbour porpoise found that they require between 4% and 9.5% of their body weight in fish per day (Kastelein *et al*., 1997). In the wild, porpoises forage almost continuously day and night to achieve their required calorific intake (Wisniewska *et al.,* 2016). This means that they are vulnerable to starvation if their foraging is interrupted. Harbour porpoise were recorded year-round and frequently within the Proposed Development marine mammal study area and therefore could be vulnerable to piling at any time of year.

1089 The variance in behavioural responses to increased subsea noise is well documented and is context specific. Factors such as the activity state of the receiving animal, the nature and novelty of the sound (i.e. previous exposure history), and the spatial relation between sound source and receiving animal are important in determining the likelihood of a behavioural response and therefore their sensitivity (Ellison *et al*., 2012). Empirical evidence from monitoring at offshore wind farms during construction suggests that pile driving is unlikely to lead to 100% avoidance of all individuals exposed, and that there will be a proportional decrease in avoidance at greater distances from the pile driving source (Brandt *et al*., 2011). This was demonstrated at Horns Rev Offshore Wind Farm, where 100% avoidance occurred in harbour porpoises at up to 4.8 km from the piles, whilst at greater distances (10 km plus) the proportion of animals displaced reduced to < 50% (Brandt *et al*., 2011). A recent study on piling at the BOWL suggests that harbour porpoise may adapt to increased noise disturbance over the course of the piling phase, thereby showing a degree of tolerance and behavioural adaptation (Graham *et al*., 2019). This study also demonstrated that the probability of occurrence of harbour porpoise (measured as porpoise positive minutes) increased exponentially moving further away from the noise source. Similarly, at a study of seven offshore wind farms constructed in the German Bight, Brandt *et al.*, (2018) also showed that detections of harbour porpoise declined several hours before the start of pling within the vicinity (up to 2 km) of the construction site and were reduced for about one to two hours post-piling, whilst at the maximum effect distances (from 17 km out to approximately 33 km) avoidance only occurred during the hours of piling. In this study, porpoise detections during piling were found at sound levels exceeding 143 dB re 1µPa^{2}s and at lower received levels - at greater distances from the source - there was little evident decline in porpoise detections (Brandt *et al.,* 2018). These studies demonstrate the dose-response relationship between received noise levels and declines in porpoise detections although noting that the extent to which responses could occur will be context-specific such that, particularly at lower received levels (i.e. 130 dB -140 dB re 1µPa^{2}s), detectable responses may not be apparent from region to region.

1090 A recent article by Southall *et al*. (2021) introduces a behavioural response severity spectrum, building on earlier work presented in Southall *et al*. (2007) and the expanding literature in this area. Southall *et al*. (2021) illustrates the progressive severity of possible responses within three response categories: survival (e.g. resting, navigation, defence), feeding (e.g. search, consumption, energetics), and reproduction (e.g. mating, parenting). For example, at the most severe end of the spectrum (scored 7 to 9), where sensitivity is highest, displacement could occur resulting in movement of animals to areas with an increased risk of predation and/or with sub-optimal feeding grounds. A failure of vocal mechanisms to compensate for noise and interruption of key reproductive behaviour including mating and socialising could occur. In these instances, there would likely be a reduction in an individual's fitness leading to potential breeding failure and impact on survival rates.

1091 Acknowledging the limitations of the single step-threshold approach for strong disturbance and mild disturbance (i.e. does not account for inter-, or intra-specific variance or context-based variance), harbour porpoise within the area modelled as 'strong disturbance' would be most sensitive to behavioural effects and therefore may have a response score of seven or above according to Southall *et al*. (2021). At the lower end of the behavioural response spectrum, the potential severity of effects reduces. Whilst there may be some detectable responses that could result in effects on the short-term health of animals, these are less likely to impact on an animals' survival rate. For example, mild disturbance (score four to six) could lead to effects such as changes in swimming speed and direction, minor disruptions in communication, interruptions in foraging, or disruption of parental attendance/nursing behaviour (Southall *et al*., 2021).

1092 Although harbour porpoise may be able to avoid the disturbed area and forage elsewhere, there may be a potential effect on reproductive success of some individuals. As mentioned previously, it is anticipated that there would be some adaptability to the elevated noise levels from piling and therefore survival rates are not likely to be affected. Due to uncertainties associated with the effects of behavioural disturbance on vital rates of harbour porpoise, the assessment is highly conservative as it assumes the same level of sensitivity for both strong and mild disturbance, noting that for the latter the sensitivity is likely to be lower.

1093 Harbour porpoise, an IEF of international value, is deemed to be of medium vulnerability and high recoverability. The sensitivity of the receptor to disturbance as a result of elevated underwater noise during piling is therefore, considered to be medium.

Bottlenose dolphin

1094 Bottlenose dolphin are not thought to be as vulnerable to disturbance as harbour porpoise; with larger body sizes – and lower metabolic rates - the necessity to forage frequently is lower in comparison. Bottlenose dolphin is largely coastally distributed in relation to the Proposed Development marine mammal study area and are more abundant during spring and summer compared to autumn and winter months

(Paxton *et al.*, 2016). Offshore sightings during the recent aerial digital surveys recorded sightings within the Proposed Development marine mammal study area during the months of October and April (see volume 3, appendix 10.2 of the Offshore EIA Report).

1095 There is limited information regarding the specific sensitivities of bottlenose dolphin to disturbance from piling noise as most studies have focussed on harbour porpoise. A study of the response of bottlenose dolphin to piling noise during harbour construction works at the Nigg Energy Park in the Cromarty Firth (north-east Scotland) found that there was a measurable (albeit weak) response to impact and vibration piling with animals reducing the amount of time they spent in the vicinity of the construction works (Graham *et al.,* 2017). Another study investigating dolphin detections in the Moray Firth during impact piling at the Moray East and BOWL found surprising results at small temporal scales with an increase in dolphin detections on the southern Moray coast on days with impulsive noise compared to days without (Fernadex-Betelu *et al.*, 2021). Predicted maximum received levels in coastal areas were 128 dB re. 1µPa^{2}s and 141 dB re. 1µPa^{2}s during piling at BOWL and Moray Offshore Renewables Limited (MORL) respectively (Fernadex-Betelu *et al.*, 2021). The authors of this study warn that caution must be exercised in interpreting these results as increased click changes do not necessarily equate to larger groups sizes but may be due to a modification in behaviour (e.g. an increase in vocalisations during piling) (Fernadex-Betelu *et al.*, 2021). The results of this study do, however, suggest that impulsive noise generated during piling at the offshore wind farms did not cause any displacement of bottlenose dolphins from their population range. Notably, the received levels during piling at MORL are higher than those predicted for the outer isopleths (130 dB and 135 dB re. 1µPa^{2}s) that overlap with the CES MU 2 m - 20 m depth contour during piling at the Proposed Development suggesting that disturbance at these lower noise levels is unlikely to lead to displacement effects.

1096 The Southall *et al*. (2021) severity spectrum applies across all marine mammals and therefore it is expected that, as described for harbour porpoise, strong disturbance in the near field could result in displacement whilst mild disturbance over greater ranges would result in other, less severe behavioural responses.

1097 Bottlenose dolphin may be able to avoid the disturbed area and whilst there may some impacts on reproduction in closer proximity to the source (i.e. within the area of 'strong disturbance'), these are unlikely to impact on survival rates as some tolerance is expected to build up over the course of the piling. It is anticipated that animals would return to previous activities once the impact had ceased.

1098 Bottlenose dolphin, IEF of international value, is deemed to be of medium vulnerability and high recoverability. The sensitivity the of receptor to disturbance as a result of elevated underwater noise during piling to disturbance is therefore, considered to be medium.

Elevated underwater noise as a result of site-investigation surveys

Grey seal, harbour seal, harbour porpoise, bottlenose dolphin

1099 The transmission frequencies of many commercial sonar systems (approximately 12 kHz – 1800 kHz) overlap with the hearing and vocal ranges of many species (Richardson *et al*., 1995), and whilst many are high frequency sonar systems with peak frequencies well above marine mammal hearing ranges, it is possible that relatively high levels of sound are also produced as sidebands at lower frequencies (Hayes and Gough, 1992) so may elicit behavioural responses in marine mammals. Fine-scale data from porpoises equipped with high-resolution location and dive loggers when exposed to airgun pulses at ranges of 420 m – 690 m with noise level estimates of 135 dB–147 dB re 1 µPa^{2}s (SEL) show different responses to noise exposure (van Beest, *et al*., 2018). One individual displayed rapid and directed movements away from the exposure site whilst two individuals used shorter and shallower dives (compared to natural behaviour) immediately after exposure. This noise-induced movement typically lasted for eight hours or less, with an additional 24-hour recovery period until natural behaviour was resumed.

1100 Results from 201 seismic surveys in the UK and adjacent waters demonstrated that cetaceans (including bottlenose dolphin) can be disturbed by seismic exploration (Stone and Tasker, 2006), with small odontocetes showing strongest lateral spatial avoidance, moving out of the area, whilst mysticetes and killer whales showed more localised spatial avoidance, orienting away from the vessel and increasing distance from source but not leaving the area completely.

1101 A study by Sarnocińska *et al*. (2020) indicated temporary displacement or change in harbour porpoise echolocation behaviour in response to a 3D seismic survey in the North Sea. No general displacement was detected from 15 km away from any seismic activity but decreases in echolocation signals were detected up to 8 km – 12 km from the active airguns. Taking into account findings of other studies (Dyndo *et al.,* 2015; Tougaard *et al.,* 2015) harbour porpoise disturbance ranges due to airgun noise are predicted to be smaller than to pile driving noise at the same energy. The reason for this is because the perceived loudness of the airgun pulses is predicted to be lower than for pile driving noise due to less energy at the higher frequencies where porpoise hearing is better (Sarnocinska *et al.,* 2020). Similarly, Thompson *et al*. (2013) used passive acoustic monitoring and digital aerial surveys to study changes in the occurrence of harbour porpoises across a 2,000 km^2 study area during a commercial two-dimensional seismic survey in the North Sea and found acoustic detections decreased significantly during the survey period in the impact area compared with a control area, but this effect was small in relation to natural variation. Animals were typically detected again at affected sites within a few hours, and the level of response declined through the ten-day survey suggesting exposure led to some tolerance of the activity (Thompson *et al.,* 2013). This study suggested that prolonged seismic survey noise did not lead to broader-scale displacement into suboptimal or higher-risk habitat. Likewise, a ten month study of overt responses to seismic exploration in humpback whales *Megaptera novaeangliae*, sperm whales *Physeter macrocephalus* and Atlantic spotted dolphins *Stenella frontalis*, demonstrated no evidence of prolonged or large-scale displacement of each species from the region during the survey (Weir, 2008).

1102 Hastie *et al*. (2014) carried out behavioural response tests to two sonar systems (200 kHz and 375 kHz systems) on grey seals at SMRU seal holding facility. Results showed that both systems had significant effects on the seals' behaviour. Seals spent significantly more time hauled out during the 200 kHz sonar operation and although seals remained swimming during operation of the 375 kHz sonar, they were distributed further from the sonar.

1103 It is expected that, to some extent, marine mammals will be able to adapt their behaviour to reduce impacts on survival and reproduction rates and tolerate elevated levels of underwater noise during site investigation surveys. Marine mammals, which are IEFs of international value, are deemed to be of medium vulnerability and high recoverability. The sensitivity of the receptor to disturbance from elevated underwater noise during site investigation surveys is therefore considered to be medium.

Elevated underwater noise as a result of vessel activity and other activities

Grey seal, harbour seal, harbour porpoise, bottlenose dolphin

1104 Disturbance levels for marine mammal receptors will be dependent on individual hearing ranges and background noise levels within the vicinity. Sensitivity to vessel noise is most likely related to the marine mammal activity at the time of disturbance (IWC, 2006; Senior *et al*., 2008).

1105 Cetaceans can both be attracted to, and disturbed by, vessels. For example, resting dolphins are likely to avoid vessels, foraging dolphins will ignore them, and socialising dolphins may approach vessels (Richardson *et al*., 1995).

1106 Harbour porpoise is particularly sensitive to high frequency noise and likely to avoid vessels; Heinänen and Skov (2015) identified that the occurrence of harbour porpoise declines significantly when the number of vessels in a 5 km^2 area exceeds 80 in one day. Wisniewska *et al*. (2018) studied the change in foraging rates of harbour porpoise in response to vessel noise in highly trafficked coastal waters. The results show that occasional high-noise levels coincided with vigorous fluking, bottom diving, interrupted foraging and even cessation of echolocation, leading to significantly fewer prey capture attempts at received levels greater than 96 dB re 1 µPa (16 kHz third-octave). Heinänen and Skov (2015) found that the occurrence of harbour porpoise declines significantly when the number of vessels in a 5 km^2 area exceeds 20,000 ships per year (approximately 80 ships per day or 18 ships per km^2).

1107 Other species of dolphin (e.g. common dolphin) are regularly sighted near vessels and may also approach vessels (e.g. bow-riding). However, dolphins are also known to show aversive behaviours to vessel presence, including increased swimming speed, avoidance, increased group cohesion and longer dive duration (Miller *et al*., 2008). Reactions of marine mammals to vessel noise are often linked to changes in the engine and propeller speed (Richardson *et al*., 1995). Disturbance in dolphins and porpoises is likely to be associated with the presence of small, fast-moving vessels as they are more sensitive to high frequency noise. Pirotta *et al*. (2015) found that transit of vessels (moving motorised boats) in the Moray Firth resulted in a reduction (by almost half) of the likelihood of recording bottlenose dolphin prey capture buzzes. They also suggest that vessel presence, not just vessel noise, resulted in disturbance. Anderwald *et al*. (2013) suggested that in the study of displacement responses to construction-related vessel traffic, grey seals were avoiding the area due to noise rather than vessel presence. In the same study, the presence of bottlenose dolphin was positively correlated with overall vessel numbers, as well as the number of construction vessels. It was, however, unclear whether the bottlenose dolphins were attracted to the vessels themselves or to particularly high prey concentrations within the study area at the time. Richardson (2012) investigated the effect of disturbance on bottlenose dolphin community structure in Cardigan Bay and found that group size was significantly smaller in areas of high vessel traffic.

1108 There is, however, evidence of habituation to boat traffic and therefore a slight increase from the existing levels of traffic in the vicinity of the Proposed Development may not result in high levels of disturbance. For example, Lusseau *et al*. (2011) (SNH commissioned report) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth did not have an adverse effect on the local population of bottlenose dolphin, although it did note that foraging may be disrupted by disturbance from vessels.

1109 Seals are particularly sensitive to disturbances in regions where vessel traffic overlaps with productive coastal waters (Robards *et al*., 2016). Richardson *et al*. (2005) reported avoidance behaviour or alert reactions in harbour seal when vessels approach within 100 m of a haul-out (Richardson *et al*., 2005); when disturbed, seals that are hauled-out typically flush into the water which could be detrimental during pupping season (e.g. Terhune and Almon, 1983; Johnson and Acevedo-Gutiérrez, 2007). The presence of vessels in foraging grounds could result in reduced foraging success, particularly in harbour seals given reduced foraging ranges (c. 50 km from haul-outs) when compared to grey seals (c. 150 km from haul-outs) (SCOS, 2017). However, seals can be curious and have been recorded approaching tour boats that regularly visit an area and may habituate to sounds from tour vessels (Bonner, 1982). Mikkelsen *et al*. (2019) used long term sound and movement tagging data to study reaction to ship noise in grey seals in the North Sea and found that animals were exposed to audible vessel noise 2.2% – 20.5% of their time when in water and that high vessel noise coincided with interruption of functional behaviours such as resting.

1110 As mentioned previously, a study on grey seals by Hastie *et al*. (2021) demonstrated how foraging context is important when interpreting avoidance behaviour and should be considered when predicting the effects of anthropogenic activities, with avoidance rates depending on the perceived risk (e.g. silence, pile driving noise, operational noise from tidal wind turbines) versus the quality of the prey patch. It highlights that sound exposure in different prey patch qualities may result in markedly different avoidance behaviour and should be considered when predicting impacts in EIAs. Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area it is expected that marine mammals could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

1111 All marine mammals, which are IEFs of international value, are deemed to be of low vulnerability and high recoverability. The sensitivity of the receptor to disturbance from elevated underwater noise during vessel activity and other activities is therefore, considered to be medium.

7.5.3 SENSITIVITY TO TTS

Elevated underwater noise as a result of UXO clearance

<u>Grey seal and harbour seal</u>

1112 A study measuring recovery rates of harbour seal following exposure to a sound source of 193 dB re 1 µPa2s (SEL_{cum}) over 360 minutes found that recovery from TTS to the pre-exposure baseline was estimated to be complete within 72 minutes following exposure (Kastelein *et al*., 2018a). These results are similar to recovery rates found in SEAMARCO (2011), which showed that for small TTS values, recovery in seals was very fast (around 30 minutes) and the higher the hearing threshold shift, the longer the recovery. Kastelein *et al*. (2019a) also demonstrated recovery was rapid, with hearing recovered fully within two hours. Therefore, in most cases, reduced hearing for such a short time probably has little effect on the total foraging period of a seal. If hearing is impaired for longer periods (hours or days) the impact is likely to be ecologically significant (SEAMARCO, 2011). The results indicate that harbour seal (and therefore grey seal, using harbour seal as a proxy) are less vulnerable to TTS than harbour porpoise for the noise bands tested. In addition, it is expected that animals would move beyond the injury range prior to the onset of TTS. The assessment considered that both grey seal and harbour seal are likely to be able to tolerate the effect without any impact on both reproduction and survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased.

<u>Harbour porpoise</u>

1113 Explosions during UXO clearance activities and associated underwater noise have the potential to produce behavioural disturbance, however there are no agreed thresholds for the onset of a behavioural response generated as a result of explosion. Given different nature of the sound, using noise levels and probability of a response to pile driving would not be appropriate. Southall *et al.* (2007) suggests that the use of TTS onset as an auditory effect may be most appropriate for single pulses (such as UXO detonation) and therefore it has been used in other assessments where the impacts of UXO clearance on marine mammals have been investigated. TTS is a temporary and reversible hearing impairment and therefore, it is anticipated that any animals experiencing this shift in hearing would recover after they are no longer exposed to elevated noise levels (i.e. they may have moved beyond the injury zone or piling has ceased). The implication of animals experiencing TTS, leading to potential displacement, is not fully understood, but it is likely that aversive responses to anthropogenic noise could temporarily affect life functions as described for PTS. However, due to the reversible nature of TTS, this is less likely to lead to acute effects and will largely depend on recoverability. The degree and speed of hearing recovery will depend on the characteristics of the sound the animal is exposed to, and on the degree of shift in hearing experienced. A study measuring recovery rates of harbour porpoise following exposure to sound source of 75 dB re 1 µPa (SEL) over 120 minutes found that recovery to the pre-exposure threshold was estimated to be

complete within 48 minutes following exposure (the higher the hearing threshold shift, the longer the recovery) (SEAMARCO, 2011).

1114 Finneran *et al*. (2000) investigated the behavioural and auditory responses of two captive bottlenose dolphins to sounds that simulated distant underwater explosions. The animals were exposed to an intense sound once per day and no auditory shift (i.e. TTS) greater than 6 dB in response to levels up to 221 dB re 1 µPa p-p (peak-peak) was observed. Behavioural shifts, such as delaying approach to the test station and avoiding the 'start' station, were recorded at 196 dB and 209 dB re 1 µPa p-p for the two dolphins and continued at higher levels. There are several caveats to this study (discussed in Nowacek *et al.* (2007)), (i.e. the signals used in this study were distant and the study measured masked-hearing signals). The animals used in the experiment were also trained and rewarded for tolerating high levels of noise and subsequently, it can be anticipated that behavioural disruption would likely be observed at lower levels in other contexts.

1115 Susceptibility to TTS depends on the frequency of the fatiguing sound causing the shift and the greatest TTS depends on the SPL (and related SEL) (Kastelein *et al*., 2021). In a series of studies measuring TTS occurrence in harbour porpoise at a range of frequencies typical of high amplitude anthropogenic sounds (0.5 kHz to 88.4 kHz) the greatest shift in mean TTS occurred at 0.5 kHz, which is very close to the lower bound of porpoise hearing (Kastelein *et al*., 2021). Hearing always recovered within 60 minutes after the fatiguing sound stopped. Scientific understanding of the biological effects of TTS is limited to the results of controlled exposure studies on small numbers of captive animals (reviewed in Finneran, 2015). Extrapolating these results to how animals may respond in the natural environment should be treated with caution as it is not possible to exactly replicate natural environmental conditions, and the small number of test subjects would not account for intraspecific differences (i.e. differences between individuals) or interspecific differences (i.e. extrapolating to other species) in response.

Bottlenose dolphin

1116 Whilst there are no available species-specific recovery rates for mid-frequency cetaceans to TTS, there is no evidence to suggest that recovery will be significantly different to harbour porpoise recovery rates therefore animals can recover their hearing after they are no longer exposed to elevated noise levels (i.e. they may have moved beyond the injury zone or piling has ceased). The assessment considered that bottlenose dolphin would be able to tolerate the effect without any impact on reproduction or survival rates and would be able to return to previous behavioural states or activities once the impacts had ceased.

1117 All marine mammals, which are IEFs of international value are deemed to be of medium vulnerability and high recoverability. The sensitivity of the receptor to TTS is therefore, considered to be low.

7.6 INFORMATION TO INFORM ASSESSMENT OF ADVERSE EFFECTS ON INTEGRITY

7.6.1 BERWICKSHIRE AND NORTH NORTHUMBERLAND COAST SAC

[14] https://sitelink.nature.scot/site/8207 Accessed 14 March 2022

European site information

1118 Berwickshire and North Northumberland Coast SAC is located 4.1 km from the Proposed Development export cable corridor and 35 km from the Proposed Development array area. The SAC extends from St Abb's Head in south-east Scotland to Alnwick in north-east England. The site is designated for Annex I habitats (considered separately in section 5.5.1), and grey seal. The breeding colonies within this SAC support around 2.5% of annual UK pup production. There are two large discrete grey seal breeding populations (the Farne Islands and Fast Castle) with different population dynamics, however, pup production in the SAC as a whole is continuing to increase and does not show any indication of reaching an asymptote (SCOS, 2020).

1119 The grey seal feature of the site was last assessed as being in 'favourable maintained' condition in November 2014[14].

1120 The accessibility and suitability of pupping areas as well as haul-out areas (including rocky and coarse sediment shores) are critical for the survival and continued presence of the population of grey seals within the Berwickshire and North Northumberland Coast SAC (English Nature and SNH, 2000). The southern half of the SAC is an important haul out area for grey seals with two main haul-out sites: Farne Islands and Lindisfarne National Nature Reserve (NNR). On the Farne Islands in particular, rocky shores provide crucial habitats for grey seal breeding.

1121 Further information on this European site is presented in appendix A.

Conservation objectives

1122 The conservation objectives for Berwickshire and North Northumberland Coast SAC have been developed jointly by NatureScot and Natural England and apply to the site and the individual species and/or assemblage of species for which the site has been classified. These high-level objectives are to ensure that, subject to natural change, the integrity of the site is maintained or restored as appropriate, and that the site contributes to achieving the Favourable Conservation Status of its qualifying features, by maintaining or restoring:

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

1123 As the most recent condition status of the grey seal feature of the site was 'favourable', it is assumed that the above list of conservation objectives must be maintained for grey seal.

1124 Supplementary advice on conservation objectives, last updated by NatureScot and Natural England on 13 March 2020[15] provide the site-specific attributes and targets specific to the grey seal feature of the site: These supplementary attributes and targets are considered in the assessments below and are provided for reference in appendix A.

1 [15]https://designatedsites.naturalengland.org.uk/Marine/SupAdvice.aspx?SiteCode=UK0017072&SiteName=berwi&SiteNameDisplay=Berwickshire+and+North+Northumberland+Coast+SAC&countyCode=&responsiblePerson=&SeaArea=&IFCAArea=&NumMarineSeasonality=1 Accessed: 14 March 2022

Features and effects for assessment

1125 The potential for adverse effects has been identified for the following Annex II marine mammal features of this site:

- Grey seal.

1126 NatureScot and MS provided scoping advice in December 2021, which recommended use of SCOS (2020) pup production estimates to inform the size of grey seal populations at Berwick shire and North Northumberland Coast SAC and Isle of May SAC. In March 2022, NatureScot and MS revised this advice following a request for clarification and recommended the use of maximum population estimates from the JNCC Standard Data Forms instead (*Marine Scotland, pers. comm* on 17 March 2022). This results in a population of 1,000 individuals at Berwickshire and North Northumberland Coast SAC (JNCC, 2015a), which will be used as the reference population against which potential effects will be assessed.

1127 The following impacts associated with the construction and decommissioning of the Proposed Development were identified as having the potential for adverse effects on grey seal at this site:

- **Injury and disturbance** from underwater noise generated by the following activities:
  - piling of fixed foundations;
  - clearance of UXO;
  - site investigation surveys; and
  - vessel use and other activities.
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1128 The following impacts associated with the operation and maintenance of the Proposed Development have been identified as having the potential for adverse effects on grey seal at this site:

- **Injury and disturbance from underwater noise** generated by site investigation surveys as well as vessel use and other activities; and
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1129 The following assessment is structured to first assess whether the construction and decommissioning impacts will have an adverse effect on the integrity of the grey seal feature of the site, and then the impacts associated with operation and maintenance will be assessed. For the purposes of these assessments, the potential effects are considered in relation to the site's conservation objectives.

Construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

1130 Underwater noise could affect the population and distribution of the qualifying species. Underwater noise modelling has been undertaken to estimate the maximum potential injury ranges for underwater noise that could arise during construction and decommissioning in relation to grey seal. The modelling was based on the maximum design scenario (as outlined in Table 7.10)Table 7.10 with summary of noise modelling provided in paragraph 271 *et seq*.

1131 The maximum range for injury to grey seal was estimated as 118 m based on SPL_{pk} and using the 1% constant CF (see paragraph 881 *et seq*). Taking into account the most conservative scenario and maximum grey seal densities (Table 7.4), less than one grey seal was predicted to be potentially injured, which accounts for <0.1% of the Berwickshire and North Northumberland Coast SAC population. As outlined in paragraph 779, while a high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Berwickshire and North Northumberland Coast SAC (Figure 7.1), a relatively high proportion were also tracked to the Isle of May SAC, with a small proportion travelling to sites further away. Therefore, whilst it is assumed that the single grey seal potentially injured may originate from the Berwickshire and North Northumberland Coast SAC (equating to <0.1% of the SAC population), this number is likely to be conservative due to the precautionary approach adopted in the assessment. With designed in measures in place (Table 7.11) which are in line with recommended best practice guidelines, the impact would result in a negligible risk of injury to grey seal.

1132 In terms of behavioural disturbance, up to 1,358 animals were predicted to be potentially disturbed from concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.15). These results are considered highly precautionary as there is a number of conservative assumptions in subsea noise model (i.e. the maximum hammer energy of 4,000 kJ is unlikely to be reached at all piling locations (see paragraph 844 for more details)).

1133 The outer behavioural disturbance contours (135 dB) overlap with shallower, coastal areas south of the Proposed Development and therefore there was predicted to be a small overlap with northern part of the Berwickshire and North Northumberland Coast SAC (Figure 7.1). However, although there is a potential for overlap of disturbance contours with northern section of the SAC, it is the southern half of the SAC which is an important breeding site for grey seals (SCOS, 2020; see Figure 7.1 where grey seal telemetry tracks are concentrated in waters around Farne Islands). Grey seals present in the southern part of the SAC, in the vicinity of the habitats which they utilise throughout their life cycle (submerged/partially submerged sea caves, intertidal mud/rock/sediment), are therefore unlikely to experience disturbance as these areas lie outside of the noise disturbance contours. As such, piling activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect maintenance of the supporting habitats.

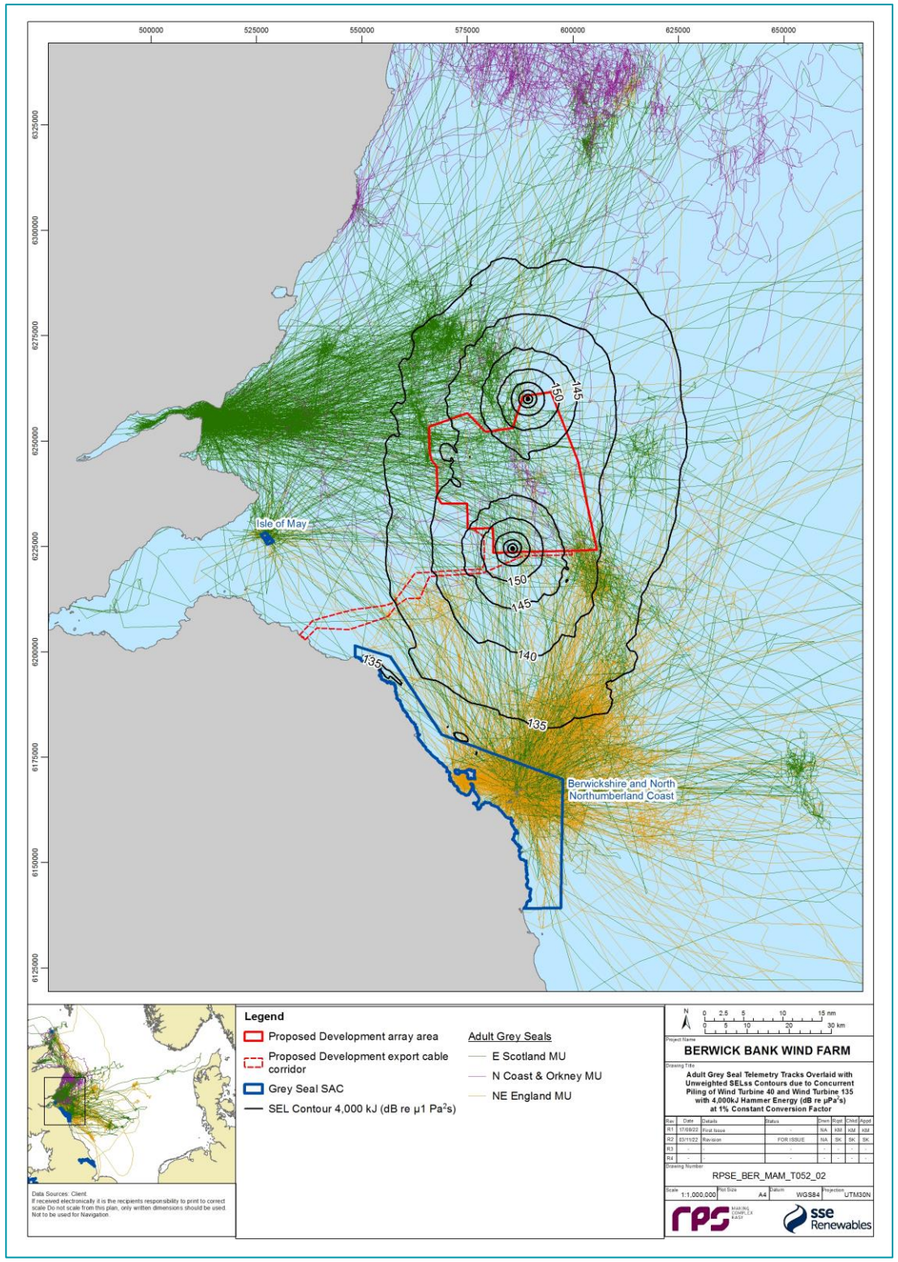

Figure 7.1: Unweighted SEL Contours Due to Concurrent Impact Piling of Wind Turbine Piles at Maximum Hammer Energy (4,000 kJ) Overlaid With Adult Grey Seal Telemetry Tracks

1134 Grey seal in inshore waters could experience mild disturbance where these areas overlap with 135 dB disturbance contour. As advised by NatureScot, grey seal in Scotland tend to stay within 20 km of the breeding colony during the breeding season (Table 2.1). Therefore, to investigate the number of animals potentially disturbed in the vicinity of the SAC, a 20 km buffer from the coast has been applied (Figure 7.2). Based on Carter *et al*. (2020) seal at-sea density grids and the area of overlap between the 20 km foraging range and the outer disturbance contour, a maximum of 532 animals could potentially experience mild disturbance or barrier effects within the foraging range from Berwickshire and North Northumberland Coast SAC. Due to the low received noise levels it is expected that grey seals will exhibit some tolerance to the mild disturbance closer to the coast. With respect to barrier effects, as outlined in paragraph 1085 *et seq*, exclusion from key foraging grounds along the coast and altered behaviour could affect reproduction and lactation in females if feeding is reduced or inhibited. Given that animals would be potentially exposed only to low noise levels, these are unlikely to lead to barrier effects. Therefore, disturbance caused by piling is considered unlikely to cause a change in reproduction and survival rates.

1135 During piling, there is the potential for some animals to be temporarily deterred from the offshore areas. As grey seals feed in the water column over a variety of habitats, they may use different foraging areas at different times of the year to target seasonal prey. Telemetry data suggest that adult grey seals from Berwickshire and North Northumberland Coast SAC mostly use the area that only slightly overlaps with outer disturbance contours (Figure 7.1), where seals are likely to experience mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement, are unlikely to occur (Southall *et al*., 2021). It must be also noted that behavioural disturbance contours presented in Figure 7.1 represent the maximum adverse scenario for concurrent piling at wind turbine locations where noise contours propagate in the direction of the Berwickshire and North Northumberland Coast SAC. Therefore, the disturbance contours will not reach that far towards the SAC during the piling at remaining wind turbine/OSP/Offshore convertor station platform locations. As described in paragraph 1084, grey seals although initially displaced due to pile-driving, are likely to return to the same area on subsequent trips following cessation of piling. Therefore, it is anticipated that piling will not result in any long-lasting changes in the distribution of adult seals from this SAC and the connectivity with areas of high importance within and outside the site is not expected to be impaired.

1136 As outlined in paragraph 884, the total duration of piling could potentially affect up to a maximum of five breeding cycles for grey seals. Piling activities will be intermittent and will occur over small timespan (372 days) within the piling phase (52 months) and therefore can affect grey seals over the medium term. Despite this, the results of the iPCoD modelling for grey seal against the ES plus NE MU population showed that the difference in population trajectory between the impacted and unimpacted population fall within the natural variance of the population (see paragraph 909 *et seq.*). Therefore, it was considered that there is no potential for the long-term effects on this species within wider population as a result of piling during construction phase of the Proposed Development (see volume 2, appendix 10.4 of the Offshore EIA Report).

1137 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of underwater noise during piling during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1138 The assessment has concluded that piling activities are highly unlikely to disrupt normal behaviours of grey seals. Animals would be potentially exposed only to low noise levels along the coast and these are unlikely to lead to barrier effects or strong behavioural responses. Therefore, disturbance caused by piling is considered unlikely to cause a change in reproduction and survival rates and will not influence the population of qualifying species. Given that grey seals are likely to return to the same area on subsequent trips following cessation of piling, piling will not result in any long-lasting changes in the distribution of

seals from this SAC and the connectivity with areas of high importance within and outside the site is not expected to be impaired. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1139 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from injury or disturbance from elevated underwater noise during piling with respect to the construction of the Proposed Development acting alone.

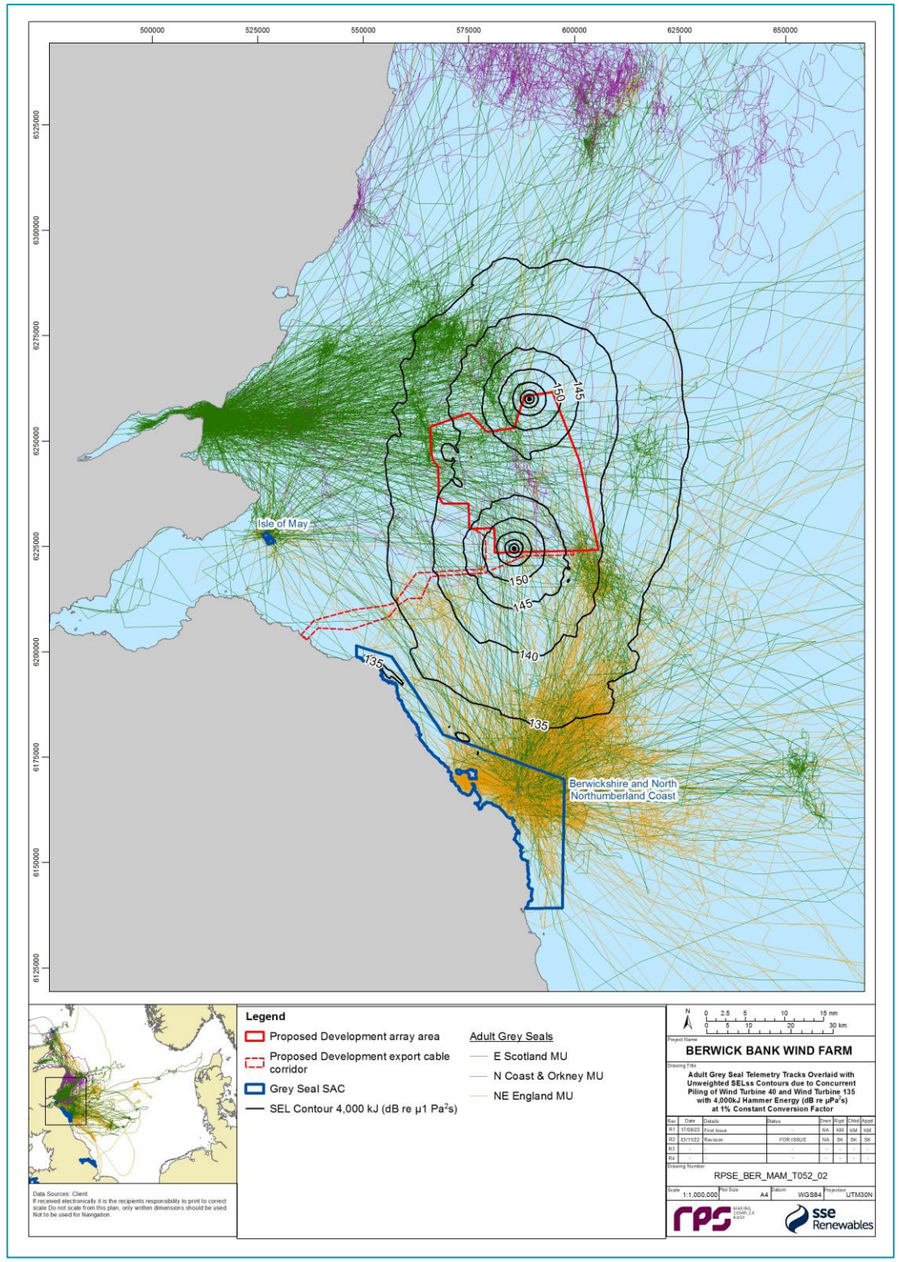

Figure 7.2: Unweighted SELss Contours Due to Concurrent Impact Piling Overlaid With 20 km Buffer from the Coast Along the Berwickshire and North Northumberland Coast SAC

Injury and disturbance from elevated underwater noise during site investigation surveys

1140 The noise modelling showed that ranges within which there is a risk of PTS to grey seals as a result of geophysical surveys are relatively low with a maximum impact range of 65 m (due to operation of SSS, SBES and SBP; Table 7.20 and Table 7.21). For geotechnical survey activities, PTS impact thresholds for grey seal are not exceeded (Table 7.21).

1141 There is potential for less than one animal to experience PTS as a result of geophysical and geotechnical site investigation surveys (<0.1% of the Berwickshire and North Northumberland Coast SAC population). The surveys are considered to be short-term as they will take place over a period of up to three months. It should be noted that since sonar-based systems have strong directivity, there is only potential for injury when marine mammals are directly underneath the sound source. With designed in measures in place, due to the low risk of PTS occurring and the short-term duration of the geophysical surveys, no adverse effects associated with auditory injury to grey seals are predicted as a result of site investigations surveys (Table 7.11). It is anticipated that there will be no introduction of barriers to wider movement or impact on connectivity between different important habitats for grey seals at the SAC as a result of elevated sound from site investigation surveys.

1142 In terms of behavioural disturbance, estimated maximum ranges for onset of disturbance are based on exceeding the 120 dB re 1 µPa (rms) threshold applicable for all marine mammals for continuous noise, noting that this threshold is for 'mild disturbance' and therefore is not likely to result in displacement of animals. The largest distance over which disturbance could occur potentially affect grey seal is out to approximately 7.5 km during vibro-coring. Using the published at-sea density maps (Carter *et al.,* 2020) the maximum number of grey seals estimated to be disturbed was 210 grey seals as a result of vibro-coring (21% of the Berwickshire and North Northumberland Coast SAC population). However, this was shown to be highly precautionary when compared with estimates of the number of grey seal using site-specific densities derived from the Proposed Development aerial digital survey data. For example, based on the mean monthly density (0.276 animals per km^2) and seasonal peak density (0.321 animals per km^2) from aerial data, the number of grey seal affected by possible disturbance during vibro-core testing, would be 48 animals (4.8% of the SAC population) and 56 animals (5.6% of the SAC population), respectively. Therefore, although there is a potential for behavioural disturbance during the vibro-core survey, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Therefore, underwater noise during site-investigation surveys is unlikely to affect grey seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates.

1143 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of underwater noise during site investigation surveys during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1144 The assessment has concluded that there will be no introduction of barriers to wider movement for grey as a result of elevated sound from site investigation surveys. Therefore site investigation surveys will not result in changes to the distribution of qualifying species within the site. Underwater noise during site-investigation surveys is unlikely to affect grey seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates and therefore will not influence the population of qualifying species. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1145 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from injury or disturbance from elevated underwater noise during site investigation surveys with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during UXO clearance

1146 Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that grey seal can be potentially affected by PTS at the maximum range of 2,085 m due to detonation of charge size of 300 kg (Table 7.24). Conservatively, the number of grey seals that could be potentially injured by the high order UXO clearance event is up to 16 animals (Table 7.27). This represents a possible 1.6% of the Berwickshire and North Northumberland Coast SAC population. As outlined in paragraph 780, while a high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Berwickshire and North Northumberland Coast SAC (Figure 7.1), a relatively high proportion were also tracked to the Isle of May SAC, with a small proportion travelling to sites further away. Therefore, this number is likely to be an over-estimation of the proportion of seals from the Berwickshire and North Northumberland Coast SAC affected.

1147 To reduce the potential of experiencing injury, designed in measures, which are in line with recommended best practice guidelines, will be adopted as part of a MMMP (see Table 7.11). Given that there is a potential to experience auditory injury by grey seal at a greater range than can be mitigated by monitoring of the 1 km mitigation zone alone (Table 7.24), an ADD will be deployed for a pre-determined length of time to deter marine mammals to a greater distance prior to any detonation. Activation of ADD for only 22 minutes is considered sufficient to deter grey seal from the potential injury zone as a result of high order detonation of 300 kg UXO (Table 7.24). A draft MMMP has been developed for the purpose of mitigating the risk of auditory injury (PTS) to marine mammals from the proposed UXO clearance activities at the Proposed Development and this will be updated post-consent based on an assessment which will be provided as a part of the EPS licence supporting information.

1148 Moreover, low order techniques will be applied as the intended methodology for clearance of UXO and it is anticipated that only 10% of all UXO clearance events will result in high order detonation. The underwater noise modelling results show that grey seal can be potentially affected by PTS at the maximum range of 250 m due to detonation of 0.5 kg clearance shot (Table 7.24), with one animal potentially affected (Table 7.25). This accounts for 0.1% of the Berwickshire and North Northumberland Coast SAC population.

1149 Given that only small number of grey seals have the potential to be affected by PTS from UXO clearance events and mitigation measures are likely to reduce the risk of injury to low, an alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC is considered highly unlikely. Grey seals present in the vicinity of the habitats which they utilise throughout their life cycle (submerged/partially submerged sea caves, intertidal mud/rock/sediment), are unlikely to experience PTS as the maximum injury range is smaller than distance from the SAC to the Proposed Development area. As such, UXO clearance activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect maintaining supporting habitats.

1150 As described in paragraph 971, the threshold for potential TTS was also assessed as this represents a behavioural, fleeing response. Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that grey seal can be potentially affected by TTS at the maximum range of 6,430 m due to detonation of charge size of 300 kg (Table 7.32) with up to 156 grey seal individuals affected (Table 7.33; 15.6% of the Berwickshire and North Northumberland Coast SAC population). Although approximately 10% of all clearance events (up to two UXOs) may result in high order detonation, low order techniques are the preferred option for UXO clearance. The underwater noise modelling predicted that grey seal can potentially experience TTS at the maximum range of 455 m due to detonation of 0.5 kg clearance shot following low order clearance (Table 7.30) with up to one grey seal potentially affected (Table 7.31). This accounts for 0.1% of the Berwickshire and North Northumberland Coast SAC population.

1151 TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Therefore, effects caused by UXO clearance are considered unlikely to cause a change in reproduction

and survival rates or alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC. Given that this effect is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired.

1152 Considering the number of animals potentially affected by the PTS and TTS, respective proportions of the SAC population potentially affected and designed in measures reducing the risk of adverse effects, it is highly unlikely that UXO clearance will influence grey seal of Berwickshire and North Northumberland population trajectory in the long-term.

1153 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of underwater noise during UXO clearance during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1154 The assessment has concluded that UXO clearance activities are highly unlikely to disrupt normal behaviours of grey seal. Since TTS is a temporary hearing impairment, it is unlikely to cause a change in reproduction and survival rates and will not influence the population of qualifying species. Changes in distribution of qualifying species within the site are highly unlikely. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1155 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from injury or disturbance from elevated underwater noise during UXO clearance with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1156 With regards to PTS, the modelling shows that for grey seal, the threshold for PTS is not exceeded by any vessel with the exception of rock placement vessels, for which an injury range of 5 m from the source was reported (Table 7.36). PTS ranges for grey seal were not exceeded for any other activities except for cable laying, where an injury range of 5 m from the source was reported. The number of grey seals potentially affected within the modelled ranges for PTS from vessels and other activities were found to be less than one individual. For Berwickshire and North Northumberland Coast SAC, this equates to <0.1% of the grey seal population. As outlined in paragraph 780, while a high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Berwickshire and North Northumberland Coast SAC (Figure 7.1), a relatively high proportion were also tracked to the Isle of May SAC, with a small proportion travelling to sites further away. Therefore, this number is likely to be an over-estimation of the proportion of seals from the Berwickshire and North Northumberland Coast SAC affected. Given that vessels will follow a Code of Conduct (including advice to operators to not deliberately approach marine mammals) and Navigational Safety Plan (NSP) combined with Vessel Management Plan (NSPVMP), the risk of potential auditory injury will be low.

1157 With regard to behavioural disturbance to grey seals, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m (Table 7.37). Similar ranges for behavioural effects are predicted to occur due to underwater noise from installation and construction vessels as well as rock placement vessels with disturbance ranges of 4,389 m. In comparison, vessels such as excavator, backhoe dredger, pipe laying, geophysical survey vessel and jack up vessel as well as jack-up rig were predicted to result in disturbance ranges out to 300 m.

1158 As discussed in paragraph 874, there is likely to be a proportionate response of animals within the modelled contours (i.e. not all animals will be disturbed to the same extent). Grey seal is likely to be sensitive to disturbance from vessel traffic. However, most of the vessel traffic associated with construction and decommissioning will take place within the Proposed Development array area and Proposed Development export cable corridor, at a distance where overlap of noise disturbance contours (Table 7.37) with the southern half of the SAC which is an important breeding site for grey seals is unlikely. It is therefore highly unlikely that the reproductive and recruitment capability of the species will be affected. Construction activities will be carried out over a medium term and since the behavioural effect is considered to be highly reversible, it is highly unlikely that it will influence grey seal population trajectory in the long-term.

1159 Most of the vessel traffic associated with construction within the Proposed Development array area will take place at distances >35 km from the Berwickshire and North Northumberland Coast SAC. Vessel movements will also increase over construction phase along the Proposed Development export cable corridor. Therefore, due to the proximity of the landfall to the SAC there is a potential for overlap of disturbance ranges with northern section of the SAC. However, it is the southern half of the SAC which is an important breeding site for grey seals (SCOS, 2020; see Figure 7.1 where grey seal telemetry tracks are concentrated in waters around the Farne Islands)

1160 As previously described in paragraph 1107, Anderwald *et al*. (2013) suggested that in the study of displacement responses to construction-related vessel traffic, grey seals avoided the area due to vessel noise. Even if individuals are temporarily deterred from offshore foraging grounds, given that the impacts of construction will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Based on telemetry tracks, the area of high importance for grey seal does not overlap with Proposed Development array area nor the Proposed Development export cable corridor (Figure 7.1). Therefore, it is anticipated that the availability of foraging grounds for grey seals from the Berwickshire and North Northumberland Coast SAC will not be significantly impacted.

1161 As outlined in paragraph 1110, foraging context is important when interpreting avoidance behaviour of grey seals and should be considered when predicting effects. Avoidance rates may depend on perceived risk versus the quality of the prey patch. Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area (see volume 2, chapter 13 of the Offshore EIA Report) it is expected that grey seal could tolerate the effects of disturbance due to vessel movements without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

1162 The effect during the decommissioning phase for both auditory injury and disturbance as a result of elevated underwater noise due to vessel use is not expected to differ or be greater than that assessed for the construction phase.

1163 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of underwater noise during vessel use and other activities during the construction and decommissioning phases (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1164 The assessment has concluded that vessel use, and other activities are highly unlikely to affect reproductive and recruitment capability of the species because important breeding areas within the SAC lie outside of the disturbance ranges. Therefore, underwater noise arising from vessel use will not influence the population of qualifying species. The overlap of disturbance ranges with the SAC is unlikely and therefore vessel use and other activities will not result in changes in the distribution of qualifying species within the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1165 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from injury or disturbance from elevated underwater noise during vessel use and other activities with respect to the construction and decommissioning of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1166 As outlined in paragraph 1010 *et seq.*, there is potential for changes to prey availability for grey seal during construction and decommissioning of the Proposed Development. These impacts include temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration.

1167 There is potential for temporary habitat loss/disturbance to affect up to 113,974,700 m^2 of seabed during the construction phase, which equates to 9.7% of the fish and shellfish ecology study area (see volume 2, chapter 9 of the Offshore EIA Report). Only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase, with areas starting to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works. It is expected that grey seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term. With regard to grey seal main prey item, monitoring studies have shown that offshore wind farm construction has not led to significant adverse effects on sandeel populations and that recovery of sandeel occurs quickly following construction operations (see volume 2, chapter 9 of the Offshore EIA Report).

1168 In terms of indirect effects on marine mammals as a result of underwater noise, it is assumed that marine mammals would be disturbed from the area in vicinity of the noise source, and so any changes to the distribution of prey resources would not affect marine mammals as they would already be disturbed from the same (or larger) area.

1169 Changes to the prey species may also occur due to an increase in SSC and associated sediment deposition (short-term avoidance of affected areas by fish and shellfish). Sandeel eggs are likely to be tolerant to some level of sediment deposition due to the nature of re-suspension and deposition within their natural high energy environment. The effects on sandeel spawning populations are predicted to be limited. Therefore, the availability of suitable food supply for grey seals is not expected to be impaired as a result of increase in SSC and associated sediment deposition.

1170 As outlined in paragraph 1023 *et seq*., while grey seal has a predominantly flatfish and sandeel, the species can forage widely, sometimes covering extensive distances. Given that the impacts of construction will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Telemetry data showed wide-ranging behaviour of grey seals within the northern North Sea, suggesting that, due to the highly mobile nature of grey seals and presence of alternative prey resources and foraging grounds available in the wider area, grey seals will not be constrained by the temporary and reversable nature of impacts associated with construction. There may be an energetic cost associated with increased travelling, however, grey seal is not considered to be particularly vulnerable to this effect as foraging trips tend to be wide-ranging, out to 100 km from a haul out site (SCOS, 2018). There is also evidence that grey seal in Scotland tend to stay within 20 km of the breeding colony during the breeding season. Telemetry data suggest that adult grey seals from Berwickshire and North Northumberland Coast SAC mostly use the area south from the Proposed Development (Figure 7.1). Due to the limited extent of effects associated with construction and decommissioning works, food availability within their foraging from the Berwickshire and North Northumberland Coast SAC is not expected to be impaired (Figure 7.1). It is expected that grey seal population would be able to tolerate the effect without any impact on reproduction and survival rates.

1171 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during the construction and decommissioning phases (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species*).*

Conclusion

1172 The assessment has concluded that grey seal distribution and connectivity with important habitats within and outside the site as well as the availability of suitable food supply is unlikely to be impaired in long term. Therefore there is no risk of structure and function of the habitats of qualifying species being affected. It is expected that grey seal population would be able to tolerate the effect of changes in fish and shellfish communities without any impact on reproduction and survival rates and the population of qualifying species will not be affected. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1173 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from changes in fish and shellfish communities affecting prey availability with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

1174 As discussed in paragraph 1140 *et seq.*, the maximum range at which there is a risk of PTS to grey seal as a result of site investigation surveys is 65 m. With designed in measures (Table 7.40) implemented for the geophysical surveys, the risk of PTS occurring to grey seals will be low. With regard to behavioural disturbance, although a maximum potential disturbance range across all survey types is 7.5 km during vibro-coring, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. It is also anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for grey seals at the SAC as a result of site investigation surveys.

1175 The maximum design scenario for routine geophysical surveys is estimated as a survey every six months for the first two years and annually thereafter. This equates to 37 surveys over the 35-year life cycle of the Proposed Development (Table 7.39). The magnitude of the impact could result in a negligible alteration to the distribution of grey seals only in close vicinity of the source. However, surveys are anticipated to be short-term in nature (weeks to a few months) and occur intermittently over the operation and maintenance phase. Given no overlap between the Proposed Development and Berwickshire and North Northumberland Coast SAC is expected, only a small proportion of grey seal SAC population could be potentially affected, and they would be able to tolerate the effect without any impact on reproduction and survival rates. Therefore, it is highly unlikely that site investigation surveys will influence grey seal population trajectory in the long-term.

1176 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of underwater noise during site investigation surveys during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1177 The assessment has concluded that there will be no introduction of barriers to wider movement for grey seal as a result of elevated sound from site investigation surveys. Therefore site investigation surveys will not result in any long-lasting changes in the distribution of qualifying species within the site. Underwater noise during site-investigation surveys is unlikely to affect grey seal at a level that would substantially

affect their behaviour and cause change in reproduction and survival rates and therefore will not influence the population of qualifying species. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1178 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from injury or disturbance from elevated underwater noise during site investigation surveys with respect to the operation of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1179 As described in paragraphs 1044 *et seq*., vessel use during the operation and maintenance phase of the Proposed Development is considered a relatively small increase in the context of baseline traffic and the size and noise outputs from vessels will be similar to those used in the construction phase. The number of vessel round trips and their frequency will be much lower compared to the construction phase.

1180 Most of the vessel traffic associated with operation and maintenance within the Proposed Development array area will take place at distances >35 km from the Berwickshire and North Northumberland Coast SAC. It can be anticipated that the number of vessel movements will increase during the operation and maintenance phase along the Proposed Development export cable corridor when compared to baseline levels. Therefore, due to the proximity of the landfall to the SAC there is a potential for overlap of disturbance ranges with northern section of the SAC. However, it is the southern half of the SAC which is an important breeding site for grey seals (SCOS, 2020; see Figure 7.1 where grey seal telemetry tracks are concentrated in waters around Farne Islands).

1181 Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area it is expected that grey seal could tolerate the effects of disturbance without any impact on reproduction and survival rate. It is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for grey seals at the SAC.

1182 Given that risk of injury will be reduced as vessels will follow a Code of Conduct and NSPVMP and since the behavioural effect is considered to be highly reversible, it is highly unlikely that vessel use and other activities will influence grey seal population trajectory in the long-term.

1183 Effects on grey seal at this SAC are considered to be the same or less than the effects of vessel use and other activities during the construction and decommissioning phases. It should be noted that operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years) and therefore only a small proportion of vessel use and other activities will occur at any one time.

1184 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of underwater noise during vessel use and other activities during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1185 The assessment has concluded that vessel use and other activities are highly unlikely to affect reproductive and recruitment capability of the species because important breeding areas within the SAC lie outside of the disturbance ranges. Therefore, it will not influence the population of qualifying species. The availability of foraging grounds for grey seals will not be impacted and therefore vessel use and other activities will not result in any long-lasting changes in the distribution of qualifying species within the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1186 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from injury or disturbance from elevated underwater noise during vessel use and other activities with respect to the operation of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1187 As outlined in paragraph 1051 *et seq.*, there is potential for changes to prey availability for grey seals due to potential impacts on prey species during operation and maintenance of the Proposed Development. These impacts include temporary subtidal habitat loss/disturbance, long-term subtidal habitat loss, increased SSC and associated sediment deposition, EMF from subsea electrical cabling and colonisation of foundations, scour protection and cable protection.

1188 Potential temporary habitat loss/disturbance during operation and maintenance equates to a smaller area than that affected during construction (up to 989,000 m^2 which equates to 0.08% of the fish and shellfish ecology area, compared with 9.7% during the construction phase; volume 2, chapter 9 of the Offshore EIA Report). Operation and maintenance activities will occur periodically over the full lifetime of the project (estimated to be 35 years). As described in paragraph 1167, only a small proportion of the maximum footprint of habitat loss/disturbance may occur at any one time, with areas starting to recover immediately after cessation of maintenance activities. It is expected that grey seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term.

1189 In terms of indirect impacts associated with underwater noise and prey resources, it is anticipated that there will be no additional displacement of grey seal, as they would already be potentially disturbed from the same or larger area as a result of underwater noise during maintenance activities.

1190 Increased SSC could occur as a result of repair or remedial burial activities during the operation and maintenance phase. The maintenance activities will be undertaken at intervals over the 35 years operation and maintenance phase. The assessment presented in volume 2, chapter 9 of the Offshore EIA Report considered that any suspended sediments and associated deposition will be of the same magnitude, or lower as for construction, with the sensitivity of the receptors similar to that assessed for the construction phase. The availability of suitable food supply for grey seals is not expected to be impaired as a result of increase in suspended sediments and associated deposition.

1191 The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. The range over which species can detect EMF will be very localised to within a few centimetres of the buried cable, with rapid decay of the EMF with increasing distance. Considering the above, adverse effects on grey seal as a result of changes in fish and shellfish communities affecting prey availability due to EMF are highly unlikely.

1192 Although there will be long term loss of habitat due to the presence of infrastructure associated with the Proposed Development, it is also anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 1021 *et seq*, evidence increasingly suggests that foraging opportunities for marine mammals, including grey seals, are increased around offshore wind farm structures.

1193 As outlined in paragraph 1023 *et seq*., while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species has an observed wide ranging foraging ability within the region. The fish and shellfish communities found within the fish and shellfish ecology study area (see volume 2, chapter 9 of the Offshore EIA Report) are characteristic of the fish and shellfish assemblages in the northern North Sea. The impacts of operation and maintenance works will be highly localised, temporary in nature and restricted to the boundaries of the Proposed Development, only a small area will ever be affected compared with the available foraging habitat for grey seals in the northern North Sea. It is therefore reasonable to assume that, due to the highly mobile nature of grey seals, there will be similar and suitable prey resources available in the wider area. Given that the habitat is likely to return to the state that existed before the activity or event which caused change, it is highly unlikely that maintenance works resulting in habitat loss/disturbance will influence grey seal population trajectory in the long-term.

1194 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Berwickshire and North Northumberland Coast SAC are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during the operation and maintenance phase (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1195 The assessment has concluded that grey seal distribution and connectivity with important habitats within and outside the site as well as the availability of suitable food supply is unlikely to be impaired in long term. Therefore there is no risk of structure and function of the habitats of qualifying species being affected. It is expected that grey seal population would be able to tolerate the effect of changes in fish and shellfish communities without any impact on reproduction and survival rates and the population of qualifying species will not be affected. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1196 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC from changes in fish and shellfish communities affecting prey availability with respect to the operation of the Proposed Development acting alone.

Effects in-combination

1197 An assessment of in-combination effects upon the qualifying Annex II marine mammal species of the Berwickshire and North Northumberland Coast SAC arising from each identified impact is provided below.

1198 The potential to experience injury in terms of PTS by marine mammal receptors as a result of underwater noise due to piling and vessel use/other activities would be expected to be largely localised within the boundaries of the respective projects (assuming similar ranges of effect as presented for the Proposed Development). It is also anticipated that standard offshore wind industry construction methods (which include soft starts and visual and acoustic monitoring of marine mammals as standard) will be applied, thereby reducing the magnitude of the impact with respect to auditory injury occurring in marine mammals. Therefore, there is no potential for significant in-combination impacts for injury from elevated underwater noise during pilling and vessel use/other activities and the in-combination assessment focuses on disturbance only.

Assessment of in-combination effects during construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

Tier 2

1199 The construction of the Proposed Development, together with the construction of the following Tier 2 projects, may lead to injury and/or disturbance to grey seal from the Berwickshire and North Northumberland Coast SAC from underwater noise during piling:

- Tier 2:
  - Inch Cape Offshore Wind Farm; and
  - Seagreen 1A Project.

1200 Both projects screened in for the in-combination assessment for grey seal are located within a behavioural disturbance footprint of the Proposed Development. The outermost contour of 135 dB represents the edge of the area within which grey seal may experience behavioural disturbance during concurrent piling at 4,000 kJ hammer energy at the Proposed Development. The assessment presented in the Inch Cape EIA (Inch Cape Offshore Limited, 2018) and original Seagreen EIA (Seagreen Wind Energy Ltd, 2012) estimated that 1,236 and 465 grey seals could experience disturbance during piling at respective projects. The duration of any disturbance at Seagreen 1A Project will be relatively short and is currently planned to take place between April and July 2023, which is more than two years before planned commencement of piling at the Proposed Development (Seagreen Wind Energy Ltd, 2020).

1201 The construction of Inch Cape and Seagreen 1A Project will be completed prior to commencement of piling at the Proposed Development so the potential for simultaneous piling, and therefore additive in-combination effects, with Proposed Development is highly unlikely. Nevertheless, population modelling was carried out to explore the potential of cumulative effects as a result of disturbance during piling to affect the population trajectory over time. Population modelling considered Seagreen 1A Project and Inch Cape Offshore Wind Farm and respective numbers of animals potentially impacted against the wider MU population (see volume 3, appendix 10.4 for methods applied in the model). Results of the cumulative iPCoD modelling for grey seal showed that no impacts are predicted on the wider MU population resulting from disturbance due to cumulative piling events, with the mean impacted population the same as the mean unimpacted population at the 25 year time point. Therefore, it was considered that there is no potential for a long-term effects on this species within wider population as a result of cumulative piling at proposed Development and respective projects (see volume 3, appendix 10.4 for more details).

1202 In temporal terms, there is a potential that animals in the vicinity of the Firth of Forth and Tay will experience disturbance consecutively as piling at different projects progresses. Grey seals are known to modify their behaviour in a response to piling noise but come back to pre-piling behaviour immediately after pile-driving ceased (Aarts *et al.,* 2018). Therefore, it is anticipated that piling will not result in any long-lasting changes in the distribution of adult seals from this SAC and the connectivity with areas of high importance within and outside the site is not expected to be impaired. Given that the risk of simultaneous piling is very low and that grey seal population in Berwickshire and North Northumberland Coast SAC is increasing, it is unlikely that effect as a result of piling in-combination with other projects has the potential to have a significant impact on grey seal population trajectory in long term. Therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be affected.

1203 As described in paragraph 1133, during piling at Proposed Development, the outer behavioural disturbance contours (135 dB) overlap with coastal areas south of the Proposed Development and therefore there is a small overlap with northern part of the Berwickshire and North Northumberland Coast SAC (in volume 2, chapter 10 of the Offshore EIA Report, Figure 7.1). As there will be no temporal overlap of piling phases with either of the projects, and since both projects are located further from the Berwickshire and North Northumberland Coast SAC, grey seals present in vicinity of habitats utilised throughout their life cycle are highly unlikely to experience disturbance cumulatively. As such, as stated for the Proposed Development alone, piling activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect reproduction and survival rates.

1204 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of underwater noise during piling during construction with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1205 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to grey seal of Berwickshire and North Northumberland during the construction

phase of the Proposed Development with the construction and operation and maintenance Eastern Link 1 and Eastern Link 2.

1206 The construction as well as operation and maintenance phases of Eastern Link 1 and Eastern Link 2, located respectively 14 km and 28 km from the Proposed Development array area, will overlap with the construction phase of the Proposed Development. Based on the Environmental Appraisals for both projects, the only underwater sound noise sources that are within hearing range of marine mammals and have potential to have an effect, are the operation of the USBL and the SBP (AECOM, 2022a; 2022b). The disturbance ranges for grey seal were estimated as 63 m for USBL and 4,642 m for SBP. The detailed assessment of impacts as a result of underwater noise during the operation of SBP for both projects was presented for installation phase only. There were no disturbance ranges presented for a USBL for the Proposed Development alone but the disturbance range for SBP has been assessed as 2,045 m. Nevertheless, the assessment presented in paragraph 955 *et seq*. is based on the maximum disturbance range all geophysical activities, which for the Proposed Development was predicted for vibro-coring as 7,459 m. Using the published at-sea density maps (Carter *et al*., 2020), the maximum number of grey seals estimated to be disturbed was 210 grey seals (21% of the Berwickshire and North Northumberland Coast SAC population). However, this was shown to be highly precautionary when compared with estimates of the number of grey seal using site-specific densities derived from the Proposed Development aerial digital survey data (see paragraph 1142 for more details).

1207 Based on the distance from the Proposed Development to both projects, the overlap of disturbance ranges is highly unlikely. The potential for an overlap exist only for site-investigation surveys taking place in the northern part of the Eastern Link 1, close to the Proposed Development export cable corridor and landfall (Figure 7.3, the Berwickshire and North Northumberland Coast SAC is 0.1 km from the Eastern Link 1 marine installation corridor). However, it must be noted that site investigation survey equipment will not be operating continuously, it will be used when required for investigations of particular areas of the seabed where additional information is required to inform the construction.

1208 With foraging ranges of up to 100 km, grey seals may be sensitive to behavioural disturbance during the site-investigation surveys as they move between haul-outs and key foraging areas. As advised by NatureScot (Table 2.1), grey seal in Scotland tend to stay within 20 km of the breeding colony during the breeding season, therefore that further restricts the foraging grounds in the vicinity of haul outs. During the breeding or moulting season many seals tend to spend more time on land, unaffected by underwater sound. Nevertheless, the availability of food is vital to offspring survival and female fitness (see paragraph 1085 *et seq.* for more details). Animals may be deterred from foraging grounds during the operation of the survey equipment. However, given that alternative areas for foraging are widely available, the disturbance to seals foraging offshore is not considered likely to have a significant impact on food availability (see paragraph 1225 *et seq*. for the in-combination assessment of impacts as a result of changes in fish and shellfish communities affecting prey availability) and therefore on fitness and survival of the grey seal population. Given that geophysical surveys will occur intermittently and are short in duration, grey seals are anticipated to return to foraging grounds when the impact has ceased and therefore the connectivity with important habitats within and outside the site is unlikely to be impaired.

1209 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of site investigation surveys during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during UXO clearance

Tier 2

1210 There is potential for in-combination effects from injury and/or disturbance from underwater noise during UXO clearance to grey seal from the Berwickshire and North Northumberland Coast SAC during the construction phase of the Proposed Development with activities associated with Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm.

1211 Projects screened in for this in-combination assessment are expected to involve similar construction activities to those described for the Proposed Development alone, including UXO clearance works. It is anticipated that, for all projects, impacts associated with these activities will require additional assessment under EPS licensing, however such applications are not yet available in the public domain.

1212 For the Proposed Development alone, the maximum range across which grey seals have the potential to experience PTS due to high order detonation of 300 kg charge was assessed as approximately 2,085 m. PTS onset ranges for Inch Cape Offshore Wind Farm and Moray West are currently unknown but for the purpose of this assessment, we can assume that the maximum adverse scenario is not greater than assessed for the Proposed Development alone. Depending on the type of detonation and size of the explosive, UXO clearance activities may have residual effects in respect to marine mammals and PTS injury. In November 2021, the UK government published a joint interim statement advising to use low noise alternatives to high order detonations where possible and it is anticipated that future developments will follow this guidance. However, due to a small inherent risk with these clearance methods that the UXO will detonate or deflagrate violently, accidental high order detonation can be expected as a maximum adverse scenario. Taking into account high order detonation of 300 kg charge and appropriate designed in and secondary mitigation measures (paragraph 967 *et seq.*), there will be no residual risk of injury and therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be impacted.

1213 In terms of TTS, for the Proposed Development alone, the range across which grey seals have the potential to experience TTS due to high order detonation of a 300 kg charge was as approximately 6,430 m. TTS onset ranges for Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm are currently unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is no greater than assessed for the Proposed Development alone. A spatial maximum adverse scenario would occur where UXO clearance activities occur concurrently at the respective projects considered in the in-combination assessment. This is however highly unlikely, as due to safety reasons the UXO clearance activities takes place before other construction activities commence, and both projects considered in the CEA start their construction activities two years before commencement of construction at Proposed Development. Temporally however, sequential UXO clearance at respective projects could lead to a longer duration of effect. Since each clearance event results in no more than a one second ensonification event and since TTS is a recoverable injury, the potential for in-combination effects with respect to TTS is considered to be very limited. Therefore, in-combination effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC. Given that effect of TTS is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired.

1214 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of underwater noise during UXO clearance during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1215 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to grey seal from the Berwickshire and North Northumberland Coast SAC during the construction and decommissioning phase of the Proposed Development with activities associated with the following projects: Eyemouth disposal site, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Neart na Gaoithe and Blyth Demo 2.

1216 Whilst there is no quantitative information available for noise disturbance ranges for offshore wind farms included in this CEA, it is anticipated that there will be a similar scale of effects with respect to noise effects as those described for Proposed Development alone (paragraph 988 *et seq*.). In terms of behavioural disturbance, the noise modelling predicted a maximum range of approximately 4 km for construction activities such as cable laying as well as activity of rock placement vessels (described in detail in volume 3, appendix 10.1 of the Offshore EIA Report) and therefore, there is a potential for disturbance effects to occur cumulatively. Given that construction activities for the other offshore wind projects have commenced in 2020 and that this is an area of relatively high vessel traffic (see paragraph 989 *et seq*. for more details), it can be anticipated that grey seals from the Berwickshire and North Northumberland Coast SAC demonstrate some degree of habituation to ship noise. Therefore, in-combination effects caused by vessel use and other activities are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC.

1217 The highest number of vessels movements was predicted during the construction phase of each offshore wind farm. There would potentially be a relatively small temporal overlap of the construction phases, with only one year of overlap with Inch Cape as well as Seagreen 1A Project and the Proposed Development. Therefore, the potential in-combination effect during construction phases of the respective projects and the proposed Development will be short-term (no more than one year).

1218 Vessel movements will be confined to the array areas and/or Proposed Development export cable corridor routes and will follow existing shipping routes to/from port. In Scotland, grey seal are thought to primarily forage within 20 km of the breeding colony during the breeding season. Given the location of respective projects screened into in-combination assessment, there is unlikely to be overlap with the zones of impact of in-combination projects with the southern part of the SAC, which is an important haul out area for grey seals (paragraph 1120). Given that the disturbance will be largely localised to boundaries of respective projects and cumulatively could affect grey seals over short term, it is highly unlikely that vessel use will influence grey seal SAC population trajectory in the long-term.

1219 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1220 There is potential for in-combination effects from underwater noise due to vessel use and other activities to grey seal from Berwickshire and North Northumberland Coast SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1221 There is currently no information on the impacts the Cambois connection will have on grey seal, although the Scoping Report have listed the types of vessels to be used during construction, including cable lay vessels, pre-lay survey vessels, rock protection vessels, support vessels, guard vessels, and possible use of jack-up vessels. There was no details about number of vessel round trips during the construction phase of Cambois connection. No data for vessel movements was presented for operation and maintenance phase of the Cambois connection.

1222 Due to lack of project information at this stage, it is not possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided. The maximum range over which potential disturbance may occur for the Proposed Development alone as a result of drilled piling and jet trenching, is predicted out to 1,900 m and 2,580 m, respectively. Cable installation activities assessed for the Proposed Development alone have the potential to disturb marine mammals out to 4,389 m. Given the location of the SAC with respect to the Proposed Development and Cambois connection, there is no potential for cumulative overlap of behavioural ZoI at respective projects and this designated site.

1223 Nevertheless, outside the SAC in offshore waters, construction activities could lead to a larger area of disturbance and larger number of animals disturbed within their foraging range compared to the Proposed Development alone if projects were to conduct construction activities over similar time periods. As described in paragraph 1216 *et seq.,* it can be anticipated that grey seals from this SAC demonstrate some degree of habituation to ship noises. Therefore, in-combination effects caused by vessel use and other activities are considered unlikely to cause a change in reproduction and survival rates or long-term alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC.

1224 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 3 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1225 There is potential for in-combination effects from changes in the prey resources available for grey seal of the Berwickshire and North Northumberland Coast SAC as a result of changes to the fish and shellfish community during the construction and decommissioning phases of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1 Offshore Wind Farm, Seagreen 1A Project, Seagreen Eastern Link 1, Seagreen 1A Export Cable Corridor, Eastern Link 2 and Eyemouth disposal site.

1226 The construction phases and/or operation and maintenance phases of projects screened into in-combination assessment may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss is 145,325,450 m^2 (=145.3 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The magnitude of long-term habitat loss caused by the presence of all structures on the seabed has been considered for the construction as well as operation and maintenance phases. The impacts have been assessed in-combination with Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, and Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Links 2 and may lead to long term subtidal habitat loss of up to 15,014,156 m^2 (=15.0 km^2).

1227 An increase in SSC and associated sediment deposition as a result of the construction as well as operation of projects screened into the in-combination assessment may result in short-term avoidance of affected areas by fish and shellfish which may have an indirect effect on grey seals. As presented in volume 2, chapter 9 of the Offshore RIA Report, adult fish have high mobility and may show avoidance behaviour in areas of high sedimentation, however, there may be impacts on the hatching success of fish and shellfish larvae and consequential effects on the viability of spawning stocks due to limited mobility. Spawning grounds for important key species, specifically sandeel overlap with the Proposed Development fish and shellfish ecology study area, however, eggs of these species are known to be tolerant to some level of sediment deposition due to the nature of re-suspension and deposition within their natural high energy environment. Elevations in SSC are expected to be of short duration, returning to background levels relatively quickly. SSC are not expected to reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Given the localised extent of impacts associated with construction and decommissioning activities, these are highly unlikely to have indirect impacts on grey seals via changes to prey species due to an increase in SSC and associated sediment deposition.

1228 As outlined in paragraph 1023 *et seq*., while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species can forage widely, sometimes covering extensive distances. Given that

the impacts of temporary and long-term habitat loss/disturbance will be localised when compared to wider habitat available and largely restricted to the boundaries of the respective projects, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Based on the telemetry study, most grey seal tracks originating from Berwickshire and North Northumberland Coast SAC are confined to the south of the Proposed Development array area and Proposed Development export cable corridor (Figure 7.1). All projects listed in paragraph 1225, except Eastern Link 1 and Easter Link 2, are located north from the Proposed Development array area and therefore do not overlap with areas characterised by high density of grey seal telemetry tracks. As such, it can be assumed that the majority of the area affected by temporary habitat disturbance/habitat loss at projects considered in in-combination assessment (Figure 7.3) does not represent important foraging grounds for individuals from Berwickshire and North Northumberland Coast SAC. Additionally, since the habitat is likely to return to the state that existed before the activity or event which caused change, the availability of suitable food supply for grey seals is not expected to be impaired hence the population trajectory is unlikely to be affected in the long-term.

1229 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1230 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to grey seal from Berwickshire and North Northumberland Coast SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1231 The construction phase of Cambois connection may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss/disturbance is 17,000,000 m^2 (=17.0 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The majority of this disturbance will not spatially overlap with the Proposed Development and where the overlap exist with the Proposed Development array area (previously impacted during the construction of the Proposed Development), it is expected to be highly localised and so the potential for repeat disturbance is considered low and unlikely to lead to an increase in the magnitude than predicted for the Proposed Development alone. The installation of Cambois connection can also result in a total area of long-term subtidal habitat loss of 306,000 m^2.

1232 There is also a potential for in-combination effects associated with SSC and associated deposition. However, elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Therefore, it is highly unlikely to have indirect impacts on grey seals from Berwickshire and North Northumberland Coast SAC via changes to prey species.

1233 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 3 projects.

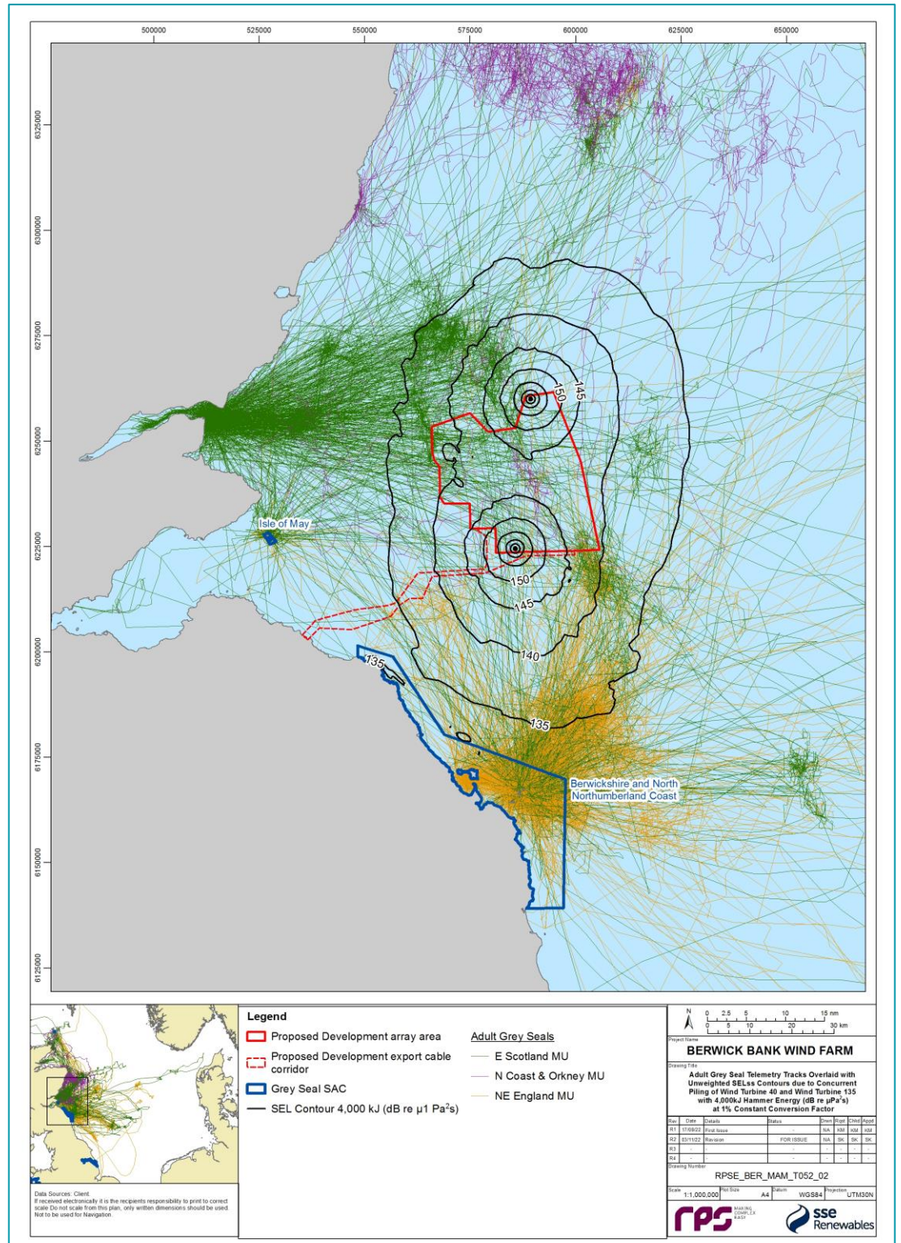

Figure 7.3: Adult Grey Seal Telemetry Tracks Overlaid with Projects Considered in In-Combination Assessment (Except Moray West Due to Scale)

Assessment of in-combination effects during operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1234 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to grey seal from the Berwickshire and North Northumberland Coast SAC during the operation and maintenance phase of the Proposed Development with the operation and maintenance Eastern Link 1 and Eastern Link 2.

1235 The maximum design scenario for Proposed Development alone comprises of routine geophysical surveys estimated to occur every six months for first two years and annually thereafter. This equates to up to 37 surveys over the 35-year life cycle of Proposed Development (Table 5.2). As presented in paragraph 1206, the detailed assessment of impacts on marine mammals as a result of underwater noise due to geophysical surveys during the operation and maintenance phase of the Eastern Link 1 and Eastern Link 2 is unavailable.

1236 An overview of potential impacts from as a result of behavioural disturbance due to elevated underwater noise during geophysical site investigation surveys is described in paragraph 1205 *et seq*. for the construction phase and has not been reiterated here for the operation and maintenance phase. The magnitude of the impact of underwater noise from geophysical surveys during operation and maintenance phase in combination with other projects considered in cumulative assessment could result in a negligible alteration to the distribution of grey seal in the short-term, however the overlap of disturbance ranges is unlikely. Given that geophysical surveys will occur intermittently over operation and maintenance phases of respective projects and are short in duration, grey seals are anticipated to return to foraging grounds when the impact has ceased and therefore the connectivity with important habitats within and outside the site is unlikely to be impaired.

1237 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of site investigation surveys during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1238 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to grey seal from the Berwickshire and North Northumberland Coast SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: the Eyemouth disposal site, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Blyth Demo 2 and Neart na Gaoithe Offshore Wind Farm.

1239 Vessels involved in the operation and maintenance of other wind farms will include a similar suite of vessels as those described for the Proposed Development alone (see paragraph 989 *et seq.*), such as vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth and replacement of access ladders. It has been assumed that future case traffic growth is likely to fluctuate depending on seasonality and cargo and industry trends. Based on the telemetry data, only few grey seals individuals from Berwickshire and North Northumberland Coast SAC may range further than 100 km radius from haul out sites (including juveniles), therefore projects located further offshore are unlikely to have in-combination effects on this SAC (Figure 7.3).

1240 Given that the number of vessel round trips and their frequency is much lower for the operation and maintenance phases compared to construction phases of the respective projects, the magnitude of the impact for disturbance as a result of elevated underwater noise due to vessel use and other activities is expected to be less than that assessed for the construction phase. However, the duration of the effect will be longer (over the 35-year operating lifetime of the Proposed Development).

1241 During the operation and maintenance phase of the Proposed Development, the wind farms listed in paragraph 1238 will reach their decommissioning age before the Proposed Development reaches its decommissioning age in 2066. The environmental statements for respective projects predicted the number and type of vessels associated with decommissioning are expected to be, at worst, similar to construction. Therefore, in-combination effects caused by vessel use and other activities during operation and maintenance phase are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC.

1242 Additionally, it can be expected that after more than ten years of construction activities taking place in the vicinity of Firth of Forth (i.e. Seagreen 1 construction activities commenced in 2021 and the operation and maintenance phase of Proposed Development is expected to start from 2033), marine mammals present in the area will demonstrate some degree of habituation to ship noises.

1243 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1244 There is potential for in-combination effects from underwater noise due to vessel use and other activities to grey seal from Berwickshire and North Northumberland Coast SAC during the operation and maintenance of the Proposed Development with activities associated with the operation of Cambois connection.

1245 As presented in paragraph 1221, there were no details about the number of vessel round trips or type of vessels that will be used during operation and maintenance phase of Cambois connection (SSE Renewables, 2022e). Due to lack of detailed project information at this stage, it was not possible to undertake full, quantitative assessment for this impact.

1246 An overview of potential impacts for behavioural disturbance to grey seal from Berwickshire and North Northumberland Coast SAC from elevated underwater noise due to vessel use and other activities is described in paragraph 1220 *et seq*. for the construction phase and have not been reiterated here for the operation and maintenance phase.

1247 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 3 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1248 There is potential for in-combination effects from changes in prey resources to grey seal from the Berwickshire and North Northumberland Coast SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1, Eastern Link 2, and Eyemouth disposal site.

1249 Operation and maintenance activities at respective projects considered in in-combination assessment may lead to temporary subtidal habitat loss/disturbance of up to 32,276,397 m^2. Additionally, Offshore Wind Farms listed above will reach their decommissioning age during Proposed Development operation and maintenance phase. It is important to note that the maximum design scenario for habitat loss from the

respective projects is precautionary, as operation and maintenance activities will occur intermittently throughout the lifetime of the Proposed Development and the temporal overlap with activities at other projects is unlikely. As described in paragraph 1167, only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time, areas will start to recover immediately after cessation of maintenance activities. It is expected that grey seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term.

1250 In-combination impacts could arise from EMFs due to the presence of subsea cabling during the operation and maintenance phases of the Proposed Development as well as Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1 and Eastern Link 2. A total length of up to 6,112 km of subsea cabling was estimated for all projects. The EMF was predicted to be of local spatial extent Considering the above, adverse effects on grey seal as a result of changes in fish and shellfish communities affecting prey availability due to EMF are unlikely.

1251 As outlined in paragraph 1023 *et seq*., while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species can forage widely, sometimes covering extensive distances. Given that the impacts of temporary and long-term will be localised when compared to wider habitat available and largely restricted to the boundaries of the respective projects, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Based on the telemetry study, most grey seal tracks originating from Berwickshire and North Northumberland Coast SAC are confined to the south of the Proposed Development array area and Proposed Development export cable corridor (Figure 7.1). Therefore, it can be assumed that the area affected by temporary habitat disturbance/habitat loss at projects considered in in-combination assessment does not represent important foraging grounds (Figure 7.3). Additionally, since the habitat is likely to return to the state that existed before the activity or event which caused change, the availability of suitable food supply for grey seals is not expected to be impaired hence the population trajectory is unlikely to be affected in the long-term.

1252 Artificial structures introduced into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. There is a potential for in-combination effects arising from colonisation due to the presence of Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Link 2 with a maximum scenario of up to 15,014,156 m^2 of hard structures from wind turbines, OSP/Offshore convertor station platforms, meteorological masts, of cable protection, and cable crossings. The in-combination effect was predicted to be of local spatial extent. There is some evidence that marine mammal populations are likely to benefit from introduction of hard substrates and associated fauna, as studies reported that grey seal were frequently recorded around offshore oil and gas structures (see paragraph 1022 for more details). Therefore, it likely that placement of man-made structures on the seabed will benefit grey seal population.

1253 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1254 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to grey seal from Berwickshire and North Northumberland Coast SAC during the operation and maintenance phase of the Proposed Development with activities associated with the operation of Cambois connection.

1255 In terms of temporary subtidal habitat loss/disturbance, there are no specific values for the operation and maintenance phase of Cambois connection which will occur during the operation and maintenance phase of the Proposed Development. However, Cambois connection has the potential to result in cumulative EMF effects from subsea electrical cabling within the Proposed Development. The Cambois connection is understood to have 680 km of cable. The effect of EMF was predicted to be of local spatial extent.

1256 The Cambois connection has the potential to create 306,000 m^2 of new hard habitat associated with rock/mattress cable protection, which represents a change in seabed type, the effects of which are described in paragraph 1022 *et seq*. As the cable protection does not extend into the water column the opportunity for colonisation by some species is reduced, nevertheless there is a potential that placement of man-made structures on the seabed will benefit grey seal population.

1257 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 3 projects.

Site conclusion

1258 In conclusion, with reference to the conservation objectives set for the Annex II marine mammal features of the site and the information presented in sections 7.3, 7.4, 7.5 and 7.6.1, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effects on Integrity on the Berwickshire and North Northumberland Coast SAC in respect of the grey seal qualifying interests.

1259 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

7.6.2 ISLE OF MAY SAC

European site information

1260 The Isle of May SAC extends over an area of 3.5 km^2 (JNCC, 2015) and is located approximately 38.5 km from the Proposed Development array area and 20.9 km from the Proposed Development export cable corridor. It is located at the entrance to the Firth of Forth on the east coast of Scotland and supports the fourth largest breeding group of grey seals in the British Isles (contributes approximately 4.5% of the annual UK pup production) (JNCC, 2015). The SAC is the largest east coast breeding colony of grey seal in Scotland and comprises up to 5,900 individuals. The annual SCOS reports suggest that the population of grey seals within this SAC is increasing (e.g. SCOS, 2019; SCOS, 2020).

1261 The grey seal feature of the site was last assessed as being in 'favourable maintained' condition in November 2014[16].

1262 NatureScot and MS provided scoping advice in December 2021, which recommended use of SCOS (2020) pup production estimates to inform grey seal populations at Berwickshire and North Northumberland Coast SAC and Isle of May SAC. In March 2022, NatureScot and MS revised this advice following a request for

[16] https://sitelink.nature.scot/site/8207 Accessed 14 March 2022

clarification and recommended the use of maximum population estimates from the JNCC Standard Data Forms instead. As outlined above, this results in a population of 5,900 individuals to be considered at Isle of May SAC (JNCC, 2015ba).

1263 Further information on this European site is presented in appendix A.

Conservation objectives

1264 The conservation objectives for grey seal at Isle of May SAC have been developed by NatureScot[17] as follows:

- To avoid the deterioration of the habitat of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

1265 No supplementary advice on the conservation objectives (similar to that available for Berwickshire and North Northumberland Coast SAC), or Conservation Advice Packages (CAP) are available for the Isle of May SAC.

Features and effects for assessment

1266 The potential for adverse effects has been identified for the following Annex II marine mammal features of this site:

- Grey seal

1267 The following impacts associated with the construction and decommissioning of the Proposed Development were identified as having the potential for adverse effects on grey seal at this site:

- **Injury and disturbance from underwater noise** generated by following activities:
  - Piling of fixed foundations;
  - Clearance of UXO;
  - Site investigation surveys; and
  - Vessel use and other activities.
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in fish and shellfish communities affecting prey availability.

1268 The following impacts associated with the operation and maintenance of the Proposed Development were identified as having the potential for adverse effects on grey seal at this site:

- **Injury and disturbance from underwater noise** generated by site investigation surveys as well as vessel use and other activities; and
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in fish and shellfish communities affecting prey availability.

1269 The following assessment is structured to first assess whether the construction and decommissioning impacts will have an adverse effect on the integrity of the grey seal feature of the site, and then the impacts associated with operation and maintenance will be assessed. For the purposes of these assessments, the potential effects are considered in relation to the site's conservation objectives.

Construction and decommissioning

<u>Injury and disturbance from elevated underwater noise during piling</u>

1270 Underwater noise could affect the population and distribution of the qualifying species. Underwater noise modelling has been undertaken to estimate the maximum potential injury ranges for underwater noise that could arise during construction and decommissioning in relation to grey seal. The modelling was based on the maximum design scenario (as outlined in Table 7.10) with summary of noise modelling provided in paragraph 834 *et seq*.

1271 The maximum range for injury as a result of piling to grey seal was estimated as 118 m based on SPL_{pk} and using the 1% constant conversion factor (see paragraph 881 *et seq*). Taking into account the most conservative scenario, less than one grey seal was predicted to be potentially injured, which accounts for <0.02% of the Isle of May SAC population. As outlined in paragraph 780, while a relatively high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Isle of May SAC (Figure 7.4), a high proportion were also tracked to the Berwickshire and North Northumberland Coast SAC, with a small proportion travelling to sites further away. Therefore, this number is likely to be an over-estimation of the proportion of seals from the Isle of May SAC affected. With designed in measures in place (Table 7.11), which are in line with recommended best practice guidelines, the magnitude of the impact would result in a negligible risk of injury to grey seal.

1272 In terms of behavioural disturbance, up to 1,358 animals were predicted to be potentially disturbed as a result of concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.15). These results are considered highly precautionary as there is a number of conservative assumptions in subsea noise model, (i.e. the maximum hammer energy of 4,000 kJ is unlikely to be reached at all piling locations (see paragraph 844 *et seq.* for more details)). This maximum disturbance scenario suggests that 24.6% of the grey seal population at Isle of May SAC have the potential to be disturbed as a result of piling, however, this is highly unlikely to be the case in reality. As outlined in paragraph 780, telemetry data showed that 41% of tagged grey seal individuals were tracked between the Proposed Development marine mammal study area and the Isle of May SAC. While there is connectivity between the SAC and the Proposed Development and there is a potential for some individuals to be present within the behavioural disturbance footprint during piling, the behavioural disturbance contours do not overlap with the SAC (Figure 7.4). It is considered highly unlikely that 24.6% of the Isle of May population would be within the disturbance zone for the duration of piling.

[17] https://sitelink.nature.scot/site/8278. Accessed 02 September 2022.

1273 As outlined in paragraph 884, the total duration of piling could potentially affect a maximum of five breeding cycles for grey seals. Piling activities will be intermittent and will occur over small timespan (372 days) within piling phase (52 months) and therefore can affect grey seals over the medium term.

1274 The behavioural disturbance contours do not reach the coast and hence do not overlap with the Isle of May SAC (Figure 7.4). Grey seals present in the vicinity of the habitats within the SAC, are therefore unlikely to experience disturbance as these areas lie outside of the noise disturbance contours. As such, piling activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect maintaining supporting habitats.

1275 Grey seal in inshore waters could experience mild disturbance where these areas overlap with 135 dB disturbance contour. To investigate the number of animals potentially disturbed in the vicinity of the SAC, a 20 km buffer around the Isle of May has been applied (based on foraging range during breeding season, see Table 2.1; Figure 7.5). Based on Carter *et al*. (2020) seal at-sea density grids and the area of overlap between the 20 km foraging range and the outer disturbance contour, a maximum of 18 animals could potentially experience mild disturbance within the foraging range from the Isle of May SAC. Given that animals would be potentially exposed only to low noise levels, these are unlikely to lead to barrier effects and it is expected that they will exhibit some tolerance to the mild disturbance at the coast. Therefore, disturbance caused by piling is considered unlikely to cause a change in reproduction and survival rates.

1276 During piling, there is the potential for some animals to be temporarily deterred from the offshore areas. As grey seals feed in the water column over a variety of habitats, they may use different foraging areas at different times of the year to target seasonal prey. Telemetry data suggest that adult grey seals from Isle of May SAC forage in waters to the north, north-east and east from the SAC and therefore there is a potential for individuals to forage within noise disturbance contours (Figure 7.4). However, as described in paragraph 1084, grey seals although initially displaced due to pile-driving, are likely to return to the same area on subsequent trips following cessation of piling. Therefore, it is anticipated that piling will not result in any long-lasting changes in the distribution of adult seals from this SAC and the connectivity with areas of high importance within and outside the site is not expected to be impaired.

1277 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of underwater noise during piling during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1278 The assessment has concluded that piling activities are highly unlikely to disrupt normal behaviours of grey seal because the behavioural disturbance contours do not reach the coast and hence do not overlap with the site. Therefore the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. Animals would be potentially exposed only to low noise levels along the coast and these are unlikely to lead to barrier effects or strong behavioural response. Therefore, disturbance caused by piling is considered unlikely to cause a change in reproduction and survival rates and will not influence the population of the species as a viable component of the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1279 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from injury and disturbance due to underwater noise during piling with respect to the construction of the Proposed Development acting alone.

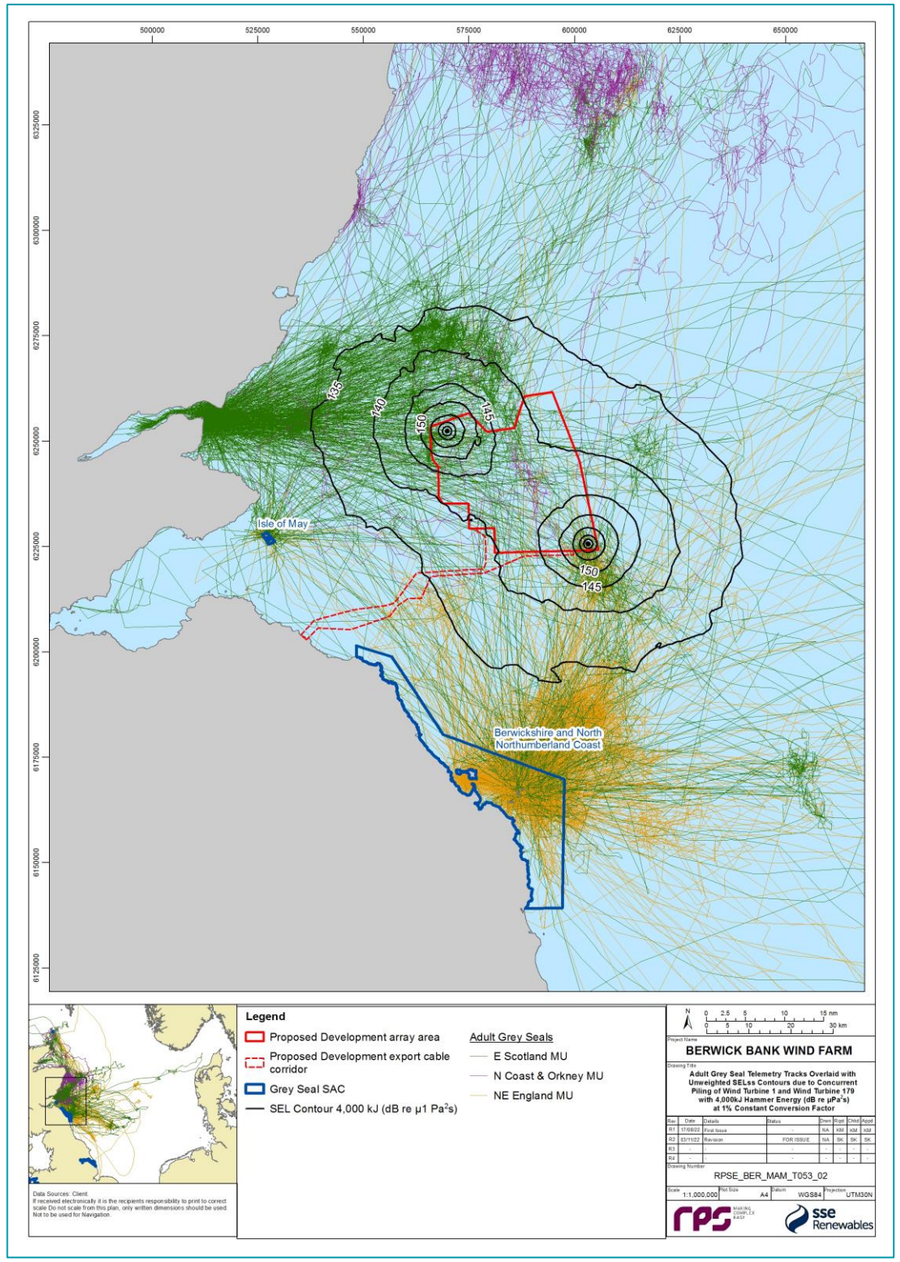

Figure 7.4: Unweighted SEL Contours Due to Concurrent Impact Piling of Wind Turbine Piles at Maximum Hammer Energy (4,000 kJ) Overlaid with Adult Grey Seal Telemetry Tracks

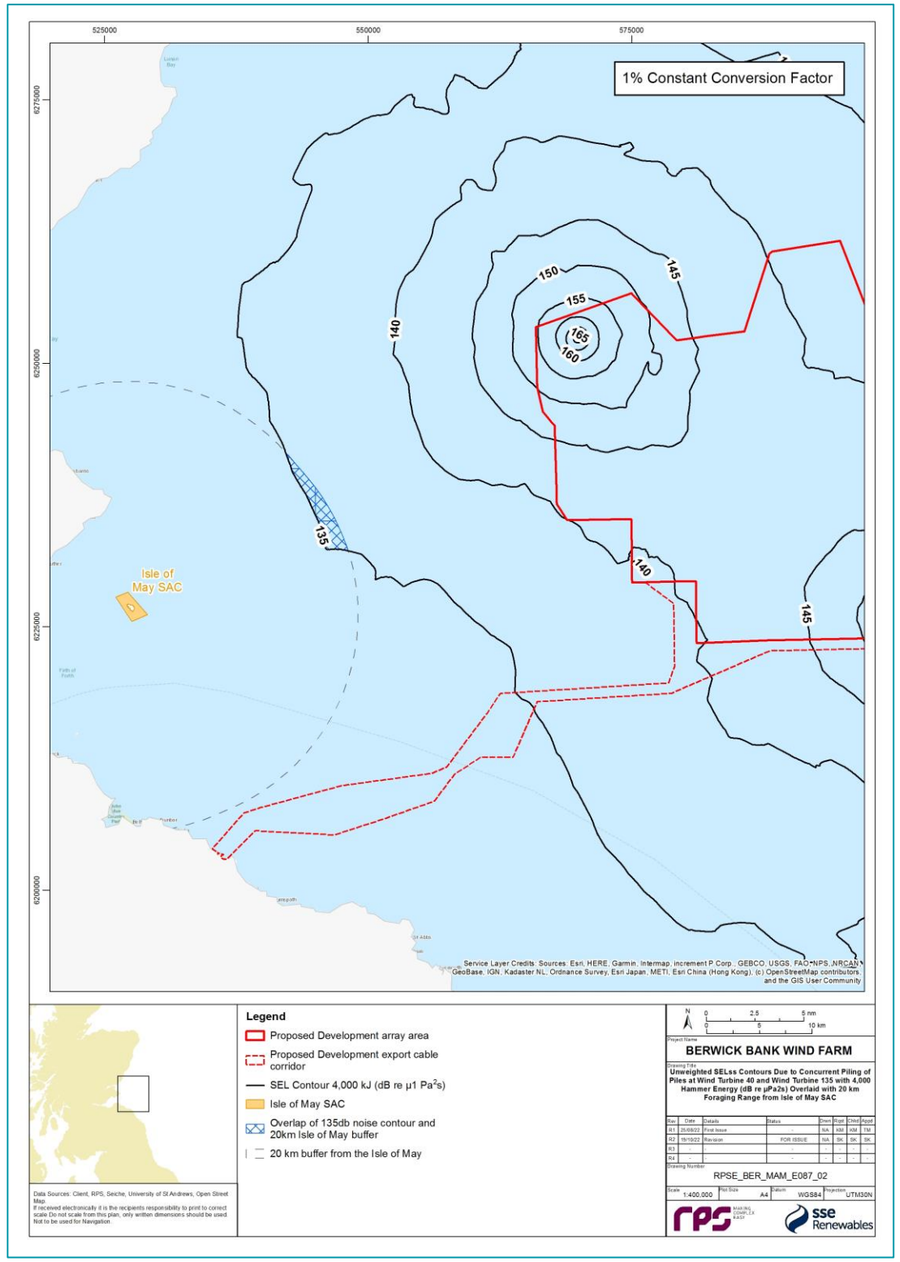

Figure 7.5: Unweighted SEL Contours Due to Concurrent Impact Piling Overlaid With 20 km Buffer from the Isle of May SAC

<u>Injury and disturbance from elevated underwater noise during site investigation surveys</u>

1280 The noise modelling showed that ranges within which there is a risk of PTS to grey seals as a result of geophysical surveys are relatively low with a maximum impact range of 65 m (due to operation of SSS, SBES and SBP; see paragraph 945 *et seq.*). For geotechnical survey activities, PTS impact thresholds for grey seal are not exceeded (Table 7.21).

1281 There is potential for less than one animal to experience PTS as a result of geophysical and geotechnical site investigation surveys (<0.02% of the Isle of May SAC population). The surveys are considered to be short-term as they will take place over a period of up to three months. It should be noted that since sonar-based systems have strong directivity, there is only potential for injury when marine mammals are directly underneath the sound source. With designed in measures in place, which are in line with recommended best practice guidelines (Table 7.11), due to the low risk of PTS occurring and the short-term duration of the geophysical surveys, no adverse effects associated with auditory injury to grey seals are predicted as a result of site investigations surveys. It is anticipated that as a result of site investigation surveys there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for grey seals at the SAC as a result of elevated sound from site investigation surveys.

1282 In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting grey seal is out to approximately 7.5 km during vibro-coring. Using the published at-sea density maps (Carter *et al.,* 2020) the maximum number of grey seals estimated to be disturbed was 210 grey seals as a result of vibro-coring (3.6% of the Isle of May SAC population). However, this was shown to be highly precautionary when compared with estimates of the number of grey seal using site-specific densities derived from the Proposed Development aerial digital survey data. and. For example, based on the mean monthly density (0.276 animals per km^2) and seasonal peak density (0.321 animals per km^2) from aerial data, the number of grey seal affected by possible disturbance during vibro-core testing, would be 48 animals (0.8% of the SAC population) and 56 animals (1.0% of the SAC population), respectively. Although there is a potential for behavioural disturbance during vibro-core survey, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Therefore, underwater noise during site-investigation surveys is unlikely to affect grey seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates.

1283 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of underwater noise during piling site investigation surveys the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

<u>Conclusion</u>

1284 The assessment has concluded that there will be no introduction of barriers to wider movement for grey seal as a result of elevated sound from site investigation surveys. Therefore the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. Underwater noise during site-investigation surveys is unlikely to affect grey seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates and therefore will not influence the population of the species as a viable component of the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1285 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the construction of the Proposed Development acting alone.

Injury disturbance from elevated underwater noise during UXO clearance

1286 Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that grey seal could be potentially affected by PTS at the maximum range of 2,085 m due to detonation of charge size of 300 kg (Table 7.24). Conservatively, the number of grey seals that could be potentially injured by the high order UXO clearance event is up to 16 animals (Table 7.27). This represents a possible 0.3% of the Isle of May SAC population. As outlined in paragraph 780, while a relatively high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Isle of May SAC, a high proportion were also tracked to the Berwickshire and North Northumberland Coast SAC, with a small proportion travelling to sites further away. Therefore, this number is likely to be an over-estimation of the proportion of seals from the Isle of May SAC affected.

1287 To reduce the potential of experiencing injury, designed in measures, which are in line with recommended best practice guidelines, will be adopted as part of a MMMP (see Table 7.11). Given that there is a potential to experience auditory injury by grey seal at a greater range than can be mitigated by monitoring of the 1 km mitigation zone alone (Table 7.24), an ADD will be deployed for a pre-determined length of time to deter marine mammals to a greater distance prior to any detonation. Activation of ADD for 22 minutes is considered sufficient to deter grey seal from the potential injury zone as a result of high order detonation of 300 kg UXO (Table 7.24). A MMMP will be developed for the purpose of mitigating the risk of auditory injury (PTS) to marine mammals from the proposed UXO clearance activities at the Proposed Development based on an assessment which will be provided as a part of the EPS licence supporting information.

1288 Moreover, it is anticipated that only 10% of all UXO clearance events will result in high order detonation as low order techniques will be applied as the intended methodology for clearance of UXO. The underwater noise modelling results show that grey seal can be potentially affected by PTS at the maximum range of 250 m due to detonation of 0.5 kg clearance shot (Table 7.24), with one animal potentially affected (Table 7.25). This accounts for 0.02% of the Isle of May Coast SAC population.

1289 Given that only small number of grey seals have the potential to be affected by PTS from UXO clearance events and mitigation measures are likely to reduce the risk of injury to low, an alteration in the distribution of the population from Isle of May SAC is considered highly unlikely. Additionally, grey seals present within the SAC are unlikely to experience PTS as maximum injury range is smaller than distance from the SAC to the Proposed Development area. As such, UXO clearance activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect maintaining supporting habitats.

1290 As described in paragraph 971, the threshold for potential temporary loss of hearing (TTS) was also assessed as it represents a behavioural, fleeing response. Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that grey seal can be potentially affected by TTS at the maximum range of 6,430 m due to detonation of charge size of 300 kg (Table 7.32) with up to 156 grey seal individuals affected (Table 7.33; 2.6% of the Isle of May SAC population). As low order techniques are preferred option for UXO clearance, the underwater noise modelling results show that grey seal can potentially experience TTS at the maximum range of 455 m due to detonation of 0.5 kg clearance shot (Table 7.30) with up to one grey seal potentially affected (Table 7.31). This accounts for 0.02% of the Isle of May SAC population.

1291 TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Therefore, effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Isle of May SAC. Given that this effect is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired.

1292 Considering the number of animals potentially affected by the PTS and TTS and respective proportions of the SAC population potentially affected, it is highly unlikely that UXO clearance will influence grey seal population trajectory in the long-term.

1293 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of underwater noise during UXO clearance during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1294 The assessment has concluded that UXO clearance activities are highly unlikely to disrupt normal behaviours of grey seal. Since TTS is a temporary hearing impairment, it is unlikely to cause a change in reproduction and survival rates and will not influence the population of qualifying species. Changes in distribution of qualifying species within the site are highly unlikely. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1295 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from injury and disturbance due to underwater noise during UXO clearance with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1296 With regards to PTS, the modelling shows that for grey seal, the threshold for PTS is not exceeded by any vessel with the exception of rock placement vessels, for which an injury range of 5 m from the source was reported (Table 7.36). PTS ranges for grey seal were not exceeded for any other activities except for cable laying, where an injury range of 5 m from the source was reported. The number of grey seals potentially affected within the modelled ranges for PTS from vessels and other activities were found to be less than one individual. For Isle of May SAC, this equates to <0.02% of the grey seal population. As outlined in paragraph 780, while a relatively high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Isle of May SAC, a high proportion were also tracked to the Berwickshire and North Northumberland Coast SAC, with a small proportion travelling to sites further away. Therefore, this number is likely to be an over-estimation of the proportion of seals from the Isle of May SAC affected. Given that vessels will follow a Code of Conduct (including advice to operators to not deliberately approach marine mammals) and NSPVMP, the risk of potential auditory injury will be low.

1297 With regard to behavioural disturbance to grey seals, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m. Similar ranges for behavioural effects are predicted to occur due to underwater noise from installation and construction vessels as well as rock placement vessels with disturbance ranges of 4,389 m. In comparison, vessels such as excavator, backhoe dredger, pipe laying, geophysical survey vessel and jack up vessel as well as jack-up rig were predicted to result in disturbance ranges out to 300 m.

1298 As discussed in paragraph 874, there is likely to be a proportionate response of animals within the modelled contours (i.e. not all animals will be disturbed to the same extent). Grey seal is likely to be sensitive to disturbance from vessel traffic. However, most of the vessel traffic associated with construction and decommissioning will take place within the Proposed Development array area and Proposed Development export cable corridor, at a distance where overlap of noise disturbance contours (Table 7.37) with the Isle of May SAC is unlikely. It is therefore highly unlikely that the reproductive and recruitment capability of the species will be affected. Construction activities will be carried out over a medium term and since the behavioural effect is considered to be highly reversible, it is highly unlikely that it will influence grey seal population trajectory in the long-term.

1299 Most of the vessel traffic associated with construction within the Proposed Development array area will take place at distances >40 km from the Isle of May SAC. Vessel movements will also increase over construction phase along the Proposed Development export cable corridor. However, due to the distance from the SAC (approximately 20 km) there is no potential for overlap of disturbance ranges with the site.

1300 As previously described in paragraph 1107, Anderwald *et al*. (2013) suggested that in the study of displacement responses to construction-related vessel traffic, grey seals were avoiding the area due to vessel noise. Even if individuals are temporarily deterred from offshore foraging grounds, given that the impacts of construction will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Therefore, availability of foraging grounds for grey seals from the Isle of May SAC will not be significantly impacted.

1301 As outlined in paragraph 1110, foraging context is important when interpreting avoidance behaviour of grey seals and should be considered when predicting effects. Avoidance rates may depend on perceived risk versus the quality of the prey patch. Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area it is expected that grey seal could tolerate the effects of disturbance without any impact on reproduction and survival rates and would return to previous activities once the impact had ceased.

1302 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of underwater noise during vessel use and other activities during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1303 The assessment has concluded that vessel use and other activities are highly unlikely to affect reproductive and recruitment capability of the species because the behavioural disturbance ranges do not reach the coast and hence do not overlap with the site. Therefore, it will not influence the population of the species as a viable component of the site. The availability of foraging grounds for grey seal will not be impacted and the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1304 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from injury and disturbance due to underwater noise during vessel use and other activities with respect to the construction and decommissioning of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1305 As outlined in paragraph 1010 *et seq.*, there is potential for changes to prey availability for grey seal during construction and decommissioning of the Proposed Development. These impacts include temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration.

1306 There is potential for temporary habitat loss/disturbance to affect up to 113,974,700 m^2 of seabed during the construction phase, which equates to 9.7% of the fish and shellfish ecology study area (see volume 2, chapter 9 of the Offshore EIA Report). Only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase, with areas starting to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works. It is expected that grey seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term. As presented in volume 2, chapter 9 of the Offshore EIA Report, monitoring studies have shown that offshore wind farm construction has not led to significant adverse effects on sandeel populations and that recovery of sandeel occurs quickly following construction operations (Jensen *et al*., 2004).

1307 In terms of indirect effects on marine mammals as a result of underwater noise, it is assumed that marine mammals would be disturbed from the area in vicinity of the noise source, and so any changes to the distribution of prey resources would not affect marine mammals as they would already be disturbed from the same (or larger) area. It is expected that grey seal population would be able to tolerate the effect without any impact on reproduction and survival rates.

1308 An increase in SSC and associated sediment deposition as a result of the installation of all wind turbines and offshore substation foundations and the installation of inter-array, interconnector and offshore export cables may result in short-term avoidance of affected areas by fish and shellfish which may have an indirect effect on grey seal. As presented in volume 2, chapter 9 of the Offshore RIA Report, adult fish have high mobility and may show avoidance behaviour in areas of high sedimentation, however, there may be impacts on the hatching success of fish and shellfish larvae and consequential effects on the viability of spawning stocks due to limited mobility. Spawning grounds for sandeel and herring overlap with the Proposed Development fish and shellfish ecology study area, however, eggs of these species are known to be tolerant to sediment deposition. Elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Given the localised extent of impacts associated with construction and decommissioning activities, these are highly unlikely to have indirect impacts on grey seal via changes to prey species due to an increase in SSC and associated sediment deposition.

1309 As outlined in paragraph 1023 *et seq*., while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species can forage widely, sometimes covering extensive distances. Given that the impacts of construction will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Telemetry data showed wide-ranging behaviour of grey seals within the northern North Sea, suggesting that, due to the highly mobile nature of grey seals and presence of alternative prey resources and foraging grounds available in the wider area, grey seals will not be constrained by the temporary and reversable nature of impacts associated with construction. There may be an energetic cost associated with increased travelling, however, grey seal is not considered to be particularly vulnerable to this effect as foraging trips tend to be wide-ranging, out to 100 km from a haul out site (SCOS, 2018). It is expected that grey seal population would be able to tolerate the effect without any impact on reproduction and survival rates.

1310 There will be no direct overlap of Proposed Development with the Isle of May SAC. Based on the telemetry data it is highly unlikely that all grey seal foraging within the Proposed Development would be from this SAC (Figure 7.4). As outlined in paragraph 780, while a relatively high proportion of tagged individuals were tracked between the Proposed Development marine mammal study area and the Isle of May SAC, a high proportion were also tracked to the Berwickshire and North Northumberland Coast SAC, with a small proportion travelling to sites further away.

1311 The magnitude of the indirect impact on marine mammals as a result of changes in fish and shellfish communities during the decommissioning phase is not expected to differ or be greater than that assessed for the construction phase.

1312 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning phases (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1313 The assessment has concluded that distribution of the species within the site and the distribution and extent of habitats supporting the species is unlikely to be impaired in long term. It is expected that grey seal population would be able to tolerate the effect of changes in fish and shellfish communities without any impact on reproduction and survival rates and it will not influence the population of the species as a viable component of the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1314 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from changes in fish and shellfish communities affecting prey availability with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

1315 As discussed in paragraph 945 *et seq.*, the maximum range at which there is a risk of PTS to grey seal as a result of site investigation surveys is 65 m. With designed in measures (Table 7.40) implemented for the geophysical surveys, the risk of PTS occurring to grey seals will be low. With regard to behavioural disturbance, although a maximum potential disturbance range across all survey types is approximately 7.5 km during vibro-coring, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. It is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for grey seals at the SAC as a result of site investigation surveys.

1316 The maximum design scenario for routine geophysical surveys is estimated as a survey every six months for the first two years and annually thereafter. This equates to 37 surveys over the 35-year life cycle of the Proposed Development (Table 7.39). The magnitude of the impact could result in a negligible alteration to the distribution of grey seals. Surveys are anticipated to be short-term in nature (weeks to a few months) and occur intermittently over the operation and maintenance phase. Given no overlap between the Proposed Development and Isle of May SAC is expected, only a small proportion of grey seal SAC population could be potentially affected and they would be able to tolerate the effect without any impact on reproduction and survival rates. Therefore, it is highly unlikely that site investigation surveys will influence grey seal population trajectory in the long-term.

1317 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of underwater noise during site investigation surveys during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1318 The assessment has concluded that there will be no introduction of barriers to wider movement for grey seal as a result of elevated sound from site investigation surveys. Therefore the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. Underwater noise during site-investigation surveys is unlikely to affect grey seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates and therefore will not influence the population of the species as a viable component of the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1319 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the operation of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1320 As described in paragraphs 1044 *et seq*., vessel use during the operation and maintenance phase of the Proposed Development is considered a relatively small increase in the context of baseline traffic and the size and noise outputs from vessels will be similar to those used in the construction phase. The number of vessel round trips and their frequency will be much lower compared to the construction phase.

1321 Most of the vessel traffic associated with operation and maintenance within the Proposed Development array area will take place at distances >40 km from the Isle of May SAC. It can be anticipated that the number of vessel movements will increase during the operation and maintenance phase along the Proposed Development export cable corridor when compared to baseline levels. However, due to the distance from the landfall to the SAC, there is no potential for overlap of disturbance ranges with the site.

1322 Given the existing levels of vessel activity in the Proposed Development shipping and navigation study area (see volume 2, chapter 13 of the Offshore EIA Report) it is expected that grey seal could tolerate the effects of disturbance without any impact on reproduction and survival rate. There will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for grey seals at the SAC.

1323 Given that risk of injury will be reduced as vessels will follow a Code of Conduct and since the behavioural effect is considered to be highly reversible, it is highly unlikely that vessel use and other activities will influence grey seal population trajectory in the long-term.

1324 Effects on grey seal at the Isle of May SAC are therefore considered to be the same or less than the effects described for vessel use and other activities during the construction and decommissioning phases. It should be noted that operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years) and therefore only a small proportion of vessel use and other activities will occur at any one time.

1325 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of underwater noise during vessel use and other activities during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1326 The assessment has concluded that vessel use and other activities are highly unlikely to affect reproductive and recruitment capability of the species because the behavioural disturbance ranges do not reach the coast and hence do not overlap with the site. Therefore, it will not influence the population of the species as a viable component of the site. The availability of foraging grounds for grey seal will not be impacted and the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1327 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from injury and disturbance due to underwater noise during vessel use and other activities with respect to the operation of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1328 As outlined in paragraph 1051 *et seq.*, there is potential for changes to prey availability for grey seals due to potential impacts on prey species during operation and maintenance of the Proposed Development. These impacts include temporary subtidal habitat loss/disturbance, long-term subtidal habitat loss, increased SSC and associated sediment deposition, EMF from subsea electrical cabling and colonisation of foundations, scour protection and cable protection.

1329 Potential temporary habitat loss/disturbance during operation and maintenance equates to a smaller area than that affected during construction (up to 989,000 m^2 which equates to 0.08% of the fish and shellfish ecology area, compared with 9.7% during the construction phase; volume 2, chapter 9 of the Offshore EIA Report). Operation and maintenance activities will occur periodically over the full lifetime of the project (estimated to be 35 years). As described in paragraph 1011, only a small proportion of the maximum footprint of habitat loss/disturbance may occur at any one time, with areas starting to recover immediately after cessation of maintenance activities. It is expected that grey seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term.

1330 Increased SSC could occur as a result of repair or remedial burial activities during the operation and maintenance phase. The maintenance activities will be undertaken at intervals over the 35 years operation and maintenance phase. Any suspended sediments and associated deposition are expected to l be of the same magnitude, or lower as for construction. Therefore, the availability of suitable food supply for grey seal is not expected to be impaired as a result of increase in SSC and associated deposition.

1331 The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. The range over which species can detect EMF will be very localised to within a few centimetres of the buried cable, with rapid decay of the EMF with increasing distance Considering the above, adverse effects on grey seal as a result of changes in prey availability due to EMF are highly unlikely.

1332 Although there will be long term loss of habitat due to the presence of infrastructure associated with the Proposed Development, it is also anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 1021 *et seq.*, evidence increasingly suggests that foraging opportunities for marine mammals, including grey seals, are increased around offshore wind farm structures.

1333 As described in paragraph 1023 *et seq.*, while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species has an observed wide ranging foraging ability within the region. The fish and shellfish communities found within the fish and shellfish ecology study area (see volume 2, chapter 9 of the Offshore EIA Report) are characteristic of the fish and shellfish assemblages in the northern North Sea. As the impacts of operation and maintenance works will be highly localised, temporary in nature and restricted to the boundaries of the Proposed Development, only a small area will ever be affected compared with the available foraging habitat for grey seals in the northern North Sea. It is therefore reasonable to assume that, due to the highly mobile nature of grey seals, there will be similar and suitable prey resources available in the wider area. Given that the habitat is likely to return to the state that existed before the activity or event which caused change, it is highly unlikely that maintenance works resulting in habitat loss/disturbance will influence grey seal population trajectory in the long-term.

1334 Significant adverse effects on the qualifying Annex II marine mammal feature grey seal of the Isle of May SAC are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance phase (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1335 The assessment has concluded that distribution of the species within the site and the distribution and extent of habitats supporting the species is unlikely to be impaired in long term. It is expected that grey seal population would be able to tolerate the effect of changes in fish and shellfish communities without any impact on reproduction and survival rates and it will not influence the population of the species as a viable component of the site. As such, the conservation objectives for Annex II species, grey seal, will not be undermined.

1336 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC from changes in fish and shellfish communities affecting prey availability with respect to the operation of the Proposed Development acting alone.

Effects in-combination

1337 An assessment of in-combination effects upon the qualifying Annex II marine mammal species of the Isle of May SAC arising from each identified impact is provided below.

1338 The potential to experience injury in terms of PTS by marine mammal receptors as a result of underwater noise due to piling and vessel use/other activities would be expected to be largely localised within the boundaries of the respective projects (assuming similar ranges of effect as presented for the Proposed Development). It is also anticipated that standard offshore wind industry construction methods (which include soft starts and visual and acoustic monitoring of marine mammals as standard) will be applied, thereby reducing the magnitude of the impact with respect to auditory injury occurring in marine mammals. Therefore, there is no potential for significant in-combination impacts for injury from elevated underwater noise during pilling and vessel use/other activities and the in-combination assessment focuses on disturbance only.

Assessment of in-combination effects during construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

Tier 2

1339 The construction of the Proposed Development, together with the construction of the Tier 2 projects, may lead to injury and/or disturbance to grey seal from the Isle of May SAC from underwater noise during piling. Other projects screened into the assessment within the regional marine mammal study area include construction of Inch Cape Offshore Wind Farm and Seagreen 1A Project.

1340 Both projects screened in for the in-combination assessment for grey seal (paragraph 1339) are located within a behavioural disturbance footprint of the Proposed Development. The outermost contour of 135 dB represents the edge of the area within which grey seal may experience behavioural disturbance during concurrent piling at 4,000kJ hammer energy at Proposed Development. The assessment presented in the Inch Cape EIA (Inch Cape Offshore Limited, 2018) and original Seagreen EIA (Seagreen Wind Energy Ltd, 2012) estimated that 1,236 and 465 grey seals could experience disturbance during piling at respective projects. The duration of any disturbance at Seagreen 1A Project will be relatively short and is currently planned to take place between April and July 2023 (i.e. more than two years before planning commencement of piling at Proposed Development (Seagreen Wind Energy Ltd, 2020)).

1341 As the construction of Inch Cape and Seagreen 1A Project will be completed prior to commencement of piling at the Proposed Development, the potential for simultaneous piling, and therefore additive in-combination effects, with Proposed Development is highly unlikely. Population modelling was carried out to explore the potential of cumulative effects as a result of disturbance during piling to affect the population trajectory over time. Population modelling considered Seagreen 1A Project and Inch Cape Offshore Wind

Farm and respective numbers of animals potentially impacted against the wider MU population (see volume 3, appendix 10.4 of the Offshore EIA Report for methods applied in the model). Results of the cumulative iPCoD modelling for grey seal showed that no impacts are predicted on the wider population resulting from disturbance due to cumulative piling events, with the mean impacted population the same as the mean unimpacted population at the 25 year time point. Therefore, it was considered that there is no potential for the long-term effects on this species within wider population as a result of cumulative piling at proposed Development and respective projects (see volume 3, appendix 10.4 of the Offshore EIA Report for more details).

1342 In temporal terms, there is a potential that animals in the vicinity of the Firth of Forth and Tay will experience disturbance consecutively as piling at different projects progresses. Grey seals are known to modify their behaviour in a response to piling noise but come back to pre-piling behaviour immediately after pile-driving ceased (Aarts *et al*., 2018). Therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be affected.

1343 As described in paragraph 1133, during piling at Proposed Development, the behavioural disturbance contours will not reach the coast and will not overlap with Isle of May Coast SAC (in volume 2, chapter 10 of the Offshore EIA Report). As there will be no overlap of piling phases with either of the projects, grey seals present in habitats within the SAC, are highly unlikely to experience disturbance. As such, piling activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect the maintenance of supporting habitats.

1344 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of underwater noise during piling during construction with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1345 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to grey seal from the Isle of May SAC during the construction phase of the Proposed Development with the construction and operation and maintenance Eastern Link 1 and Eastern Link 2.

1346 The construction as well as operation and maintenance phases of Eastern Link 1 and Eastern Link 2, located respectively 14 km and 28 km from the Proposed Development array area, will overlap with the construction phase of the Proposed Development. Based on the Environmental Appraisals for both projects, the only underwater sound noise sources that are within hearing range of marine mammals and have potential to have an effect, are the operation of the USBL and the SBP (AECOM, 2022a; 2022b). The disturbance ranges for grey seal were estimated as 63 m for USBL and 4,642 m for SBP. The detailed assessment of impacts as a result of underwater noise during the operation of SBP for both projects was presented for installation phase only. There are no disturbance ranges presented for the USBL for the Proposed Development alone but the disturbance range for SBP has been assessed as 2,045 m. Nevertheless, the assessment presented in paragraph 955 945*et seq*. is based on the maximum disturbance range all geophysical activities, which for the Proposed Development was predicted for vibro-coring as 7,459 m. Using the published at-sea density maps (Carter *et al*., 2020), the maximum number of grey seals estimated to be disturbed was 210 grey seals (3.6% of the Isle of May SAC population). However, this was shown to be highly precautionary when compared with estimates of the number of grey seal using site-specific densities derived from the Proposed Development aerial digital survey data (see paragraph 1282 for comparison).

1347 Based on the distance from the Proposed Development to both projects, the overlap of disturbance ranges is highly unlikely. The potential for an overlap exist only for site-investigation surveys taking place in the northern part of the Eastern Link 1, close to the Proposed Development export cable corridor and landfall (Figure 7.3). Based on the telemetry tracks, the areas close to the landfall are not regularly visited by individuals from this SAC and although the connectivity between these areas and grey seals from the Isle of May SAC cannot be discounted, the behavioural disturbance could potentially affect a negligible proportion of the population. It needs to be noted that site investigation survey equipment will not be operating continuously, it will be used when required for investigations of particular areas of the seabed where additional information is required to inform the construction.

1348 With foraging ranges of up to 100 km, grey seals may be sensitive to a behavioural disturbance during the site-investigation surveys as they move between haul-outs and key foraging areas. During the breeding or moulting season many seals tend to spend more time on land, unaffected by underwater sound. Nevertheless, the availability of food is vital to offspring survival and female fitness (see paragraph 1085 *et seq* for more details). As advised by NatureScot (Table 2.1), grey seal in Scotland tend to stay within 20 km of the breeding colony during the breeding season. Given the distance from Eastern Link 1 and Eastern Link 2 to the SAC (approximately 26 and 90 km, respectively), operation of the survey equipment is unlikely to disturb animals from this SAC within their main foraging grounds during the breeding season. Disturbance ranges during vibro-coring at Proposed Development have the potential to slightly overlap with foraging ranges of grey seal from the Isle of May SAC, however, given that alternative areas for foraging are widely available, the disturbance to seals is not considered likely to have a significant impact on food availability (see paragraph 1364 *et seq*. for the in-combination assessment of impacts as a result of changes in prey availability) and therefore on fitness and survival of the grey seal population. Given that geophysical surveys will occur intermittently and are short in duration, grey seals are anticipated to return to foraging grounds when the impact has ceased and therefore the connectivity with important habitats within and outside the site is unlikely to be impaired.

1349 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of site investigation surveys during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during UXO clearance

Tier 2

1350 There is potential for in-combination effects from injury and/or disturbance from underwater noise during UXO clearance to grey seal from the Isle of May SAC during the construction phase of the Proposed Development with activities associated with the Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm.

1351 Projects screened in for this in-combination assessment are expected to involve similar construction activities to those described for the Proposed Development alone, including UXO clearance activities. It is anticipated that, for all projects, impacts associated with these activities will require additional assessment under EPS licensing, however such applications are not yet available in the public domain. The conclusions presented in volume 2, chapter 10 of the Offshore EIA Report demonstrated that the residual risk to grey seals, in terms of injury (PTS and TTS) as a result of UXO clearance activities at Proposed Development and respective projects would be low.

1352 For the Proposed Development alone, the maximum range across which grey seals have the potential to experience PTS due to high order detonation of 300 kg charge was assessed as approximately 2,085 m. PTS onset ranges for Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm are currently unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is no greater than assessed for the Proposed Development alone. Depending on the type of detonation and size of UXO, UXO clearance activities may have residual effects in respect to marine mammals and PTS injury. In November 2021, the UK government published a joint interim statement advising to use low noise alternatives to high order detonations where possible and it is anticipated that future developments will follow this guidance. However, due to a small inherent risk with these clearance methods that the UXO will

detonate or deflagrate violently, accidental high order detonation can be expected as a maximum adverse scenario. Taking into account high order detonation of 300 kg charge and appropriate designed in and secondary mitigation measures (paragraph 978 *et seq.*), there will be no residual risk of injury and therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be affected.

1353 In terms of TTS, for the Proposed Development alone, the range across which grey seals have the potential to experience TTS due to high order detonation of a 300 kg charge was as approximately 6,430 m (see paragraph 971 *et seq*.). TTS onset ranges for Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm are currently unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is no greater than assessed for the Proposed Development alone. A spatial maximum adverse scenario would occur where UXO clearance activities occur concurrently at the respective projects considered in the in-combination assessment. This is however highly unlikely, as due to safety reasons the UXO clearance activities takes place before other construction activities commence, and both projects considered in the in-combination start their construction activities two years before commencement of construction at Proposed Development. Temporally however, sequential UXO clearance at respective projects could lead to a longer duration of effect. Since each clearance event results in no more than a one second ensonification event and since TTS is a recoverable injury, the potential for in-combination effects with respect to TTS is considered to be very limited. Therefore, in-combination effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Isle of May SAC. Given that effect of TTS is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired.

1354 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of underwater noise during UXO clearance during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1355 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to grey seal from the Isle of May SAC during the construction and decommissioning phase of the Proposed Development with activities associated with the following projects: Eyemouth, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Neart na Gaoithe and Blyth Demo 2.

1356 Whilst there is no quantitative information available for noise disturbance ranges for offshore wind farms included in the in-combination assessment, it is anticipated that there will be a similar scale of effects with respect to noise effects as those described for Proposed Development alone (paragraph 988 *et seq*.). In terms of behavioural disturbance, the noise modelling predicted a maximum range of approximately 4 km for construction activities such as cable laying as well as activity of rock placement vessels (described in detail in volume 3, appendix 10.1 of the Offshore EIA Report) and therefore, disturbance effects are likely to occur cumulatively. The Isle of May SAC is located at the entrance to the Firth of Forth and there is a risk that vessels will pass next to the SAC on route to ports or harbours, including Grangemouth, Rosyth, Leith and Braefoot Bay (see volume 2, chapter 13 of the Offshore EIA Report). Additionally, due to the presence of offshore wind farms, such as Inch Cape, deviations from main commercial routes are anticipated, including the need to pass north of the Isle of May or alter course sharply once beyond the two special marks located east of the Isle of May. As previously discussed in paragraph 1109, seals exhibit avoidance behaviour or alert reactions when disturbed, as hauled out seals typically flush into the water which may be detrimental during pupping season. Therefore, increases in vessel movements next to the SAC between late September and January may pose a risk of affecting lactation and milk intake of pups, which can be detrimental to their condition and impact rearing success. It is however an industry standard that vessels follow a Code of Conduct, which include advice not to approach marine mammals and it is anticipated that operation and maintenance vessels at all relevant projects will follow these guidelines. Grey seals that live around the island all year are expected to tolerate presence of vessels, as boat tours to Isle of May SAC are very frequent between April and September each year. Therefore, in-combination effects caused by vessel use and other activities during operation and maintenance phase are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Isle of May SAC.

1357 The highest number of vessels movements was predicted during the construction phase of each offshore wind farm. There would potentially be a relatively small temporal overlap of the construction phases, with only one year of overlap with Inch Cape as well as Seagreen 1A Project and the Proposed Development and three years overlap with installation of offshore cables – Eastern Link 1 and Eastern Link 2. Therefore, the potential in-combination effect during construction phases of the respective projects and the proposed Development will be medium-term.

1358 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1359 There is potential for in-combination effects from underwater noise due to vessel use and other activities to grey seal from the Isle of May SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1360 There is currently no information on the impacts the Cambois connection will have on grey seal, although the Scoping Report have listed the types of vessels to be used during construction, including cable lay vessels, pre-lay survey vessels, rock protection vessels, support vessels, guard vessels, and possible use of jack-up vessels (SSE Renewables, 2022e). There were no details about number of vessel round trips during the construction phase of Cambois connection. No data for vessel movements was presented for operation and maintenance phase of the Cambois connection.

1361 Due to lack of project information at this stage, it is not possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided. The maximum range over which potential disturbance may occur for the Proposed Development alone as a result of drilled piling and jet trenching, is predicted out to 1,900 m and 2,580 m, respectively. Cable installation activities assessed for the Proposed Development alone have the potential to disturb marine mammals out to 4,389 m. Given the location of the SAC with respect to the Proposed Development and Cambois connection, there is no potential for cumulative overlap of behavioural ZoI at respective projects and this designated site.

1362 Nevertheless, outside the SAC in offshore waters, construction activities could lead to a larger area of disturbance and larger number of animals disturbed within their foraging range compared to the Proposed Development alone if projects were to conduct construction activities over similar time periods. As described in paragraph 1216 *et seq.,* it can be anticipated that grey seals from the Isle of May SAC demonstrate some degree of habituation to ship noises. Therefore, in-combination effects caused by vessel use and other activities are considered unlikely to cause a change in reproduction and survival rates or long-term alteration in the distribution of the population from the Isle of May SAC.

1363 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 3 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1364 There is potential for in-combination effects from changes in the prey resources available for grey seal of the Isle of May SAC as a result of changes to the fish and shellfish community during the construction and decommissioning phases of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1 Offshore Wind Farm, Seagreen 1A Project, Seagreen Eastern Link 1, Seagreen 1A Export Cable Corridor, Eastern Link 2 and Eyemouth disposal site

1365 The construction phases and/or operation and maintenance phases respective projects may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss is 145,325,450 m^2 (=145.3 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The magnitude of long-term habitat loss caused by the presence of all structures on the seabed has been considered for the construction as well as operation and maintenance phases. The impacts have been assessed in-combination with Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, and Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Links 2 and may lead to long term subtidal habitat loss of up to 15,014,156 m^2 (=15.0 km^2).

1366 An increase in SSC and associated sediment deposition as a result of the construction as well as operation of projects screened into the in-combination assessment may result in short-term avoidance of affected areas by fish and shellfish which may have an indirect effect on grey seals. Elevations in SSC are expected to be of short duration, returning to background levels relatively quickly. SSC are not expected to reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Given that the effect on spawning grounds of grey seal prey key resource (sandeel) are predicted to be limited as a result of increased SSC and associated sediment deposition (see paragraph 1227) and small temporal overlap of construction phases at respective projects, the availability of suitable food supply for grey seals is not expected to be impaired.

1367 OSP/Offshore convertor station platforms outlined in paragraph 1023 *et seq*., while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species can forage widely, sometimes covering extensive distances. Given that the impacts of temporary and long-term will be localised when compared to wider habitat available and largely restricted to the boundaries of the respective projects, only a fraction will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Since the habitat is likely to return to the state that existed before the activity or event which caused change, the availability of suitable foraging grounds for grey seals is not expected to be impaired hence the population trajectory is unlikely to be affected in the long-term.

1368 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1369 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to grey seal from Isle of May SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1370 The construction phase of Cambois connection may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss/disturbance is 17,000,000 m^2 (=17.0 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The majority of this disturbance will not spatially overlap with the Proposed Development and where the overlap exist with the Proposed Development array area (previously impacted during the construction of the Proposed Development), it is expected to be highly localised and so the potential for repeat disturbance is considered low and unlikely to lead to an increase in the magnitude than predicted for the Proposed Development alone. The installation of Cambois connection can also result in a total area of long-term subtidal habitat loss of 306,000 m^2.

1371 There is also a potential for in-combination effects associated with SSC and associated deposition. However, elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Therefore, it is highly unlikely to have indirect impacts on grey seals from Isle of May SAC via changes to prey species.

1372 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1373 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to grey seal during the operation and maintenance phase of the Proposed Development with the operation and maintenance Eastern Link 1 and Eastern Link 2.

1374 The maximum design scenario for Proposed Development alone comprises of routine geophysical surveys estimated to occur every six months for first two years and annually thereafter. This equates to up to 37 surveys over the 35-year life cycle of Proposed Development (Table 5.2). As presented in paragraph 1346, the detailed assessment of impacts on marine mammals as a result of underwater noise due to geophysical surveys during the operation and maintenance phase of the Eastern Link 1 and Eastern Link 2 is unavailable.

1375 An overview of potential impacts from as a result of behavioural disturbance due to elevated underwater noise during geophysical site investigation surveys is described in paragraph 1345 *et seq*. for the construction phase and has not been reiterated here for the operation and maintenance phase. The magnitude of the impact of underwater noise from geophysical surveys during operation and maintenance phase in combination with other projects considered in cumulative assessment could result in a negligible alteration to the distribution of grey seal in the short-term, however the overlap of disturbance ranges is unlikely. Given that geophysical surveys will occur intermittently over operation and maintenance phases of respective projects and are short in duration, grey seals are anticipated to return to foraging grounds when the impact has ceased and therefore the connectivity with important habitats within and outside the site is unlikely to be impaired.

1376 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of site investigation surveys during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1377 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to grey seal from the Isle of May SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: the Eyemouth disposal site, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Blyth Demo 2 and Neart na Gaoithe Offshore Wind Farm.

1378 Vessels involved in the operation and maintenance of other wind farms will include a similar suite of vessels as those described for the Proposed Development alone (see paragraph 1044 *et seq.*), such as vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth and replacement of access ladders. Given that the number of vessel round trips and their frequency is much lower for the operation and maintenance phases compared to construction phases of the respective projects, the magnitude of the impact for disturbance as a result of elevated underwater noise due to vessel use and other activities is expected to be less than that assessed for the construction phase. However, the duration of the effect will be longer (over the 35-year operating lifetime of the Proposed Development).

1379 During the operation and maintenance phase of the Proposed Development, the wind farms listed in paragraph 1377 will reach their decommissioning age before the Proposed Development reaches its decommissioning age in 2066. The environmental statements for respective projects predicted the number and type of vessels associated with decommissioning are expected to be, at worst, similar to construction. The Isle of May SAC is located at the entrance to the Firth of Forth and there is a risk that vessels will pass next to the SAC on route to ports or harbours, including Grangemouth, Rosyth, Leith and Braefoot Bay (see volume 2, chapter 13 of the Offshore EIA Report). Additionally, due to the presence of offshore wind farms, such as Inch Cape, deviations from main commercial routes are anticipated, including the need to pass north of the Isle of May or alter course sharply once beyond the two special marks located east of the Isle of May. As previously discussed in paragraph 1109, seals exhibit avoidance behaviour or alert reactions when disturbed, as hauled out seals typically flush into the water which may be detrimental during pupping season. Therefore, increases in vessel movements next to the SAC between late September and January may pose a risk of affected lactation and milk intake of pups, which can be detrimental to their condition and impact rearing success. It is however an industry standard that vessels follow a Code of Conduct, which include advice not to approach marine mammals and it is anticipated that vessels from all relevant projects will follow these guidelines. Grey seals that live around the island all year are expected to tolerate presence of vessels, as boat tours to Isle of May SAC are very frequent between April and September each year. Additionally, it can be expected that after more than ten years of construction activities taking place in the vicinity of Firth of Forth (i.e. Seagreen 1 construction activities commenced in 2021 and the operation and maintenance phase of Proposed Development is expected to start from 2033), marine mammals present in the area will demonstrate some degree of habituation to ship noises. Therefore, in-combination effects caused by vessel use and other activities during operation and maintenance phase are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Isle of May SAC.

1380 As presented in volume 2, chapter 13 of the Offshore EIA Report, the commercial vessel numbers in the vicinity of the Proposed Development are expected to remain reasonably consistent in the future. In the longer term, there may be increases in wind farm related traffic associated with the ScotWind developments north and east of the Proposed Development. However, given the low data confidence associated with these developments it was not possible to make any quantitative assumptions. It has been assumed that future case traffic growth is likely to fluctuate depending on seasonality and cargo and industry trends. The Scotwind developments will be located offshore and therefore the extent to which grey seals from Isle of May SAC may be affected will depend on the location of the port/harbour that the vessels will be travelling to/from. It is an industry standard that vessels follow a Code of Conduct, which include advice not to approach marine mammals and it is anticipated that vessels at all relevant projects will follow these guidelines.

1381 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1382 There is potential for in-combination effects from underwater noise due to vessel use and other activities to grey seal from Isle of May SAC during the operation and maintenance of the Proposed Development with activities associated with the operation of Cambois connection.

1383 As presented in paragraph 1360, there were no details about the number of vessel round trips or type of vessels that will be used during operation and maintenance phase of Cambois connection (SSE Renewables, 2022e). Due to lack of detailed project information at this stage, it was not possible to undertake full, quantitative assessment for this impact.

1384 An overview of potential impacts for behavioural disturbance to grey seal from the Isle of May SAC from elevated underwater noise due to vessel use and other activities is described in paragraph 1359 *et seq*. for the construction phase and have not been reiterated here for the operation and maintenance phase.

1385 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 3 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1386 There is potential for in-combination effects from changes in prey resources to grey seal from the Isle of May SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1, Eastern Link 2, and Eyemouth disposal site.

1387 Operation and maintenance activities at respective projects considered in in-combination assessment may lead to temporary subtidal habitat loss/disturbance of up to 32,276,397 m^2. Additionally, Offshore Wind Farms listed above will reach their decommissioning age during Proposed Development operation and maintenance phase. However, it is important to note that the maximum design scenario for habitat loss from the in-combination projects is precautionary, as operation and maintenance activities will occur intermittently throughout the lifetime of the Proposed Development and the temporal overlap with activities at other projects is unlikely. Only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time, areas are starting to recover immediately after cessation of maintenance activities. It is expected that grey seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term.

1388 In-combination impacts could arise from EMFs due to the presence of subsea cabling during the operation and maintenance phases of the Proposed Development as well as Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable, Eastern Link 1 and Eastern Link 2. A total length of up to 6,112 km of subsea cabling was estimated for all projects. The effect of EMF was predicted to be of local spatial extent.

1389 As outlined in paragraph 1023 *et seq*., while grey seal has a relatively selective diet of predominantly flatfish and sandeel, the species can forage widely, sometimes covering extensive distances. Given that

the impacts of temporary and long-term will be localised when compared to wider habitat available and largely restricted to the boundaries of the respective projects, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. Since the habitat is likely to return to the state that existed before the activity or event which caused change, the availability of suitable food supply for grey seals is not expected to be impaired hence the population trajectory is unlikely to be affected in the long-term. Considering the above, adverse effects on grey seal as a result of changes in prey availability due to EMF are unlikely.

1390 Artificial structures introduced into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. There is a potential for in-combination effects arising from colonisation due to the presence of Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, and Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Link 2 with a maximum scenario of up to 15,014,156 m^2 of hard structures from wind turbines, OSP/Offshore convertor station platforms, meteorological masts, of cable protection, and cable crossings. The in-combination effect was predicted to be of local spatial extent. There is some evidence that marine mammal populations are likely to benefit from introduction of hard substrates and associated fauna, as studies reported that grey seal were frequently recorded around offshore oil and gas structures (see paragraph 1022 for more details). Therefore, it is highly unlikely that placement of man-made structures on the seabed will adversely influence grey seal SAC population trajectory.

1391 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1392 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to grey seal from the Isle of May SAC during the operation and maintenance phase of the Proposed Development with activities associated with the operation of Cambois connection.

1393 In terms of temporary subtidal habitat loss/disturbance, there are no specific values for the operation and maintenance phase of Cambois connection which will occur during the operation and maintenance phase of the Proposed Development. However, Cambois connection has the potential to result in cumulative EMF effects from subsea electrical cabling within the Proposed Development. The Cambois connection is understood to have 680 km of cable. The effect of EMF was predicted to be of local spatial extent.

1394 The Cambois connection has the potential to create 306,000 m^2 of new hard habitat associated with rock/mattress cable protection, which represents a change in seabed type, the effects of which are described in paragraph 1022 *et seq*. As the cable protection does not extend into the water column the opportunity for colonisation by some species is reduced, nevertheless there is a potential that placement of man-made structures on the seabed will benefit grey seal population.

1395 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Isle of May SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 3 projects.

[18] https://sitelink.nature.scot/site/8257 Accessed 01 April 2022

Site conclusion

1396 In conclusion, with reference to the conservation objectives set for the Annex II marine mammal features of the site and the information presented in section 7.3, 7.4, 7.5 and 7.6.2, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the Isle of May SAC in respect of the grey seal qualifying interests, as a result of the Proposed Development.

1397 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

7.6.3 FIRTH OF TAY AND EDEN ESTUARY SAC

European site information

1398 The Firth of Tay and Eden Estuary SAC lies approximately 47 km from the Proposed Development array area and 45 km from the Proposed Development export cable corridor, covers an area of approximately 155 km^2 and comprises two high quality estuarine areas, which are integral components of a large, geomorphologically complex area (JNCC, 2021a). The SAC supports a breeding colony of harbour seal. It has been documented that there has been a slow decline of harbour seal numbers over the period since 1990 (Hanson *et al*., 2015). From 2002 to 2017 the harbour seal count for the Firth of Tay and Eden Estuary SAC decreased rapidly at approximately 18.6% p.a. (see volume 3, appendix 10.2, annex B of the Offshore EIA Report). Subsequently, the count in 2019 for this SAC was 41 individuals, which represents a 95% decrease from the mean counts recorded between 1990 and 2002 (SCOS, 2020). Sporadic counts in the Firth of Forth indicate, however, that the decline is localised within the SAC and may not represent the trends in the overall MU population.

1399 The harbour seal feature of the site was last assessed as being in 'unfavourable declining' condition due to recreation/disturbance in August 2013[18].

1400 Further information on this European site is presented in appendix A.

Conservation objectives

1401 The conservation objectives for harbour seal at Firth of Tay and Eden Estuary SAC have been developed by NatureScot[19] as follows:

- To avoid the deterioration of the habitat of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features; and
- To ensure for the qualifying species that the following are maintained in the long term:
  - Population of the species as a viable component of the site;
  - Distribution of the species within site;
  - Distribution and extent of habitats supporting the species;
  - Structure, function and supporting processes of habitats supporting the species; and
  - No significant disturbance of the species.

[19] https://sitelink.nature.scot/site/8257 Accessed 02 September 2022.

1402 No supplementary advice on the conservation objectives, or Conservation Advice Packages (CAP) are available for the Firth of Tay and Eden Estuary SAC.

Features and effects for assessment

1403 The potential for adverse effects has been identified for the following Annex II marine mammal features of this site:

- Harbour seal

1404 The following impacts associated with the construction and decommissioning of the Proposed Development have been identified as having the potential for adverse effects on harbour seal at this site:

- **Injury and disturbance** from underwater noise generated by following activities:
  - piling of fixed foundations;
  - clearance of UXO;
  - site investigation surveys; and
  - vessel use and other activities.
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1405 The following impacts associated with the operation and maintenance of the Proposed Development have been identified as having the potential for adverse effects on harbour seal at this site:

- **Injury and disturbance from underwater noise** generated by site investigation surveys as well as vessel use and other activities;
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1406 The following assessment is structured to first assess whether the construction and decommissioning impacts will have an adverse effect on the integrity of the harbour seal feature of the site, and then the impacts associated with operation and maintenance will be assessed. For the purposes of these assessments, the potential effects are considered in relation to the site's conservation objectives.

Construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

1407 Underwater noise could affect the population and distribution of the qualifying species. Underwater noise modelling has been undertaken to estimate the maximum potential injury ranges for underwater noise that could arise during construction and decommissioning in relation to harbour seal. The modelling was based on the maximum design scenario (as outlined in Table 7.10) with summary of noise modelling provided in paragraph 834 *et seq*.

1408 The maximum range for injury to harbour seal was estimated as 118 m based on SPL_{pk} and using the 1% constant conversion factor (see paragraph 881 *et seq*). Taking into account the most conservative scenario and maximum harbour seal densities (Table 7.4), less than one individual was predicted to be potentially injured, which accounts for 2.4% of the Firth of Tay and Eden Estuary SAC population. As outlined in paragraph 785, of the 46 adult harbour seals tagged in East Scotland between 2001 and 2017, 25 had telemetry track data recorded within the Proposed Development Marine Mammal study area and all 25 of these harbour seals also showed connectivity with the Firth of Tay and Eden Estuary SAC (Figure 7.6). With designed in measures in place (Table 7.11) which are in line with recommended best practice guidelines, the magnitude of the impact would result in a negligible risk of injury to harbour seal.

1409 In terms of behavioural disturbance, up to three animals were predicted to be potentially disturbed from concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.16; Figure 7.6). On the basis of the assumption that the three animals potentially disturbed originate from the SAC, this represents 7.3% of the Firth of Tay and Eden Estuary SAC population. These results are, however, considered highly precautionary as there is a number of conservative assumptions in subsea noise model (i.e. the maximum hammer energy of 4,000 kJ is unlikely to be reached at all piling locations (see paragraph 844 *et seq*. for more details)). Additionally, although the population of harbour seals withing the East Scotland MU is mainly concentrated in the Firth of Tay and Eden Estuary SAC, additional groups are also present in the Firth of Forth, Montrose Basin and at coastal sites in Aberdeenshire (SCOS, 2021). Therefore it is highly unlikely that all seals potentially present within the noise disturbance contours will originate from this SAC.

1410 The outer behavioural disturbance contours do not overlap with Firth of Tay and Eden Estuary SAC (Figure 7.6). Harbour seals present in the vicinity of the habitats which they utilise throughout their life cycle (sandbanks and estuaries), are therefore unlikely to experience disturbance as these areas lie outside of the noise disturbance contours. As such, piling activities are highly unlikely to disrupt normal behaviours of harbour seals or adversely affect maintaining supporting habitats.

1411 Harbour seal in inshore waters could experience mild disturbance where these areas overlap with 135 dB disturbance contour, but prolonged or sustained behavioural effects, including displacement, are unlikely to occur (Southall *et al*., 2021). As outlined in paragraph 1085 *et seq*, barrier effects and altered behaviour could affect reproduction and lactation, however, harbour seal foraging is restricted during this period (see paragraph 1086 *et seq)*. Considering that barrier effects are unlikely, disturbance caused by piling is not anticipated to result in reduced reproductive success and will not affect the status of this population as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development, see paragraph 1414).

1412 Harbour seals tend to stay within 50 km of the coast, although most foraging trips are over shorter ranges (see paragraph 1025). Telemetry tracks show that few animals may venture further from the coast and therefore during piling, there is the potential for some animals to be temporarily deterred from the offshore areas (Figure 7.6). It should be noted that behavioural disturbance contours presented in Figure 7.6 represent the maximum adverse scenario for concurrent piling at wind turbine locations where noise contours propagate in the direction of the Firth of Tay and Eden Estuary SAC. Therefore, the disturbance contours will not reach that far towards the SAC during the piling at remaining wind turbine/OSP-Offshore convertor station platform locations. As described in paragraph 1477, harbour seals although initially displaced due to pile-driving, are likely to return to the same area within two hours following cessation of piling. Therefore, it is anticipated that piling will not result in any long-lasting changes in the distribution of seals from this SAC and the connectivity with areas of high importance outside the site is not expected to be impaired.

1413 As outlined in paragraph 884, the total duration of piling could potentially affect a maximum of five breeding cycles for harbour seals. Piling activities will be intermittent and will occur over small timespan (372 days) within piling phase (52 months) and therefore can affect harbour seals over the medium term.

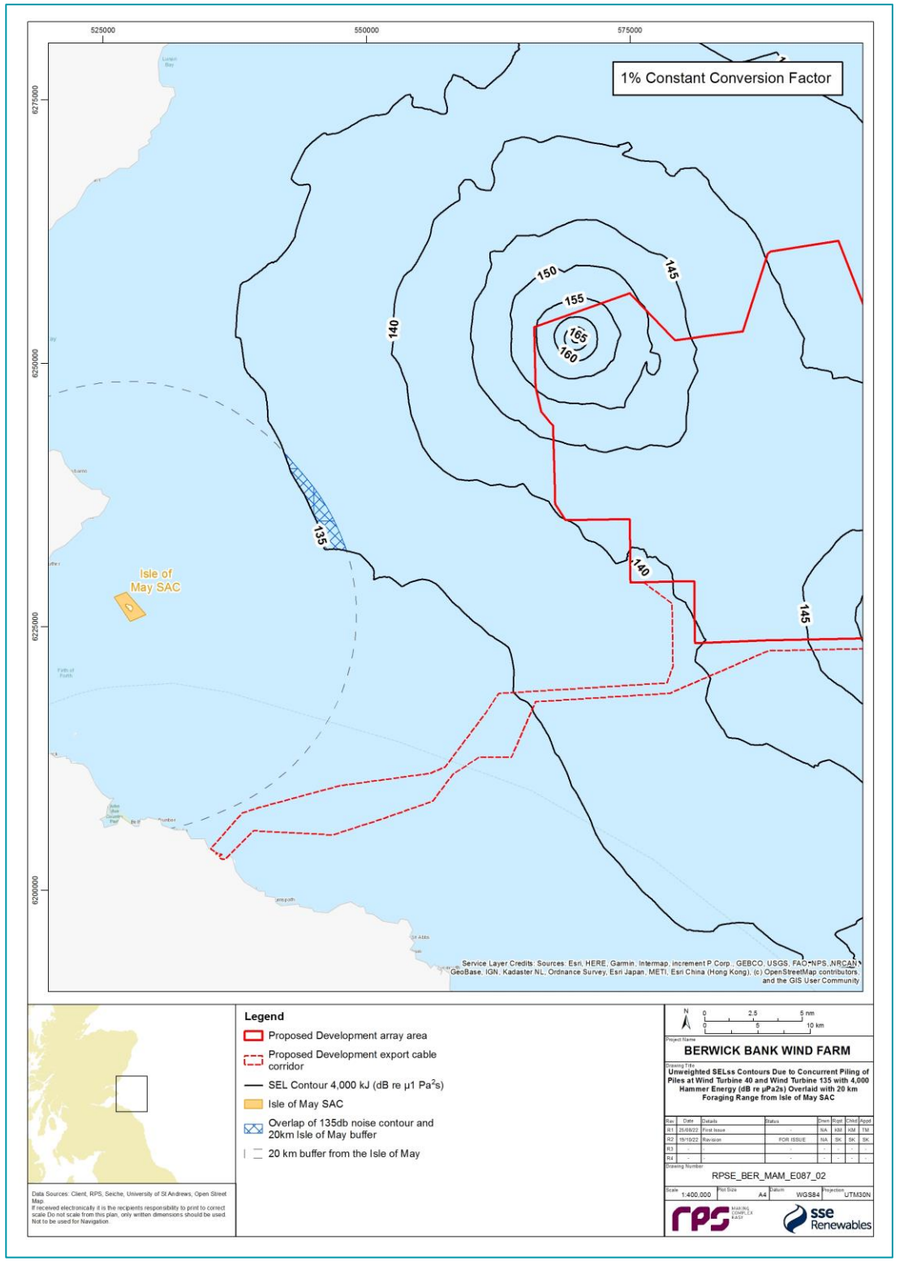

Figure 7.6: Unweighted SELss Contours Due to Concurrent Impact Piling of Wind Turbine Piles at Maximum Hammer Energy (4,000 kJ) Overlaid With Adult Harbour Seal Telemetry Tracks

1414 The population of harbour seals in Firth of Tay and Eden Estuary SAC is known to be in decline since the early 2000s after the phocine distemper virus (PDV) epidemic (see volume 3, appendix 10.2, annex B of the Offshore EIA Report). Population modelling work conducted for the Firth of Tay and Eden Estuary SAC population has concluded that if this declining trend continues, the population may become extinct within the next 20 years (Hanson *et al*., 2017). The same study concluded that although the cause of this decline is unknown, it must be reducing adult survival because the high rate of decline cannot be wholly accounted for by changes in other demographic parameters. There are a few theories about potential links to population decline, including harmful algal toxins (Hall and Frame, 2010; Jensen *et al.,* 2015) or competition between grey seals and harbour seals (see Figure 7.1 where the density of adult grey seal telemetry tracks with connectivity to the Firth of Tay and Eden Estuary SAC is high; Wilson and Hammond, 2016). This population is deemed sensitive to any additional anthropogenic disturbance, especially during the breeding season (spring and summer), however, based on findings of Hanson *et al*. (2017) the population will not recover if sources of increased mortality is not identified and measures to manage these are not put in place. Therefore, although potential anthropogenic disturbance may be intolerable for this species, it will also not influence the population trajectory, which is in decline.

1415 No population trajectory is available for Firth of Forth, although sporadic counts in the area indicate that the decline is localised within the SAC and may not represent the trends in the overall MU population (SCOS, 2020; Sinclair *et al*., 2020). The results of the iPCoD modelling for harbour seal against the wider ES MU population showed that the difference in population trajectory between the impacted and unimpacted population fall within the natural variance of the population (see paragraph 919 *et seq.*). Therefore, it was considered that there is no potential for long-term effects on this species within the wider population as a result of piling during construction phase of the Proposed Development (see volume 2, chapter 10 of the Offshore EIA Report).

1416 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC are not predicted to occur as a result of underwater noise during piling during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1417 The assessment has concluded that piling activities are highly unlikely to disrupt normal behaviours of harbour seal because the behavioural disturbance contours do not reach the coast and hence do not overlap with the site. Therefore the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. Animals would be potentially exposed only to low noise levels along the coast and these are unlikely to lead to barrier effects or strong behavioural response. Therefore, disturbance caused by piling is considered unlikely to cause a change in reproduction and survival rates and will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1418 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from injury and disturbance due to underwater noise during piling with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during site investigation surveys

1419 The noise modelling showed that ranges within which there is a risk of PTS to harbour seal as a result of geophysical surveys are relatively low with a maximum impact range of 65 m (due to operation of SSS, SBES and SBP; see paragraph 945 *et seq.*). For geotechnical survey activities, PTS impact thresholds for harbour seal are not exceeded (Table 7.21).

1420 There is potential for less than one animal to experience PTS as a result of geophysical and geotechnical site investigation surveys (2.4% of the Firth of Tay and Eden Estuary SAC population). The surveys are considered to be short-term as they will take place over a period of up to three months. It should be noted that since sonar-based systems have strong directivity, there is only potential for injury when marine mammals are directly underneath the sound source. With designed in measures in place (Table 7.11), due to the low risk of PTS occurring and the short-term duration of the geophysical surveys, no adverse effects associated with auditory injury to harbour seals are predicted as a result of site investigations surveys. It is anticipated that as a result of site investigation surveys there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for harbour seals at the SAC.

1421 In terms of behavioural disturbance, estimated maximum ranges for onset of disturbance are based on exceeding the 120 dB re 1 µPa (rms) threshold applicable for all marine mammals, noting that this threshold is for 'mild disturbance' and therefore is not likely to result in displacement of animals. Additionally, Russell *et al*. (2017) study reported the highest received level at which a response was detected by seals at 135 dB SEL_{ss} with a zero probability of response measured at 130 dB SEL_{ss}. The largest distance over which disturbance could occur potentially affecting harbour seal is out to approximately 7.5 km during vibro-coring. The assessment predicted that a maximum of one individual could be disturbed as a result of vibro-coring (2.4% of the Firth of Tay and Eden Estuary SAC population). Since the adult harbour seal telemetry tracks are mostly confined to the northern part of the Proposed Development array area, only surveys taking place in close vicinity to this area could result in a potential disturbance. Although there is a potential for behavioural disturbance during vibro-core survey, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Therefore, the underwater noise during site-investigation surveys is unlikely to result in reduced reproductive success and will not affect the status of this population as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development, see paragraph 1414).

1422 It is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for harbour seals at the SAC as a result of site investigation surveys. Therefore, it is highly unlikely that site investigation surveys will influence distribution of the species within and outside the site.

1423 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of underwater noise during site investigation surveys during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1424 The assessment has concluded that there will be no introduction of barriers to wider movement for harbour seal as a result of elevated sound from site investigation surveys. Therefore the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. Underwater noise during site-investigation surveys is unlikely to affect harbour seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates and therefore will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1425 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during UXO clearance

1426 Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that harbour seal can be potentially affected by PTS at the maximum range of 2,085 m due to detonation of charge size of 300 kg (Table 7.24). Conservatively, the number of harbour seals that could be potentially injured by the high order UXO clearance event has been assessed as up to one animal (Table 7.27). This represents a possible 2.4% of the Firth of Tay and Eden Estuary SAC population.

1427 To reduce the potential of experiencing injury, designed in measures, which are in line with recommended best practice guidelines, will be adopted as part of a MMMP (see Table 7.11). Given that there is a potential to experience auditory injury by harbour seal at a greater range than can be mitigated by monitoring of the 1 km mitigation zone alone (Table 7.24), an ADD will be deployed for a pre-determined length of time to deter marine mammals to a greater distance prior to any detonation. Activation of ADD for 22 minutes is considered sufficient to deter harbour seal from the potential injury zone as a result of high order detonation of 300 kg UXO (Table 7.24). A MMMP will be developed for the purpose of mitigating the risk of auditory injury (PTS) to marine mammals from the proposed UXO clearance activities at the Proposed Development based on an assessment which will be provided as a part of the EPS licence supporting information.

1428 Moreover, it is anticipated that only 10% of all UXO clearance events will result in high order detonation as low order techniques will be applied as the intended methodology for clearance of UXO. The underwater noise modelling results show that harbour seal can be potentially affected by PTS at the maximum range of 250 m due to detonation of 0.5 kg clearance shot (Table 7.24), with one animal potentially affected (Table 7.25, 2.4% of the Firth of Tay and Eden Estuary SAC population).

1429 As described in paragraph 971, the threshold for potential temporary loss of hearing (TTS) was also assessed. The onset of TTS also corresponds to a 'fleeing response' as this is the threshold at which animals are likely to flee from the ensonified area. Thus, the onset of TTS reflects the threshold at which behavioural displacement could occur. It is important to note that the sound is unlikely to be impulsive in character once it has propagated more than a few kilometres. It is particularly important when interpreting results for TTS with impact ranges of several kilometres as these are likely to be significantly lower than predicted.

1430 Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that harbour seal can be potentially affected by TTS at the maximum range of 6,430 m due to detonation of charge size of 300 kg (Table 7.32) with up to 156 harbour seal individuals affected (Table 7.33). As low order techniques are preferred option for UXO clearance, the underwater noise modelling results show that harbour seal can potentially experience TTS at the maximum range of 455 m due to detonation of 0.5 kg clearance shot (Table 7.30) with less than one animal potentially affected (Table 7.31). This accounts for 2.4% of the Firth of Tay and Eden Estuary SAC population.

1431 TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Therefore, effects caused by UXO clearance are considered is unlikely to result in reduced reproductive success and will not affect the status of this population as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development, see paragraph 1414).

1432 Considering the number of animals potentially affected by the PTS and TTS, respective proportions of the SAC population potentially affected and designed in measures reducing the risk of adverse effects, an alteration in the distribution of the population from Firth of Tay and Eden Estuary SAC is considered highly unlikely.

1433 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of underwater noise during UXO

clearance during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1434 The assessment has concluded that UXO clearance activities are highly unlikely to disrupt normal behaviours of harbour seal. Since TTS is a temporary hearing impairment, it is unlikely to cause a change in reproduction and survival rates and will not influence the population of qualifying species (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). Changes in distribution of qualifying species within the site are highly unlikely. As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1435 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from injury and disturbance due to underwater noise during UXO clearance with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1436 With regards to PTS, the modelling shows that for harbour seal, the threshold for PTS is not exceeded by any vessel with the exception of rock placement vessels, for which an injury range of 5 m from the source was reported (Table 7.35). PTS ranges for seal were not exceeded for any other activities except for cable laying, where an injury range of 5 m from the source was reported. The number of harbour seals potentially affected within the modelled ranges for PTS from vessels and other activities were found to be less than one individual. For Firth of Tay and Eden Estuary SAC, this equates to 2.4% of harbour seal population. Given that vessels will follow a Code of Conduct (including advice to operators to not deliberately approach marine mammals) and NSPVMP, the risk of potential auditory injury will be low.

1437 With regard to behavioural disturbance to harbour seal, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m. Similar ranges for behavioural effects are predicted to occur due to underwater noise from installation and construction vessels as well as rock placement vessels with disturbance ranges of 4,389 m. In comparison, vessels such as excavator, backhoe dredger, pipe laying, geophysical survey vessel and jack up vessel as well as jack-up rig were predicted to result in disturbance ranges out to 300 m.

1438 As discussed in paragraph 874, there is likely to be a proportionate response of animals within the modelled contours (i.e. not all animals will be disturbed to the same extent). Most of the vessel traffic associated with construction within the Proposed Development array area will take place at distances >45 km from the Firth of Tay and Eden Estuary SAC. Vessel movements will also increase over construction phase along the Proposed Development export cable corridor. Although there is some connectivity of individual harbour seal telemetry tracks between the SAC and Proposed Development export cable corridor, majority of harbour seal movements are confined within the outer Firth of Tay and north-west to the Proposed Development array area (Figure 7.6).

1439 Additionally, vessels will be moving to and from ports and harbours and this traffic is likely to intersect with the areas characterised by high density of harbour seal telemetry tracks (Figure 7.6). As previously discussed in paragraph 1109, seals exhibit avoidance behaviour or alert reactions when disturbed, as hauled out seals typically flush into the water which may be detrimental during pupping season. The presence of vessels in foraging grounds could result in reduced foraging success, particularly in harbour seals given reduced foraging ranges out to 50 km. Study commissioned by the FTOWDG presented analysis of telemetry data available from harbour seals tagged by SMRU in the East Scotland SMA between 2001 and 2008 and the analysis demonstrated that harbour seal movements are mostly coastal (Sparling *et al.,* 2012). The NSPVMP will be produced and will include agreed routes and potential speed restrictions in order to reduce the disturbance. Given the existing levels of vessel activity within the Firths of Tay and Forth, it is expected that harbour seals could tolerate the effects of vessel presence to some extent. Even if individuals are temporarily deterred from offshore foraging grounds, given that the impacts of construction will be highly localised, largely restricted to the boundaries of the Proposed Development (vessel movements intersecting the areas potentially important for harbour seal closer to the coast will be intermittent), only a small area will be affected when compared to available foraging habitat for harbour seals. Therefore, it is anticipated that the connectivity with suitable foraging grounds and supporting habitats will not be impaired. As such, impacts associated with vessel use are considered is unlikely to result in reduced reproductive success and will not affect the status of this population as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development, see paragraph 1414).

1440 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of underwater noise during vessel use and other activities during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1441 The assessment has concluded that vessel use and other activities are highly unlikely to affect reproductive and recruitment capability of the species because the behavioural disturbance ranges do not reach the coast and hence do not overlap with the site. Therefore, it will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). The availability of foraging grounds for harbour seal will not be impacted and the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1442 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from injury and disturbance due to underwater noise during vessel use and other activities with respect to the construction and decommissioning of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1443 As outlined in paragraph 1001 *et seq.*, there is potential for changes to prey availability for harbour seal during construction and decommissioning of the Proposed Development. These impacts include temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration.

1444 There is potential for temporary habitat loss/disturbance to affect up to 113,974,700 m^2 of seabed during the construction phase, which equates to 9.7% of the fish and shellfish ecology study area (see volume 3, chapter 9 of the Offshore EIA Report). Only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase, with areas starting to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works. The impacts will be highly localised. As presented in Figure 7.6, areas within the Proposed Development array area and Proposed Development export cable corridor are not characterised by high densities of harbour seal telemetry tracks and therefore these areas are highly unlikely to represent important foraging grounds for this species. However, for these individuals visiting Proposed Development to find prey, it is expected that harbour seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term.

1445 In terms of indirect effects on marine mammals as a result of underwater noise, it is assumed that marine mammals would be disturbed from the area in vicinity of the noise source, and so any changes to the distribution of prey resources would not affect marine mammals as they would already be disturbed from the same (or larger) area.

1446 Elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/juvenile or eggs survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Additionally, given that overlap of harbour seal telemetry tracks with Proposed Development is limited, only construction and decommissioning activities taking place within the northern part of the Proposed Development array area have a potential to have indirect impact on harbour seals via changes to prey species due to an increase in SSC and associated sediment deposition. Given the small and localised extent of these effects, the availability of suitable foraging grounds for harbour seal is not expected to be impaired.

1447 As outlined in paragraph 1026 *et seq*., harbour seals are generalist feeders and can forage on variety of species, usually within 50 km from the coast. Given that the impacts of construction will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat within the outer Firth of Tay. Based on the telemetry data (Figure 7.6), harbour seal presence is confined mostly within approximately 30 km from the SAC limits and the overlap with Proposed Development is limited. Due to the presence of alternative prey resources and foraging grounds available in the wider area, harbour seals are not expected to be constrained by the temporary and reversable nature of impacts associated with construction. It is expected that harbour seal population would be able to tolerate the effect without any impact on reproduction and survival rates.

1448 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning phases (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1449 The assessment has concluded that distribution of the species within the site and the distribution and extent of habitats supporting the species is unlikely to be impaired in long term. It is expected that harbour seal population would be able to tolerate the effect of changes in fish and shellfish communities without any impact on reproduction and survival rates and it will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1450 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from changes in fish and shellfish communities affecting prey availability with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

1451 As discussed in paragraph 945 *et seq.*, the maximum range at which there is a risk of PTS to harbour seal as a result of site investigation surveys is 65 m. With designed in measures (Table 7.40) implemented for the geophysical surveys, the risk of PTS occurring to harbour seals will be low. With regard to behavioural disturbance, although a maximum potential disturbance range across all survey types is 7.5 km during vibro-coring, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased.

1452 The maximum design scenario for routine geophysical surveys is estimated as a survey every six months for the first two years and annually thereafter. This equates to 37 surveys over the 35-year life cycle of the Proposed Development (Table 7.10). Surveys are anticipated to be short-term in nature (weeks to a few months) and occur intermittently over the operation and maintenance phase. Given that the surveys will be confined within limits of the Proposed Development, it is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for harbour seals. Therefore, it is highly unlikely that they will influence distribution of harbour seal within and outside the SAC.

1453 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of underwater noise during site investigation surveys during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1454 The assessment has concluded that there will be no introduction of barriers to wider movement for harbour seal as a result of elevated sound from site investigation surveys. Therefore the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. Underwater noise during site-investigation surveys is unlikely to affect harbour seal at a level that would substantially affect their behaviour and cause change in reproduction and survival rates and therefore will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1455 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the operation of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1456 As described in paragraphs 989 *et seq*., vessel use during the operation and maintenance phase of the Proposed Development is considered a relatively small increase in the context of baseline traffic and the size and noise outputs from vessels will be similar to those used in the construction phase. The number of vessel round trips and their frequency will be much lower compared to the construction phase.

1457 Most of the vessel traffic associated with operation and maintenance within the Proposed Development array area will take place at distances >45 km from the Firth of Tay and Eden Estuary SAC. Vessel movements may occasionally increase along the Proposed Development export cable corridor. Although there is some connectivity of individual harbour seal telemetry tracks between the SAC and Proposed Development export cable corridor, majority of harbour seal movements are confined within the outer Firth of Tay and north-west to the Proposed Development array area (Figure 7.6).

1458 Additionally, vessels will be moving to and from ports and harbours and this traffic is likely to intersect with the areas characterised by high density of harbour seal telemetry tracks (Figure 7.6). Richardson *et al*. (2005) reported avoidance behaviour or alert reactions in harbour seal when vessels approach within 100 m of a haul-out site and when disturbed, seals that are hauled-out typically flush into the water which could be detrimental during pupping season (see paragraph 1109 *et seq.*). As previously described for the construction phase, the presence of vessels in foraging grounds could result in reduced foraging success (paragraph 1439). Impacts associated with vessel use are considered is unlikely to result in reduced reproductive success and will not affect the status of this population as a viable component of the site

(noting that the population of this SAC is in decline due to factors not associated with the Proposed Development, see paragraph 1414).

1459 Effects on harbour seal at this SAC are therefore considered to be the same or less than the effects of vessel use and other activities during the construction and decommissioning phases. It should be noted that operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years) and therefore only a small proportion of vessel use and other activities will occur at any one time.

1460 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of underwater noise during vessel use and other activities during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1461 The assessment has concluded that vessel use and other activities are highly unlikely to affect reproductive and recruitment capability of the species because the behavioural disturbance ranges do not reach the coast and hence do not overlap with the site. Therefore, it will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). The availability of foraging grounds for harbour seal will not be impacted and the distribution of the species within the site will not be affected and neither will be the distribution and extent of habitats supporting the species. As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1462 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from injury and disturbance due to underwater noise during vessel use and other activities with respect to the operation of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1463 As outlined in paragraph 1051 *et seq.*, there is potential for changes to prey availability for harbour seal due to potential impacts on prey species during operation and maintenance of the Proposed Development. These impacts include temporary subtidal habitat loss/disturbance, long-term subtidal habitat loss, increased SSC and associated sediment deposition, EMF from subsea electrical cabling and colonisation of foundations, scour protection and cable protection.

1464 Potential temporary habitat loss/disturbance during operation and maintenance equates to a smaller area than that affected during construction (up to 989,000 m^2 which equates to 0.08% of the fish and shellfish ecology area, compared with 9.7% during the construction phase; see volume 2, chapter 9 of the Offshore EIA Report). Operation and maintenance activities will occur periodically over the full lifetime of the project (estimated to be 35 years) and only a small proportion of the maximum footprint of habitat loss/disturbance may occur at any one time, with areas starting to recover immediately after cessation of maintenance activities. As presented in Figure 7.6, areas within the Proposed Development array area and Proposed Development export cable corridor are not characterised by high densities of harbour seal telemetry tracks and therefore these areas are highly unlikely to represent important foraging grounds for this species. However, for these individuals visiting Proposed Development to find prey, it is expected that harbour seal could come back to forage within areas previously disturbed after cessation of works. Therefore, the distribution and extent of habitats supporting the species outside of the SAC is unlikely to be impaired.

1465 Increased SSC could occur as a result of repair or remedial burial activities during the operation and maintenance phase. The maintenance activities will be undertaken at intervals over the 35 years operation and maintenance phase. The assessment presented in volume 2, chapter 9 of the Offshore EIA Report considered that any suspended sediments and associated deposition will be of the same magnitude, or lower as for construction. Given the small and localised extent of these effects, the availability of suitable foraging grounds for harbour seal is not expected to be impaired.

1466 The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. The range over which species can detect EMF will be very localised to within a few centimetres of the buried cable, with rapid decay of the EMF with increasing distance Considering the above, adverse effects on harbour seal as a result of changes in prey availability due to EMF are highly unlikely.

1467 Although there will be long term loss of habitat due to the presence of infrastructure associated with the Proposed Development, it is also anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 1021 *et seq*, evidence increasingly suggests that foraging opportunities for marine mammals are increased around offshore wind farm structures. Individual harbour seals demonstrate high levels of site-fidelity and foraging ranges may be constrained around these favoured breeding and haul-out sites (Thompson *et al.,* 2013). Additionally, because displacement could potentially lead to increased competition for food between competing species (grey seal and harbour seal; Wilson and Hammond, 2016), presence of artificial structures in offshore waters is unlikely to benefit harbour seal population.

1468 As outlined in paragraph 1026 *et seq.*, harbour seals are generalist feeders and can forage on variety of species, usually within 50 km from the coast. Given that the impacts of construction will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat within the outer Firth of Tay. Based on the telemetry data (Figure 7.6), harbour seal presence is confined mostly within approximately 30 km from the SAC limits and the overlap with Proposed Development is limited. Due to the presence of alternative prey resources and foraging grounds available in the wider area, harbour seals are not expected to be constrained by the temporary and reversable nature of impacts associated with operation and maintenance phase. It is expected that harbour seal population would be able to tolerate the effect without any impact on reproduction and survival rates.

1469 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour seal of the Firth of Tay and Eden Estuary SAC, are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance phase (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1470 The assessment has concluded that distribution of the species within the site and the distribution and extent of habitats supporting the species is unlikely to be impaired in long term. It is expected that harbour seal population would be able to tolerate the effect of changes in fish and shellfish communities without any impact on reproduction and survival rates and it will not influence the population of the species as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development). As such, the conservation objectives for Annex II species, harbour seal, will not be undermined.

1471 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC from changes in fish and shellfish communities affecting prey availability with respect to the operation of the Proposed Development acting alone.

Effects in-combination

1472 An assessment of in-combination effects upon the qualifying Annex II marine mammal species of the Firth of Tay and Eden Estuary SAC arising from each identified impact is provided below.

1473 The potential to experience injury in terms of PTS by marine mammal receptors as a result of underwater noise due to piling and vessel use/other activities would be expected to be largely localised within the boundaries of the respective projects (assuming similar ranges of effect as presented for the Proposed Development). It is also anticipated that standard offshore wind industry construction methods (which include soft starts and visual and acoustic monitoring of marine mammals as standard) will be applied, thereby reducing the magnitude of the impact with respect to auditory injury occurring in marine mammals. Therefore, there is no potential for significant in-combination impacts for injury from elevated underwater noise during pilling and vessel use/other activities and the in-combination assessment focuses on disturbance only.

Assessment of in-combination effects during construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

Tier 2

1474 The construction of the Proposed Development, together with the construction of the Tier 2 projects, may lead to injury and/or disturbance to harbour seal from the Firth of Tay and Eden Estuary SAC from underwater noise during piling. Other projects screened into the assessment within the regional marine mammal study area include construction of Inch Cape Offshore Wind Farm and Seagreen 1A Project.

1475 Both projects screened in for the in-combination assessment for harbour seal (paragraph 1474) are located within a behavioural disturbance footprint of the Proposed Development. The outermost contour of 135 dB represents the edge of the area within which harbour seal may experience behavioural disturbance during concurrent piling at 4,000kJ hammer energy at Proposed Development. The assessment presented in the Inch Cape EIA (Inch Cape Offshore Limited, 2018) and original Seagreen EIA (Seagreen Wind Energy Ltd, 2012) estimated that 20 and 51 individuals could experience disturbance during piling at respective projects. The duration of any disturbance at Seagreen 1A Project will be relatively short and is currently planned to take place between April and July 2023 (i.e. more than two years before planning commencement of piling at the Proposed Development (Seagreen Wind Energy Ltd, 2020)).

1476 The construction of Inch Cape and Seagreen 1A Project will be completed prior to commencement of piling at the Proposed Development so the potential for simultaneous piling, and therefore additive in-combination effects, with Proposed Development is highly unlikely. Nevertheless, as requested by consultees via Road Map process (see volume 3, appendix 10.3 of the Offshore EIA Report), population modelling was carried out to explore the potential of cumulative effects as a result of disturbance during piling to affect the population trajectory over time. Population modelling considered Seagreen 1A Project and Inch Cape Offshore Wind Farm and respective numbers of animals potentially impacted against the wider MU population (see volume 3, appendix 10.4 for methods applied in the model). Results of the cumulative iPCoD modelling for harbour seal showed that no impacts are predicted on the wider population resulting from disturbance due to cumulative piling events, with the mean impacted population the same as the mean unimpacted population at the 25 year time point. Therefore, it was considered that there is no potential for the long-term effects on this species within wider population as a result of cumulative piling at proposed Development and respective projects (see volume 3, appendix 10.4 for more details). As previously presented for iPCoD results for proposed Development alone (paragraph 919), these results are not in agreement with findings of Hanson *et al*. (2017), who suggested that the continuation of current decline trend in the Forth of Tay and Eden Estuary SAC could result in the species disappearing from this area within next 20 years. The reason for this discrepancy is that the revised demographic parameters to inform iPCoD models (Sinclair *et al*., 2020) indicate that with inclusion of the Firth of Forth counts, the total East Scotland MU counts appear to be relatively stable. Additionally, sporadic counts in the area indicate that the decline is localised within the SAC and may not represent the trends in the overall MU population (SCOS, 2020; Sinclair *et al*., 2020).

1477 In temporal terms, there is a potential that animals in the vicinity of the Firth of Forth and Tay will experience disturbance consecutively as piling at different projects progresses. As described in paragraph 1477, harbour seals although initially displaced due to pile-driving, are likely to return to the same area within two hours following cessation of piling. Therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be affected. Additionally, given that the risk of simultaneous piling is very low, it is unlikely that in-combination effect as a result of piling has the potential to result in reduced reproductive success. Therefore, it is unlikely that the status of this population as a viable component of the site will be affected (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development in-combination with other projects, see paragraph 1414).

1478 As described in paragraph 1410, during piling at Proposed Development, behavioural disturbance contours do not overlap with Firth of Tay and Eden Estuary SAC (Figure 7.6). Given the limited extent of behavioural disturbance footprint of respective projects, harbour seals present in the vicinity of the habitats which they utilise throughout their life cycle (sandbanks and estuaries), are unlikely to experience disturbance. As such, piling activities are highly unlikely to change the distribution of species within site.

1479 Additionally, considering that there will be no overlap of piling phases with either of the projects and piling will be intermittent over medium term, it is anticipated that piling will not result in any long-lasting changes in the distribution of adult seals and the connectivity with areas of high importance within and outside the site is not expected to be impaired.

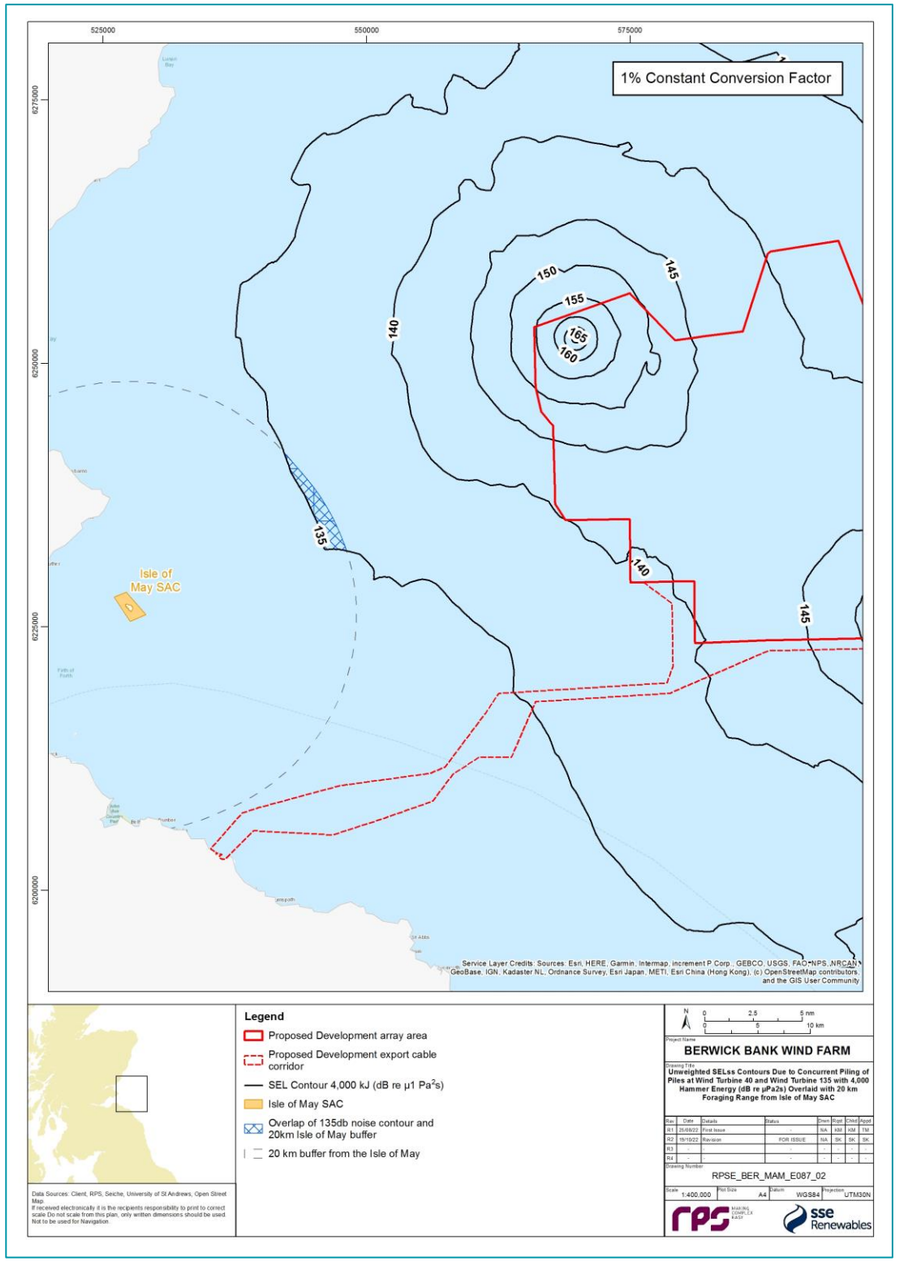

Figure 7.7: Adult Harbour Seal Telemetry Tracks Overlaid with Projects Considered in In-Combination Assessment (Except Moray West Due to Scale)

1480 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of underwater noise during piling during construction with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1481 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to harbour seal from the Firth of Tay and Eden Estuary SAC during the construction phase of the Proposed Development with the construction and operation and maintenance Eastern Link 1 and Eastern Link 2.

1482 The construction as well as operation and maintenance phases of Eastern Link 1 and Eastern Link 2, located respectively 14 km and 28 km from the Proposed Development array area, will overlap with the construction phase of the Proposed Development. Based on the Environmental Appraisals for both projects, the only underwater sound noise sources that are within hearing range of marine mammals and have potential to have an effect, are the operation of the USBL and the SBP (AECOM, 2022a; 2022b). The disturbance ranges for harbour seal were estimated as 63 m for USBL and 4,642 m for SBP. The detailed assessment of impacts as a result of underwater noise during the operation of SBP for both projects was presented for installation phase only. There are no disturbance ranges presented for the USBL for the Proposed Development alone but the disturbance range for SBP has been assessed as 2,045 m. Nevertheless, the assessment presented in paragraph 955 *et seq*. is based on the maximum disturbance range estimated as 7,459 m for vibro-coring. Using the published at-sea density maps (Carter *et al*., 2020), the assessment predicted that less than one individual could be disturbed as a result of vibro-coring (2.4% of the Firth of Tay and Eden Estuary SAC population). However, since the adult harbour seal telemetry tracks are mostly confined to the northern part of the Proposed Development array area (Figure 7.7), only surveys taking place in close vicinity to this area could result in a potential disturbance.

1483 Based on the distance from the Proposed Development to both projects, the overlap of disturbance ranges is highly unlikely. The potential for an overlap exist only for site-investigation surveys taking place in the northern part of the Eastern Link 1, close to the Proposed Development export cable corridor and landfall (Figure 7.3). Based on the telemetry tracks, the areas close to the landfall are not regularly visited by individuals from this SAC and although the connectivity between these areas and harbour seals from the Firth of Tay and Eden Estuary SAC cannot be discounted, the behavioural disturbance could potentially affect a negligible proportion of the population. It needs to be noted that site investigation survey equipment will not be operating continuously, it will be used when required for investigations of particular areas of the seabed where additional information is required to inform the construction.

1484 With foraging ranges of up to 50 km, harbour seals may be sensitive to a behavioural disturbance during the site-investigation surveys as they move between haul-outs and key foraging areas. Given the distance from Eastern Link 1 and Eastern Links 2 to the SAC (approximately 50 and 93 km, respectively), operation of the survey equipment is unlikely to disturb animals from this SAC within their main foraging grounds. Disturbance ranges during vibro-coring at Proposed Development have the potential to slightly overlap with foraging ranges of harbour seal from the Firth of Tay and Estuary SAC, however, given that alternative areas for foraging are widely available, the disturbance to seals is not considered likely to have a significant impact on food availability (see paragraph 1501 *et seq*. for the cumulative assessment of impacts as a result of changes in prey availability) and therefore on fitness and survival of the harbour seal population. Given that geophysical surveys will occur intermittently and are short in duration, harbour seals are anticipated to return to foraging grounds when the impact has ceased and therefore the connectivity with important habitats within and outside the site is unlikely to be impaired.

1485 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of site investigation surveys during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during UXO clearance

Tier 2

1486 There is potential for in-combination effects from injury and/or disturbance from underwater noise during UXO clearance to harbour seal from the Firth of Tay and Eden Estuary SAC during the construction phase of the Proposed Development with activities associated with Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm.

1487 Projects screened in for this in-combination assessment are expected to involve similar construction activities to those described for the Proposed Development alone, including UXO clearance activities. It is anticipated that, for all projects, impacts associated with these activities will require additional assessment under EPS licensing, however such applications are not yet available in the public domain.

1488 For the Proposed Development alone, the maximum range across which harbour seal have the potential to experience PTS due to high order detonation of 300 kg charge was assessed as approximately 2,085 m. PTS onset ranges for Inch Cape Offshore Wind Farm and Moray West are currently unknown but for the purpose of this assessment, we can assume that the maximum adverse scenario is not greater than assessed for the Proposed Development alone. Depending on the type of detonation and size of UXO, UXO clearance activities may have residual effects in respect to marine mammals and PTS injury. In November 2021, the UK government published a joint interim statement advising to use low noise alternatives to high order detonations where possible and it is anticipated that future developments will follow this guidance. However, due to a small inherent risk with these clearance methods that the UXO will detonate or deflagrate violently, accidental high order detonation can be expected as a maximum adverse scenario. Taking into account high order detonation of 300 kg charge and appropriate designed in and secondary mitigation measures, there will be no residual risk of injury and therefore, it is highly unlikely that the reproductive and recruitment capability of the harbour seal will be affected.

1489 In terms of TTS, for the Proposed Development alone, the range across which harbour seal have the potential to experience TTS due to high order detonation of a 300 kg charge was as approximately 6,430 m (see paragraph 971 *et seq*.). TTS onset ranges for Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm are currently unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is no greater than assessed for the Proposed Development alone. A spatial maximum adverse scenario would occur where UXO clearance activities occur concurrently at the respective projects considered in the in-combination assessment. This is however highly unlikely, as due to safety reasons the UXO clearance activities takes place before other construction activities commence, and both projects considered in the CEA start their construction activities two years before commencement of construction at Proposed Development. Temporally however, sequential UXO clearance at respective projects could lead to a longer duration of effect. Since each clearance event results in no more than a one second ensonification event and since TTS is a recoverable injury, the potential for in-combination effects with respect to TTS is considered to be very limited. Therefore, in-combination effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the harbour seal population from the Firth of Tay and Eden Estuary SAC. Given that effect of TTS is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired.

1490 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of underwater noise during UXO clearance during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1491 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to harbour seal from the Firth of Tay and Eden Estuary SAC during the construction and decommissioning phase of the Proposed Development with activities associated with the following projects: Eyemouth disposal site, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Neart na Gaoithe and Blyth Demo 2.

1492 Whilst there is no quantitative information available for noise disturbance ranges for offshore wind farms included in this CEA, it is anticipated that there will be a similar scale of effects with respect to noise effects as those described for Proposed Development alone (paragraph 995 *et seq*.). In terms of behavioural disturbance, the noise modelling predicted a maximum range of approximately 4 km for construction activities such as cable laying as well as activity of rock placement vessels (described in detail in volume 3, appendix 10.1 of the Offshore EIA Report) and therefore, there is a potential for disturbance effects to occur cumulatively. Given that construction activities for the other offshore wind projects have commenced in 2020 and that this is an area of relatively high vessel traffic (see paragraph 989 *et seq*. for more details), it can be anticipated that harbour seal from the Firth of Tay and Eden Estuary SAC demonstrate some degree of habituation to ship noise.

1493 As discussed in paragraph 874, there is likely to be a proportionate response of animals within the modelled contours (i.e. not all animals will be disturbed to the same extent). Most of the vessel traffic associated with offshore wind farms considered in the in-combination assessment will take place within the array areas of respective projects. Based on telemetry data, array areas of respective projects have connectivity with seals from the Firth of Tay and Eden Estuary SAC (Figure 7.6). Vessel movements will also increase over construction phase along the Proposed Development export cable corridor. Although there is some connectivity of individual harbour seal telemetry tracks between the SAC and Proposed Development export cable corridor, majority of harbour seal movements are confined within the outer Firth of Tay and north-west to the Proposed Development array area (Figure 7.6).

1494 The highest number of vessels movements was predicted during the construction phase of each offshore wind farm. Vessels will be moving to and from ports and harbours and this traffic is likely to intersect with the areas characterised by high density of harbour seal telemetry tracks (Figure 0.12). As presented in more detail in paragraph 1439, harbour seal display avoidance behaviour or alert reactions when vessels approach within 100 m of a haul-out site. Therefore, it is crucial for all projects to adhere to the Vessel Management Plans, which should include agreed routes and potential speed restrictions in order to reduce the disturbance. Given the existing levels of vessel activity within the Firths of Tay and Forth, it is expected that harbour seals could tolerate the effects of vessel presence to some extent. The impacts of construction will be highly localised, largely restricted to the boundaries of the respective projects (vessel movements intersecting the areas potentially important for harbour seal closer to the coast will be intermittent) and only a small area will be affected when compared to available foraging habitat for harbour seals. Therefore, it is anticipated that the connectivity with suitable foraging grounds and supporting habitats will not be impaired. Given that there will be a relatively small temporal overlap of the construction phases, with only one year of overlap with Inch Cape as well as Seagreen 1A Project and the Proposed Development, impacts associated with vessel use are considered is unlikely to result in reduced reproductive success and are unlikely to affect the status of this population as a viable component of the site (noting that the population of this SAC is in decline due to factors not associated with the Proposed Development, see paragraph 1419).

1495 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1496 There is potential for in-combination effects from underwater noise due to vessel use and other activities to harbour seal from the Firth of Tay and Eden Estuary SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1497 There is currently no information on the impacts the Cambois connection will have on harbour seal, although the Scoping Report have listed the types of vessels to be used during construction, including cable lay vessels, pre-lay survey vessels, rock protection vessels, support vessels, guard vessels, and possible use of jack-up vessels (SSE Renewables, 2022e). There were no details about number of vessel round trips during the construction phase of Cambois connection. No data for vessel movements was presented for operation and maintenance phase of the Cambois connection.

1498 Due to lack of project information at this stage, it is not possible to undertake full, quantitative assessment for this impact and therefore a qualitative assessment is provided. The maximum range over which potential disturbance may occur for the Proposed Development alone as a result of drilled piling and jet trenching, is predicted out to 1,900 m and 2,580 m, respectively. Cable installation activities assessed for the Proposed Development alone have the potential to disturb marine mammals out to 4,389 m. Given the location of the SAC with respect to the Proposed Development and Cambois connection, there is no potential for cumulative overlap of behavioural ZoI at respective projects and this designated site.

1499 Adult harbour grey seal telemetry tracks do not indicate that individuals from this SAC regularly move within waters in the vicinity of the Cambois connection (Figure 7.7). Nevertheless, the potential connectivity cannot be discounted and in offshore waters, construction activities could lead to a larger area of disturbance and larger number of animals disturbed compared to the Proposed Development alone if projects were to conduct construction activities over similar time periods. Given the existing levels of vessel activity within the Firths of Tay and Forth, it is expected that harbour seals could tolerate the effects of vessel presence to some extent. The impacts of operation and maintenance will be localised in the areas of small importance to harbour seal, largely restricted to the boundaries of the respective projects (vessel movements intersecting the areas potentially important for harbour seal closer to the coast will be intermittent) and only a small area will be affected when compared to available foraging habitat for harbour seals. Therefore, it is anticipated that the connectivity with suitable foraging grounds and supporting habitats will not be impaired.

1500 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 3 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1501 There is potential for in-combination effects from changes in the prey resources available for harbour seal from the Firth of Tay and Eden Estuary SAC as a result of changes to the fish and shellfish community during the construction and decommissioning phases of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Seagreen 1A Export Cable and Eyemouth disposal site.

1502 The construction phases and/or operation and maintenance phases of projects screened into in-combination assessment may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss is 145,325,450 m^2 (145.3 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The magnitude of long-term habitat loss caused by the presence of all structures on the seabed has been considered for the construction as well as operation and maintenance phases. The impacts have been assessed in-combination with Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, and Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Links 2 and may lead to long term subtidal habitat loss of up to 15,014,156 m^2 (=15.0 km^2).

1503 An increase in SSC and associated sediment deposition as a result of the installation of all wind turbines and offshore substation foundations and the installation of inter-array, interconnector and offshore export cables may result in short-term avoidance of affected areas by fish and shellfish which may have an indirect effect on harbour seals. Elevations in SSC are expected to be of short duration, returning to background levels relatively quickly. SSC is not expected to reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Therefore, the availability of suitable food supply for harbour seal within the wider area is not expected to be impaired as a result of increase in SSC and associated deposition.

1504 As outlined in paragraph 1026 *et seq.*, harbour seals are generalist feeders and can forage on variety of species. They usually within 50 km from the coast, however studies demonstrated that in the outer Firth of Tay harbour seal movements are mostly coastal (see paragraph 1439). Given that the impacts associated with construction and decommissioning will be localised when compared to wider habitat available and largely restricted to the boundaries of the respective projects, only a small area will be affected when compared to available foraging habitat for harbour seal. Since the habitat is likely to return to the state that existed before the activity or event which caused change, the availability of suitable food supply for harbour seal is not expected to be impaired. Therefore, it is anticipated that the distribution and extent of habitats supporting the species will be maintained.

1505 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1506 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to harbour seal from Firth of Tay and Eden Estuary SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1507 The construction phase of Cambois connection may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss/disturbance is 17,000,000 m^2 (=17.0 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The majority of this disturbance will not spatially overlap with the Proposed Development and where the overlap exist with the Proposed Development array area (previously impacted during the construction of the Proposed Development), it is expected to be highly localised and so the potential for repeat disturbance is considered low and unlikely to lead to an increase in the magnitude than predicted for the Proposed Development alone. The installation of Cambois connection can also result in a total area of long-term subtidal habitat loss of 306,000 m^2. Adult harbour grey seal telemetry tracks do not indicate that individuals from this SAC regularly move within waters in the vicinity of the Cambois connection (Figure 7.7). Therefore, it can be assumed that the area affected by temporary habitat disturbance/habitat loss within Cambois connection does not represent important foraging grounds for individuals from Berwickshire and North Northumberland Coast SAC.

1508 There is also a potential for in-combination effects associated with SSC and associated deposition. However, elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Therefore, it is highly unlikely to have indirect impacts on harbour seals from the Firth of Tay and Eden Estuary SAC via changes to prey species.

1509 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1510 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to harbour seal from the Firth of Tay and Eden Estuary SAC during the operation and maintenance phase of the Proposed Development with the operation and maintenance Eastern Link 1 and Eastern Link 2.

1511 The maximum design scenario for Proposed Development alone comprises of routine geophysical surveys estimated to occur every six months for first two years and annually thereafter. This equates to up to 37 surveys over the 35-year life cycle of Proposed Development (Table 5.2). As presented in paragraph 1482, the detailed assessment of impacts on marine mammals as a result of underwater noise due to geophysical surveys during the operation and maintenance phase of the Eastern Link 1 and Eastern Link 2 is unavailable.

1512 An overview of potential impacts from as a result of behavioural disturbance due to elevated underwater noise during geophysical site investigation surveys is described in paragraph 1481 *et seq*. for the construction phase and has not been reiterated here for the operation and maintenance phase. The magnitude of the impact of underwater noise from geophysical surveys during operation and maintenance phase in combination with other projects considered in cumulative assessment could result in a negligible alteration to the distribution of harbour seal in the short-term, however the overlap of disturbance ranges is unlikely. Given that geophysical surveys will occur intermittently over operation and maintenance phases of respective projects and are short in duration, harbour seals are anticipated to return to foraging grounds when the impact has ceased and therefore the connectivity with important habitats within and outside the site is unlikely to be impaired.

1513 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of site investigation surveys during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1514 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to harbour seal from the Firth of Tay and Eden Estuary SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: the Eyemouth disposal site, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Eastern Link 1, Eastern Link 2, Blyth Demo 2 and Neart na Gaoithe Offshore Wind Farm.

1515 Vessels involved in the operation and maintenance of other wind farms will include a similar suite of vessels as those described for the Proposed Development alone (see paragraph 1044 *et seq.*), such as vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth and replacement of access ladders. Given that the number of vessel round trips and their frequency is much lower for the operation and maintenance phases compared to construction phases of the respective projects, the magnitude of the impact for disturbance as a result of elevated underwater noise due to vessel use and other activities is expected to be less than that assessed for the construction phase. However, the duration of the effect will be longer (over the 35-year operating lifetime of the Proposed Development).

1516 Whilst there is no quantitative information available for noise disturbance ranges for offshore wind farms included in this CEA, it is anticipated that there will be a similar scale of effects with respect to noise effects as those described for Proposed Development alone (paragraph 995 *et seq*.).

1517 It can be expected that after more than ten years of construction activities taking place in the vicinity of Firth of Forth (i.e. Seagreen 1 construction activities commenced in 2021 and the operation and maintenance phase of Proposed Development is expected to start from 2033), marine mammals present in the area will demonstrate some degree of habituation to ship noise.

1518 As discussed in paragraph 874, there is likely to be a proportionate response of animals within the modelled contours (i.e. not all animals will be disturbed to the same extent). Most of the vessel traffic associated with offshore wind farms considered in the in-combination assessment will take place within the array areas of respective projects. Based on telemetry data, array areas of respective projects have connectivity with seals from the Firth of Tay and Eden Estuary SAC (Figure 7.6). Vessel movements will also increase over construction phase along the Proposed Development export cable corridor. Although there is some connectivity of individual harbour seal telemetry tracks between the SAC and Proposed Development export cable corridor, majority of harbour seal movements are confined within the outer Firth of Tay and north-west to the Proposed Development array area (Figure 7.6).

1519 During the operation and maintenance phases of respective projects vessels will be moving to and from ports and harbours and this traffic is likely to intersect with the areas characterised by high density of harbour seal telemetry tracks (Figure 7.7). As presented in more detail in paragraph 14581439, harbour seal display avoidance behaviour or alert reactions when vessels approach within 100 m of a haul-out site. Therefore, it is crucial for all projects to adhere to the Vessel Management Plans, which should include agreed routes and potential speed restrictions in order to reduce the disturbance. It is expected that harbour seal population would be able to tolerate the effect without any significant impact on reproduction and survival rates.

1520 During the operation and maintenance phase of the Proposed Development, the wind farms listed in paragraph 1514 will reach their decommissioning age before the Proposed Development reaches its decommissioning age in 2066. The environmental statements for respective projects predicted the number and type of vessels associated with decommissioning are expected to be, at worst, similar to construction.

1521 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1522 There is potential for in-combination effects from underwater noise due to vessel use and other activities to harbour seal from the Firth of Tay and Eden Estuary SAC during the operation and maintenance of the Proposed Development with activities associated with the operation of Cambois connection.

1523 As presented in paragraph 1360, there were no details about the number of vessel round trips or type of vessels that will be used during operation and maintenance phase of Cambois connection (SSE Renewables, 2022e). Due to lack of detailed project information at this stage, it was not possible to undertake full, quantitative assessment for this impact.

1524 An overview of potential impacts for behavioural disturbance to harbour seal from the Firth of Tay and Eden Estuary SAC from elevated underwater noise due to vessel use and other activities is described in paragraph 1496 *et seq*. for the construction phase and have not been reiterated here for the operation and maintenance phase.

1525 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 3 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1526 There is potential for in-combination effects from changes in prey resources to harbour seal from the Firth of Tay and Eden Estuary SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1, Eastern Link 2 and Eyemouth disposal site.

1527 Operation and maintenance activities at respective projects considered in in-combination assessment may lead to temporary subtidal habitat loss/disturbance of up to 32,287,197 m^2. Additionally, Offshore Wind Farms listed above will reach their decommissioning age during Proposed Development operation and maintenance phase. However, it is important to note that the maximum design scenario for habitat loss from the respective projects is precautionary, as operation and maintenance activities will occur intermittently throughout the lifetime of the Proposed Development and the temporal overlap with activities at other projects is unlikely. As described in paragraph 1011, only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time, areas will start to recover immediately after cessation of maintenance activities. It is expected that harbour seal could come back to forage within areas previously disturbed after cessation of works and therefore the distribution and extent of habitats supporting the species outside of the SAC is unlikely to be impaired.

1528 In-combination impacts could arise from EMFs due to the presence of subsea cabling during the operation and maintenance phases of the Proposed Development as well as Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable. A total length of up to 4,888 km of subsea cabling was estimated for all projects. The effect of EMF was predicted to be of local spatial extent. Considering the above, adverse effects on harbour seal as a result of changes in prey availability due to EMF are unlikely.

1529 As outlined in paragraph 1026 *et seq.*, harbour seals are generalist feeders and can forage on variety of species. They usually within 50 km from the coast, however studies demonstrated that in the outer Firth of Tay harbour seal movements are mostly coastal (see paragraph 1439). Given that the impacts associated with operation and maintenance be localised when compared to wider habitat available and largely restricted to the boundaries of the respective projects, only a small area will be affected when compared to available foraging habitat for harbour seal. Since the habitat is likely to return to the state that existed before the activity or event which caused change, the availability of suitable food supply for harbour seal is not expected to be impaired. Therefore, it is anticipated that the distribution and extent of habitats supporting the species will be maintained.

1530 Artificial structures introduced into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. There is a potential for in-combination effects arising from colonisation due to the presence of Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, and Seagreen 1A Export Cable with a maximum scenario of up to 15,214,071 m^2 of hard structures from wind turbines, OSP/Offshore convertor station platforms, meteorological masts, of cable protection, and cable crossings. The in-combination effect was predicted to be of local spatial extent. There is some evidence that marine mammal populations are likely to benefit from introduction of hard substrates and associated fauna. Individual harbour seals demonstrate high levels of site-fidelity and foraging ranges may be constrained around these favoured breeding and haul-out sites (Thompson *et al.,* 2013). Additionally, because displacement could potentially lead to increased competition for food between competing species (harbour seal and harbour seal; Wilson and Hammond, 2016), presence of artificial structures in offshore waters is unlikely to benefit harbour seal population.

1531 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1532 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to harbour seal from Firth of Tay and Eden Estuary SAC during the operation and maintenance phase of the Proposed Development with activities associated with the operation of Cambois connection.

1533 In terms of temporary subtidal habitat loss/disturbance, there are no specific values for the operation and maintenance phase of Cambois connection which will occur during the operation and maintenance phase of the Proposed Development. Adult harbour grey seal telemetry tracks do not indicate that individuals from this SAC regularly move within waters in the vicinity of the Cambois connection (Figure 7.7). Therefore, it can be assumed that the area affected by temporary habitat disturbance/habitat loss within Cambois connection does not represent important foraging grounds for individuals from Berwickshire and North Northumberland Coast SAC.

1534 Cambois connection has the potential to result in cumulative EMF effects from subsea electrical cabling within the Proposed Development. The Cambois connection is understood to have 680 km of cable. The effect of EMF was predicted to be of local spatial extent.

1535 The Cambois connection has the potential to create 306,000 m^2 of new hard habitat associated with rock/mattress cable protection, which represents a change in seabed type, the effects of which are described in paragraph 1022 *et seq*. As the cable protection does not extend into the water column the opportunity for colonisation by some species is reduced. Due to reasons described in more detail in paragraph 1530, the presence of artificial structures in offshore waters is unlikely to benefit harbour seal population.

1536 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 3 projects.

Site conclusion

1537 In conclusion, with reference to the conservation objectives set for the Annex II marine mammal features of the site and the information presented in section 7.3, 7.4, 7.5 and 7.6.3, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC in respect of the harbour seal qualifying interests.

1538 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

7.6.4 SOUTHERN NORTH SEA SAC

European site information

1539 The Southern North Sea SAC, covering an area of 36,951 km^2, was designated to conserve harbour porpoise (JNCC, 2021b). The majority of the site lies offshore (88%), extending into English inshore waters (12%) and it is located 146 km to the south-east from the Proposed Development array area and 151 km from the Proposed Development export cable corridor. Population estimates within the site based on the 2016 survey are a minimum of 20,237 and a maximum of 41,538 individuals (JNCC, 2019a). The SAC area supports an estimated 17.5% of the UK North Sea MU population. The northern part supports higher densities of porpoises during the summer season (April to September), whilst the southern part is recognised as an important area during the winter season (October to March) (JNCC, 2021b).

1540 Harbour porpoise condition has not yet been assessed at this site, however, the site assessment assigns a grade of A conservation to the site, which is deemed excellent.

1541 Further information on this European site is presented in appendix A.

Conservation objectives

1542 The conservation objectives for the Southern North Sea SAC have been developed jointly by JNCC and Natural England (JNCC, 2019b) and are as follows:

- To ensure that the integrity of the site in 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:
  - harbour porpoise is a viable component of the site;
  - there is no significant disturbance of the species; and
  - the condition of supporting habitats and processes, and the availability of prey is maintained.

1543 In the Advice on Operations for harbour porpoise and Southern North Sea SAC (JNCC, 2019b), noise disturbance from a plan individually or in-combination is regarded as significant if it excludes harbour porpoises from more than 20% of the part of the SAC that was designated on the basis of higher persistent densities for specific season (thereafter referred to as relevant area) in any given day, and an average of 10% of the relevant area of the site over specific season.

1544 It is noted that the advice on operations (JNCC, 2019b) state that, with regard to assessing impacts to Conservation Objective 1 (harbour porpoise is a viable component of the site), '*the reference population for assessments against this objective is the Management Unit (MU) population in which the SAC is situated (IAMMWG, 2015)*.' As agreed through the Road Map process (volume 3, appendix 10.3 of the Offshore EIA Report), IAMMWG (2021) abundance data are used as the reference population for harbour porpoise. The IAMMWG (2021) estimated abundance for the North Sea Management Unit (NS MU) is 346,601 individuals.

1545 Further information on the conservation objectives for the Southern North Sea SAC is provided in the document 'conservation objectives and Advice on Operations' (JNCC, 2019b). This further advice is outlined in appendix A.

Features and effects for assessment

1546 The potential for adverse effects has been identified for the following Annex II marine mammal features of this site:

- Harbour porpoise

1547 The following impacts associated with the construction and decommissioning of the Proposed Development have been identified as having the potential for adverse effects on harbour porpoise at this site:

- **Injury and disturbance** from underwater noise generated by following activities:
  - piling of fixed foundations;
  - clearance of UXO; and
  - site investigation surveys.
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1548 The following impacts associated with the operation and maintenance of the Proposed Development have been identified as having the potential for adverse effects on harbour porpoise at this site:

- **Injury and disturbance** from underwater noise generated by site investigation surveys; and
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1549 The following assessment is structured to first assess whether the construction and decommissioning impacts will have an adverse effect on the integrity of the harbour porpoise feature of the site, and then the impacts associated with operation and maintenance will be assessed. For the purposes of these assessments, the potential effects are considered in relation to the site's conservation objectives.

Construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

1550 Underwater noise could affect the population and distribution of the qualifying species. Underwater noise modelling has been undertaken to estimate the maximum potential injury ranges for underwater noise that could arise during construction and decommissioning in relation to harbour porpoise. The modelling was based on the maximum design scenario (as outlined in Table 7.10) with summary of noise modelling provided in paragraph 834 *et seq*.

1551 The maximum range for injury to harbour porpoise was estimated as 449 m based on SPL_{pk} and using the 4% reducing to 0.5% conversion factor (see paragraph 887 *et seq*). Taking into account the most conservative scenario, less than one harbour porpoise was predicted to be potentially injured, which accounts for <0.005% of the Southern North Sea SAC population. Additionally, with designed in measures in place (Table 7.11) which are in line with recommended best practice guidelines, the magnitude of the impact would result in a negligible risk of injury to harbour porpoise.

1552 In terms of behavioural disturbance, up to 2,822 animals were predicted to be potentially disturbed from concurrent piling at a maximum hammer energy of 4,000 kJ (Table 7.17). These results are considered highly precautionary as there is a number of conservative assumptions in subsea noise model (i.e. the

maximum hammer energy of 4,000 kJ is unlikely to be reached at all piling locations (see paragraph 844 for more details)).

1553 It should be noted that because harbour porpoise are highly mobile, the numbers utilising UK waters will vary both seasonally and annually (Teilmann *et al.,* 2008; Sveegaard *et al.,* 2011). Therefore, although there is no potential for overlap of noise disturbance contours with this designated site, there is a potential for individuals from this SAC to be present within noise disturbance contours. The maximum disturbance scenario suggests that a maximum of 14% of the harbour porpoise population from Southern North Sea SAC (based on a minimum SAC population size of 20,237 animals) have the potential to be disturbed as a result of piling. This maximum disturbance scenario suggests that a relatively large proportion of the Southern North Sea SAC have the potential to be disturbed as a result of piling. However, considering the distance from the Proposed Development to the SAC, it is a highly precautionary assumption that 100% of disturbed animals will come from this SAC. Therefore, this number is likely to be an over-estimation of the proportion of harbour porpoises from the Southern North Sea SAC affected.

1554 Findings presented in paragraph 793 suggest that the Firth of Forth and Tay area is unlikely to represent important breeding or foraging habitat for harbour porpoise that would not be available elsewhere within the species' home range over the North Sea. If individuals are deterred from the foraging grounds in the vicinity of the Proposed Development, it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone (Benhemma-Le Gall *et al*., 2021).

1555 Piling activities will not take place within or nearby to the SAC and therefore will not exclude harbour porpoise from the relevant area of the site up to the threshold limit (20% in any given day or 10% over a season)[20], behavioural disturbance as a result of piling is unlikely to be significant. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on Southern North Sea SAC population can be considered long term.

1556 Additionally, since there is no potential for injury ranges or disturbance contours to reach the SAC, it will not affect foraging habitats and areas important for breeding and calving within the designated site. Therefore, there is no potential for piling activities to restrict the survivability and reproductive potential of harbour porpoises using the site. As such harbour porpoise will remain a viable component of the site.

1557 As previously described for harbour porpoise in paragraph 889, the duration of piling could potentially overlap with a maximum of five breeding cycles. However, it is worth noting that piling will be intermittent and will occur over small timespan (372 days) within piling phase (52 months). Considering the above, the duration of the effect in the context of life cycle of harbour porpoise is classified as medium term.

1558 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour porpoise of the Southern North Sea SAC, are not predicted to occur as a result of underwater noise during piling during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1559 The assessment has concluded that piling activities will not take place within or nearby to the Southern North Sea SAC and will not exclude harbour porpoise from the relevant area of the site up to the threshold limit. Therefore, underwater noise from piling will not result in significant disturbance of the species. Piling will not affect areas important for breeding and calving within the site and therefore harbour porpoise will remain a viable component of the site. Piling activities will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1560 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity of the Southern North Sea SAC from injury and disturbance due to underwater noise during piling with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during site investigation surveys

1561 The noise modelling demonstrated that ranges within which there is a risk of PTS to harbour porpoise as a result of geophysical surveys are relatively low with a maximum impact range of 360 m (due to operation of SBP; Table 7.20 and Table 7.21). PTS ranges for harbour porpoise as a result of cone penetration test and vibro-coring are 60 m and 5 m, respectively (Table 7.21). There is potential for less than one animal to experience PTS as a result of geophysical and geotechnical site investigation surveys (<0.005% of the Southern North Sea SAC population). It should be noted that since sonar-based systems have strong directivity, there is only potential for injury when marine mammals are directly underneath the sound source. The site-investigation surveys are considered to be short term as they will take place over up to a period of up to three months. With designed in measures in place, which are in line with recommended best practice guidelines (see Table 7.11), due to the low risk of PTS occurring and the short-term duration of the geophysical surveys, no adverse effects associated with auditory injury and disturbance to harbour porpoise were predicted as a result of site investigations surveys.

1562 In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting harbour porpoise is out to approximately 7.5 km during vibro-coring with up to 144 harbour porpoises predicted to be potentially disturbed (Table 7.23). The maximum disturbance scenario suggests that a maximum of 0.7% of the harbour porpoise population from Southern North Sea SAC (based on a minimum SAC population size of 20,237 animals) have the potential to be disturbed as a result of vibro-coring piling. However, considering the distance from the Proposed Development to the SAC, it is a highly precautionary assumption that 100% of disturbed animals will come from this SAC. Therefore, this number is likely to be an over-estimation of the proportion of harbour porpoises from the Southern North Sea SAC affected.

1563 Site investigation surveys are expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Site investigation activities will not take place within or nearby to the SAC and therefore will not exclude harbour porpoise from relevant proportion from the site[22], behavioural disturbance is unlikely to be significant. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on Southern North Sea SAC population can be considered long term.

1564 Additionally, since there is no potential for injury ranges or disturbance contours to reach the SAC, it will not affect foraging habitats and areas important for breeding and calving within the designated site. Therefore, there is no potential for site investigation surveys to restrict the survivability and reproductive potential of harbour porpoise using the site. As such harbour porpoise will remain a viable component of the site.

[20] As per Conservation Objectives and Advice on Operations for Southern North Sea SAC, available here: https://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-conservation-advice.pdf. Accessed on 12 Aug 2022.

1565 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour porpoise of the Southern North Sea SAC, are not predicted to occur as a result of underwater noise during site investigation surveys during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1566 The assessment has concluded that site investigation surveys will not take place within or nearby to the Southern North Sea SAC and will not exclude harbour porpoise from the relevant area of the site up to the threshold limit. Therefore, underwater noise from site investigation surveys will not result in significant disturbance of the species. Site investigation surveys will not affect areas important for breeding and calving within the site and therefore harbour porpoise will remain a viable component of the site. Site investigation surveys will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1567 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during UXO clearance

1568 Harbour porpoise is sensitive to potential injury from high order UXO clearance. Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that harbour porpoise could be potentially affected by PTS at the maximum range of 10,630 m due to detonation of charge size of 300 kg (Table 7.24). There is potential for up to 293 animals to experience PTS as a result of UXO clearance using high order detonation (<1.5% of the Southern North Sea SAC population). It is however anticipated that only 10% of all UXO clearance events will result in high order detonation as low order techniques will be applied as the intended methodology for clearance of UXO. The underwater noise modelling results show that harbour porpoise can be potentially affected by PTS at the maximum range of 1,265 m due to detonation of 0.5 kg clearance shot (Table 7.25).

1569 To reduce the potential of harbour porpoise experiencing injury, designed in measures, which are in line with recommended best practice guidelines, will be adopted as part of a MMMP (see Table 7.11). Given that there is a potential to experience auditory injury by harbour at a greater range than can be mitigated by monitoring of the 1 km mitigation zone alone, an ADD and soft-start charges will be deployed to deter marine mammals to a greater distance prior to any detonation. However, the maximum deterrence zone has been assessed as 7,200 m and PTS range for this species has been modelled as 10,630 m, and so there is a risk that animals could potentially experience an auditory injury at distances that cannot be fully mitigated by application of ADD and soft-start charges. Post application submission, when details about UXO sizes and specific clearance techniques to be used become available, a more detailed assessment will be produced as a part of the EPS licence supporting information for the UXO clearance works. Appropriate mitigation measures will be agreed with stakeholders as a part of a UXO specific MMMP. Therefore following the application of mitigation measures, the risk of injury will be reduced to low.

1570 As described in paragraph 971, the threshold for potential temporary loss of hearing (TTS) was also assessed. Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that harbour porpoise can be potentially affected by TTS at the maximum range of 19 km due to detonation of charge size of 300 kg (Table 7.32) with up to 995 animals impacted. TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from the Southern North Sea SAC.

1571 UXO clearance activities will not take place within or nearby to the Southern North Sea SAC and therefore will not exclude harbour porpoise from the relevant area of the site up to the threshold limit (20% in any given day or 10% over a season)[21], behavioural disturbance as a result of UXO clearance is unlikely to be significant. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on Southern North Sea SAC population can be considered long term.

1572 Additionally, since there is no potential for injury ranges or disturbance contours to reach the SAC, it will not affect foraging habitats and areas important for breeding and calving within the designated site. Therefore, there is no potential for UXO clearance activities to restrict the survivability and reproductive potential of harbour porpoises using the site. As such harbour porpoise will remain as a viable component of the site.

1573 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour porpoise of the Southern North Sea SAC, are not predicted to occur as a result of underwater noise during UXO clearance during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1574 The assessment has concluded that UXO clearance will not take place within or nearby to the Southern North Sea SAC and will not exclude harbour porpoise from the relevant area of the site up to the threshold limit. Therefore, injury and disturbance due to underwater noise during UXO clearance will not result in significant disturbance of the species. UXO clearance will not affect areas important for breeding and calving within the site and therefore harbour porpoise will remain a viable component of the site. UXO clearance activities will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1575 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC from injury and disturbance due to underwater noise during UXO clearance with respect to the construction of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1576 As outlined in paragraph 1010 *et seq.*, there is potential for changes to prey availability for harbour porpoise during construction and decommissioning of the Proposed Development. These impacts include temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, injury and/or disturbance from underwater noise and vibration.

1577 There is potential for temporary habitat loss/disturbance to affect up to 113,974,700 m^2 of seabed during the construction phase, which equates to 9.7% of the fish and shellfish ecology study area. Only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase, with areas starting to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic

[21] As per Conservation Objectives and Advice on Operations for Southern North Sea SAC, available here: https://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-conservation-advice.pdf. Accessed on 12 Aug 2022.

infaunal species from the sediment, potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works. The presence of infrastructure within the Proposed Development, including foundations and associated scour protection, cable protection, OSP/Offshore convertor station platform interconnector and offshore export cables will result in long term habitat loss of up to 7,798,856 m^2 (0.7% of the Proposed Development fish and shellfish ecology study area; volume 2, chapter 9 of the Offshore EIA Report. The areas within Southern North Sea SAC provide good foraging habitat for harbour porpoise. Given that all construction and decommissioning activities will take place outside the SAC, the condition of supporting habitats and processes within site will not be impaired and the availability of prey will be maintained.

1578 In terms of indirect effects on marine mammals as a result of underwater noise, it is assumed that marine mammals would be disturbed from the area in vicinity of the noise source, and so any changes to the distribution of prey resources would not affect marine mammals as they would already be disturbed from the same (or larger) area.

1579 An increase in SSC and associated sediment deposition as a result of the installation of wind turbines and OSP/Offshore convertor station platform foundations and the installation of inter-array, interconnector and offshore export cables may result in short-term avoidance of affected areas by fish and shellfish. Elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on adult/larvae fish and shellfish survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Considering the distance from the Proposed Development to the SAC, as well as the localised extent of impacts associated with construction and decommissioning activities, these are highly unlikely to have indirect impacts on harbour porpoise via changes to prey species due to an increase in SSC and associated sediment deposition.

1580 The impacts of construction and decommissioning will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat in the North Sea and impacts will take place outside of the Southern North Sea SAC. Harbour porpoise eat a variety of prey including gobies, sandeel, whiting, herring and sprat. Findings presented in paragraph 793 suggest that for this species Firth of Forth and Tay area is unlikely to represent important breeding or foraging habitat that would not be available elsewhere within the species home range over the North Sea. There may be, however, an energetic cost associated with increased travelling and due to harbour porpoise high metabolic rate (see paragraph 1028), this species may be particularly vulnerable to this effect. However, harbour porpoises have a widespread distribution and individuals have been documented either switching to different prey species depending on the prey availability (Santos and Pierce, 2003) or moving relatively large distances on a daily basis (Nielsen *et al*., 2013). Based on findings of Benhemma-Le Gall *et al*. (2021) it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone. Therefore, individuals may move to alternative foraging grounds without affecting animals health.

1581 The magnitude of the indirect impact on marine mammals as a result of changes in fish and shellfish communities during the decommissioning phase is not expected to differ or be greater than that assessed for the construction phase.

1582 Considering the above, it is anticipated that the availability of suitable foraging grounds for harbour porpoise will not be impaired and availability of prey will be maintained within the wider distributional range.

1583 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour porpoise of the Southern North Sea SAC, are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning phases (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1584 The assessment has concluded that the impacts of construction and decommissioning will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat in the North Sea and impacts will take place outside of the Southern North Sea SAC. Therefore, the condition of supporting habitats and processes will not be affected. Given that individuals may move to alternative foraging grounds without affecting animals' health, availability of prey within the wider distributional range will not be affected. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1585 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC from changes in fish and shellfish communities affecting prey availability with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

1586 As discussed in paragraph 1561 *et seq.*, the maximum range at which there is a risk of PTS to harbour porpoise as a result of site investigation surveys is 360 m. With designed in measures (Table 7.11), which are in line with recommended best practice guidelines, implemented for the geophysical surveys, the risk of PTS occurring to harbour porpoise will be low. With regard to behavioural disturbance, a maximum potential disturbance range across all survey types is approximately 7.5 km during vibro-coring. The assessment based on a maximum disturbance scenario suggests that a maximum of 0.7% of the harbour porpoise population from Southern North Sea SAC (based on a minimum SAC population size of 20,237 animals) have the potential to be disturbed as a result of vibro-coring piling. Considering the distance from the Proposed Development to the Southern North Sea SAC, it is a highly precautionary assumption that 100% of the disturbed animals will come from this SAC. Therefore, this number is likely to be an over-estimation of the proportion of harbour porpoises from the Southern North Sea SAC affected.

1587 The maximum design scenario for routine geophysical surveys is estimated as a survey every six months for the first two years and annually thereafter. This equates to 37 surveys over the 35-year life cycle of the Proposed Development (Table 7.10).

1588 Site investigation surveys are expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Site investigation activities will not take place within or nearby to the SAC and therefore will not exclude harbour porpoise from the relevant area of the site up to the threshold limit (20% in any given day or 10% over a season)[22], behavioural disturbance is therefore unlikely to be significant. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on Southern Nort Sea SAC population can be considered long term.

[22] As per Conservation Objectives and Advice on Operations for Southern North Sea SAC, available here: https://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-conservation-advice.pdf. Accessed on 12 Aug 2022.

1589 Additionally, since there is no potential for injury ranges or disturbance contours to reach the SAC, it will not affect foraging habitats and areas important for breeding and calving within the designated site. Therefore, there is no potential for site investigation surveys to restrict the survivability and reproductive potential of harbour porpoises using the site. As such harbour porpoise will remain a viable component of the site.

1590 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour porpoise of the Southern North Sea SAC, are not predicted to occur as a result of underwater noise during site investigation surveys during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1591 The assessment has concluded that site investigation surveys will not take place within or nearby to the Southern North Sea SAC and will not exclude harbour porpoise from the relevant area of the site up to the threshold limit. Therefore, underwater noise during site investigation surveys will not result in significant disturbance of the species. Site investigation surveys will not affect areas important for breeding and calving within the site and therefore harbour porpoise will remain a viable component of the site. Site investigation surveys will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1592 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the operation of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1593 As outlined in paragraph 1048 *et seq.*, there is potential for changes to prey availability for harbour porpoise due to potential impacts on prey species during operation and maintenance of the Proposed Development. These impacts include temporary subtidal habitat loss/disturbance, long-term subtidal habitat loss, increased SSC and associated sediment deposition, EMF from subsea electrical cabling and colonisation of foundations, scour protection and cable protection.

1594 Potential temporary habitat loss/disturbance during operation and maintenance equates to a smaller area than that affected during construction (up to 989,000 m^2 which equates to 0.08% of the fish and shellfish ecology area, compared with 9.7% during the construction phase). Operation and maintenance activities will occur periodically over the full lifetime of the project (estimated to be 35 years) and therefore only a small proportion of the maximum footprint of habitat loss/disturbance may occur at any one time (e.g. during offshore export cable repair/reburial or wind turbine replacement events). Affected areas are expected to start recovering immediately after cessation of maintenance activities. The areas within Southern North Sea SAC provide good foraging habitat for harbour porpoise. Given that all operation and maintenance activities will take place outside the SAC, the condition of supporting habitats and processes within site will not be impaired and the availability of prey will be maintained.

1595 Increased SSC could occur as a result of repair or remedial burial activities during the operation and maintenance phase. The maintenance activities will be undertaken at intervals over the 35 years operation and maintenance phase. The assessment presented in volume 2, chapter 9 of the Offshore EIA Report considered that any suspended sediments and associated deposition will be of the same magnitude, or lower as for construction. Therefore, the availability of suitable food supply for harbour porpoise is not expected to be impaired as a result of increase in SSC and associated deposition.

1596 The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. The range over which species can detect EMF will be very localised to within a few centimetres of the buried cable, with rapid decay of the EMF with increasing distance. Considering the above, adverse effects on harbour porpoise as a result of changes in prey availability due to EMF are unlikely.

1597 The impacts of activities undertaken as a part of the operation and maintenance phase of the Proposed Development will be highly localised and largely restricted to the boundaries of the Proposed Development, with only a small area affected when compared to available foraging habitat in the North Sea. Harbour porpoise eat a variety of prey including gobies, sandeel, whiting, herring and sprat. Findings presented in paragraph 793 suggest that Firth of Forth and Tay area for this species is unlikely to represent important breeding or foraging habitat that would not be available elsewhere within the species home range over the North Sea. There may be, however, an energetic cost associated with increased travelling and due to harbour porpoise high metabolic rate (see paragraph 1028), this species may be particularly vulnerable to this effect. However, harbour porpoises have a widespread distribution and individuals have been documented either switching to different prey species depending on the prey availability (Santos and Pierce, 2003) or moving relatively large distances on a daily basis (Nielsen *et al*., 2013). Based on findings of Benhemma-Le Gall *et al*. (2021) it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone. The availability of wider suitable habitat suggest that individuals may move to alternative foraging grounds without affecting animals health.

1598 Although there will be long term loss of habitat due to the presence of infrastructure associated with the Proposed Development, it is also anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 1021 *et seq*, evidence increasingly suggests that foraging opportunities for marine mammals are increased around offshore wind farm structures. Acoustic results from a T-POD measurement within a Dutch wind farm found that relatively more harbour porpoises are found in the wind farm area compared to the two reference areas, likely due to increased food availability as well as the exclusion of fisheries and reduced vessel traffic in the wind farm (shelter effect, see paragraph 1022). Therefore, presence of artificial structures may benefit harbour porpoise population in the long-term.

1599 Considering the above, it is anticipated that the availability of suitable foraging grounds for harbour porpoise will not be impaired and availability of prey will be maintained within the wider distributional range.

1600 Significant adverse effects on the qualifying Annex II marine mammal feature, harbour porpoise of the Southern North Sea SAC, are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance phase (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1601 The assessment has concluded that the impacts of construction and decommissioning will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat in the North Sea and impacts will take place outside of the Southern North Sea SAC. Therefore, the condition of supporting habitats and processes will not be affected. Given that individuals may move to alternative foraging grounds without affecting animals' health, availability of prey within the wider distributional range will not be affected. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1602 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC from changes in fish and shellfish communities affecting prey availability with respect to the operation of the Proposed Development acting alone.

Effects in-combination

1603 An assessment of in-combination effects upon the qualifying Annex II marine mammal species of the Southern North Sea SAC arising from each identified impact is provided below.

1604 The potential to experience injury in terms of PTS by marine mammal receptors as a result of underwater noise due to piling be expected to be largely localised within the boundaries of the respective projects (assuming similar ranges of effect as presented for the Proposed Development). It is also anticipated that standard offshore wind industry construction methods (which include soft starts and visual and acoustic monitoring of marine mammals as standard) will be applied, thereby reducing the magnitude of the impact with respect to auditory injury occurring in marine mammals. Therefore, there is no potential for significant cumulative impacts for injury from elevated underwater noise during pilling and the cumulative assessment focuses on disturbance only.

Assessment of in-combination effects during construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

Tier 2

1605 The construction of the Proposed Development, together with the construction of the Tier 2 projects, may lead to injury and/or disturbance to harbour porpoise from the Southern North Sea SAC from underwater noise during piling. Other projects screened into the assessment within the regional marine mammal study area include construction of Inch Cape Offshore Wind Farm, Seagreen 1A Project, Moray West, Dogger Bank Creyke Beck A, Dogger Bank Creyke Beck B, Dogger Bank Teesside A, Sofia Offshore Wind Farm, Hornsea Project Three and Hornsea Project Four.

1606 Behavioural disturbance is expected to occur during piling at all offshore wind farms. Of all projects listed in paragraph 1605, only construction of Dogger Bank Teesside A, Sofia Offshore Wind Farm, Hornsea Project Three and Hornsea Project Four will overlap with the piling phase for Proposed Development. Although there is an overlap of construction of Inch Cape and Seagreen 1A Project and construction of Proposed Development, the construction of both projects will be completed prior to commencement of piling at the Proposed Development and therefore could lead to a longer duration of piling operations (i.e. sequential rather than concurrent piling). The construction phases of Moray West, Blyth Demo 2, Dogger Bank Creyke Beck A and Dogger Back Creyke Beck B finish in the year following commencement of construction works at Proposed Development (i.e. two years before the commencement of the piling phase at Proposed Development). However, these projects are included in the assessment to consider temporal scenario to take account for potential disturbance to harbour porpoise caused by subsequent piling at Proposed Development. Where project piling phases overlap, the assessment is, conservatively, based on a maximum design scenario of all projects potentially piling at exactly the same time, however, in practice this is considered to be unlikely. For example, in order to reduce impacts on harbour porpoise within the Southern North Sea SAC, as a part of Site Integrity Plan, Hornsea Project Three and Hornsea Project Four have committed to schedule piling having regard to previous, ongoing and future piling associated with other offshore developments and other activities likely to act in-combination (GoBe, 2018b; GoBe, 2021).

1607 Seagreen 1A Project predicted that up to 1,882 animals could be exposed to noise levels that could result in behavioural disturbance at any one time during piling at Seagreen 1A Project (Seagreen Wind Energy Ltd, 2020). The original EIA (Seagreen Wind Energy Ltd, 2012) indicated that there is no evidence to show that the impacted area for this species represents important breeding or foraging habitat that would not be available elsewhere within the species home range over the North Sea793). The revised EIA for Inch Cape predicted that up to 302 harbour porpoises could be disturbed as a result of piling (Inch Cape Offshore Limited, 2018). The EIA for Moray West assessed potential numbers of harbour porpoises potentially affected by behavioural disturbance during piling as 1,609 individuals (Moray West, 2018).

1608 In terms of projects located in English waters, Dogger Bank Creyke A and B predicted that up to 3,119 animals can be exposed to noise levels that could result in behavioural disturbance at any one time during piling (Forewind, 2013).

1609 It should be noted that there is no potential for overlap of piling phases for projects considered in paragraphs 1607 and 1608 and piling at Proposed Development, therefore if animals would be impacted by behavioural disturbance that would happen sequentially, rather than concurrently.

1610 Piling at projects considered in this paragraph have a potential to occur simultaneously with piling phase at Proposed Development. The Dogger Bank Teesside A EIA predicted that harbour porpoise is expected to be disturbed within approximately 34 km from the source with up to 2,148 animals potentially affected (Royal Haskoning DHV, 2020). The assessment for Sofia Offshore Wind farm demonstrated that potential numbers of harbour porpoises potentially affected by behavioural disturbance during piling is up to 2,263 individuals (Innogy, 2020). The assessment for Hornsea Project Three predicted 7,330 porpoises to be exposed to behavioural disturbance during concurrent piling events (GoBe, 2018a). Hornsea Project Four predicted that up to 9,686 harbour porpoises could be disturbed during piling and the residual effect of behavioural disturbance on harbour porpoise from piling was predicted to be slight.

1611 Most projects and respective EIAs refer to the North Sea reference population, which, as presented in original Seagreen EIA (Seagreen Wind Energy Ltd, 2012), stretches across an area of 750,000 km^2. The number of harbour porpoise potentially disturbed has been considered for projects located more than 300 km from the Proposed Development array area. Delineating the spatial extent of cumulative effects is commonly acknowledged as a challenge and although harbour porpoise is generally rare in waters >200 m depth, the fact that this species utilises such a vast area further complicates a choice of appropriate spatial scale (Murray *et al*., 2014). Population modelling was carried out to explore the potential of cumulative effects as a result of disturbance during piling to affect the wider population trajectory over time. Population modelling considered all projects listed in paragraph 1605 and respective numbers of animals potentially impacted against the MU population (see volume 3, appendix 10.4 for methods applied in the model). Results of the cumulative iPCoD modelling for harbour porpoise showed that the difference in population trajectory between the impacted and unimpacted population fall within the natural variance of the population (see paragraph 927 *et seq.*). Therefore, it was considered that there is no potential for the long-term effects on this species within wider population as a result of cumulative piling at proposed Development and respective projects (see volume 3, appendix 10.4 for more details).

1612 As previously described in paragraph 1543, noise disturbance from a project individually or in-combination is regarded as significant if it excludes harbour porpoises from more than 20% of the relevant area in any given day, and an average of 10% of the relevant area of the site over a specific season (JNCC, 2019c). Although there is a potential for harbour porpoises to be present within behavioural disturbance footprint of Proposed Development and that is the primary reason why the SAC has been screened in for the in-combination assessment, the advice on operations suggest that HRA should be considered for projects using pile driving within the SAC or within 26 km of site boundaries (JNCC, 2019c). Given the distance from the Southern North Sea SAC, the behavioural disturbance footprint of the Proposed Development will not contribute to total of 20% of the relevant area disturbed in any given day or 10% of the relevant area of the site over season with projects located in closer vicinity to the SAC and therefore behavioural disturbance as a result of piling in-combination with other projects is unlikely to be significant. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on SAC population can be considered long term.

1613 As presented by Benhemma Le Gall *et al.* (2021) during extended periods of disturbance, porpoises must make trade-offs between fleeing or remaining in areas that have a higher risk of disturbance. The study found that individual responsiveness to anthropogenic disturbances is therefore to be context dependent

(i.e. whether the animal decides to flee high-quality feeding habitat or not and related to animal fitness). As presented in more details in paragraph 793, the Firth of Forth and Tay are not expected to represent important foraging grounds for harbour porpoise. If disturbed from the area by sequential piling at Inch Cape, Seagreen 1A Project and the Proposed Development, animals may leave the foraging grounds, however even with incurred energetic cost, it is likely that they will move to areas with the same or better quality of foraging habitat. Based on findings of the same study it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone (Benhemma-Le Gall *et al*., 2021). Therefore, it is anticipated that the availability of suitable foraging grounds for harbour porpoise will not be impaired and availability of prey will be maintained within the wider distributional range.

1614 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC as a result of underwater noise during piling during construction with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during UXO clearance

Tier 2

1615 There is potential for in-combination effects from injury and/or disturbance from underwater noise during UXO clearance to harbour porpoise from the Southern North Sea SAC during the construction phase of the Proposed Development with activities associated with the following projects Inch Cape Offshore Wind Farm, Blyth Demo 2, Dogger Bank Creyke Beck A, Dogger Bank Creyke Beck B, Dogger Bank Teesside A, Sofia Offshore Wind Farm, Hornsea Project Three and Hornsea Project Four.

1616 For the Proposed Development alone, the maximum range across which harbour porpoise have the potential to experience PTS due to high order detonation of 300 kg charge was assessed as approximately 10,630 m. To reduce the potential of experiencing injury, designed in measures, which are in line with recommended best practice guidelines, will be adopted as part of a MMMP (see Table 7.11). As described in paragraph 1569, there is a risk that harbour porpoise could potentially experience an auditory injury at distances that cannot be fully mitigated by application of ADD and soft-start charges (the maximum deterrence zone has been assessed as 7,200 m and PTS range for this species has been modelled as 10,630 m). Given that details about UXO clearance technique to be used and charge sizes will not be available until after the consent is granted (pre-construction phase, following UXO survey), it is not possible to quantify the effects of UXO detonations and therefore the residual number of animals affected is not presented within this document. At a later stage, when details about UXO sizes and specific clearance techniques to be used become available, it will be possible to provide detailed assessment and tailor the secondary mitigation to specific UXO sizes and species to reduce the risk of injury. Therefore, prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information for the UXO clearance works. Appropriate mitigation measures will be agreed with stakeholders as a part of a UXO specific MMMP. It is therefore anticipated that following the application of mitigation measures following receipt of more detail regarding size and number of UXO, the risk of injury will be reduced to low.

1617 In November 2021, the UK government published a joint interim statement advising to use low noise alternatives to high order detonations where possible and it is anticipated that future developments will follow this guidance. During the low order clearance, harbour porpoise can be potentially affected by PTS at the maximum range of 1,265 m due to detonation of 0.5 kg clearance shot. However, due to a small inherent risk with these clearance methods that the UXO will detonate or deflagrate violently, accidental high order detonation can be expected as a maximum adverse scenario.

1618 Projects screened in for this cumulative assessment are expected to involve similar construction activities to those described for the Proposed Development alone, including UXO clearance works. It is anticipated that, for all projects, impacts associated with these activities will require additional assessment under EPS licensing, however such applications are not yet available in the public domain. PTS onset ranges for Inch Cape Offshore Wind Farm, Blyth Demo 2, Dogger Bank Creyke Beck A, Dogger Bank Creyke Beck B, Dogger Bank Teesside A and Sofia Offshore Wind Farm are unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is not greater than assessed for the Proposed Development alone. Depending on the type of detonation and size of UXO, UXO clearance activities may have residual effects in respect to marine mammals and PTS injury.

1619 For Hornsea Project Three there was no site-specific modelling undertaken, however as a part of the EIA, the assessment of potential impacts in terms of injury (PTS) on marine mammals as a result of underwater noise during UXO clearance was based on the NOAA modelling for Hornsea Project One (GoBe, 2018a). The assessment predicted that up to 200 animals could experience injury, however, following the application of appropriate secondary mitigation measures (to be agreed as a part of a UXO specific MMMP) the residual risk of injury was expected to be negligible (GoBe, 2018a). Due to lack of project specific UXO noise modelling, in the EIA for Hornsea Project Four, the assessment of potential impacts used estimates of the source level and predicted PTS-onset impact ranges based on Hornsea Project Two, estimating that up to 630 animals could be potentially injured (SMRU Consulting, 2021). It was highlighted in the assessment that PTS-onset impact ranges, and number of animals affected, are likely to be overestimated, especially for large charge sizes (example here is based on 800kg UXO size). The assessment concluded that with secondary mitigation measures, which will be agreed as a part of the UXO MMMP, the impact of the UXO clearance on marine mammals will not be significant.

1620 As such, with appropriate designed in and secondary mitigation measures, only small proportion of the SAC population could be potentially affected and considering the size of the harbour porpoise population within Southern North Sea SAC, it is highly unlikely that the reproductive and recruitment capability of the species will be affected. Therefore, harbour porpoise will remain a viable component of the site.

1621 In terms of TTS, for the Proposed Development alone, the range across which harbour porpoise have the potential to experience TTS due to high order detonation of a 300 kg charge was assessed as approximately 19 km (see paragraph 971 *et seq*.). TTS onset ranges for Inch Cape Offshore Wind Farm, Blyth Demo 2, Dogger Bank Creyke Beck A, Dogger Bank Creyke Beck B, Dogger Bank Teesside A and Sofia Offshore Wind Farm are unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is no greater than assessed for the Proposed Development alone. Hornsea Project Three assessed potential impacts from TTS on marine mammals using two approaches, however one of them is more precautionary and therefore will be discussed further. The buffer of 26 km around the source location was applied to determine behavioural impact area and the assessment estimated that up to 1,869 harbour porpoises could potentially experience disturbance (GoBe, 2018a). Hornsea Project Four presented the predicted ranges for the onset of TTS from UXO clearance, but since no assessment of the number of animals was given, TTS with respect to this project could not be quantitatively assessed (SMRU Consulting, 2021).

1622 A spatial maximum adverse scenario would occur where UXO clearance activities occur concurrently at the respective projects considered in the cumulative assessment. This is however highly unlikely, as due to safety reasons the UXO clearance activities takes place before other construction activities commence, and all projects listed in paragraph 1615 start their construction activities at least a year before commencement of construction at Proposed Development. Temporally however, sequential UXO clearance at respective projects could lead to a longer duration of effect. Since each clearance event results in no more than a one second ensonification event and since TTS is a recoverable injury, the potential for cumulative effects with respect to TTS is considered to be very limited.

1623 As previously described in paragraph 1543, noise disturbance from a plan individually or in-combination is regarded as significant if it excludes harbour porpoises from more than 20% of the relevant area in any given day, and an average of 10% of the relevant area of the site over specific season (JNCC, 2019c). Given the distance from the Southern North Sea SAC, the PTS and/or TTS footprint of the Proposed

Development will not contribute to total of 20% of relevant area disturbed in any given day or 10% of the relevant area of the site over a season with projects located in closer vicinity to the SAC and therefore disturbance as a result of UXO clearance in-combination with other projects is unlikely to be significant. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on SAC population can be considered long term. Therefore, harbour porpoise will remain a viable component of the site.

1624 Additionally, as presented in more detail in paragraph 1613, if the animal flees the ensonified area, it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone (Benhemma-Le Gall *et al*., 2021). Given that Firth of Forth and Tay are not expected to represent important foraging grounds for harbour porpoise (see paragraph 793), it is anticipated that the availability of suitable foraging grounds for harbour porpoise will not be impaired and availability of prey will be maintained within the wider distributional range.

1625 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC as a result of site investigation surveys during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Changes in Fish and Shellfish Communities Affecting Prey Availability

Tier 2

1626 There is potential for in-combination effects from changes in the prey resources available for harbour porpoise from the Southern North Sea SAC as a result of changes to the fish and shellfish community during the construction and decommissioning phases of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1 Offshore Wind Farm, Seagreen 1A Project, Seagreen Eastern Link 1, Seagreen 1A Export Cable Corridor, Eastern Link 2 and Eyemouth disposal site.

1627 The construction phases and/or operation and maintenance phases of projects screened into in-combination assessment may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss is 145,325,450 m^2 (145.3 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The magnitude of long-term habitat loss caused by the presence of all structures on the seabed has been considered for the construction as well as operation and maintenance phases. The impacts have been assessed in-combination with Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, and Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Links 2 and may lead to long term subtidal habitat loss of up to 15,014,156 m^2 (15.0 km^2). The areas within the Southern North Sea SAC provide good foraging habitat for harbour porpoise and given that all construction and decommissioning activities at Proposed Development will take place outside the SAC, there will be no adverse effects on the site in-combination with other projects. The condition of supporting habitats and processes within site will not be impaired and the availability of prey will be maintained.

1628 An increase in SSC and associated sediment deposition as a result of the construction as well as operation of projects screened into the in-combination assessment may result in short-term avoidance of affected areas by fish and shellfish which may have an indirect effect on harbour porpoise. Elevations in SSC are expected to be of short duration, returning to background levels relatively quickly. SSC are not expected to reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Given the localised extent of this effect, the availability of suitable food supply for harbour porpoises within the wider area is not expected to be impaired.

1629 The impacts of construction and decommissioning will be highly localised and largely restricted to the boundaries of respective projects. Given that the temporal overlap in construction activities between projects will be small, there will only be a small area of temporary habitat loss happening at any one time. Harbour porpoise eat a variety of prey including gobies, sandeel, whiting, herring and sprat. Findings presented in paragraph 793 suggest that Firth of Forth and Tay area for this species is unlikely to represent important breeding or foraging habitat that would not be available elsewhere within the species home range over the North Sea. There may be, however, an energetic cost associated with increased travelling and due to harbour porpoise high metabolic rate, this species may be particularly vulnerable to this effect. However, harbour porpoises have a widespread distribution and individuals have been documented either switching to different prey species depending on the prey availability (Santos and Pierce, 2003) or moving relatively large distances on a daily basis (Nielsen *et al*., 2013). Based on findings of Benhemma-Le Gall *et al*. (2021) it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone. The availability of wider suitable habitat suggest that individuals may move to alternative foraging grounds without affecting the health of animals.

1630 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1631 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to harbour porpoise from Southern North Sea SAC during the construction and decommissioning phases of the Proposed Development with activities associated with the construction and operation of Cambois connection.

1632 The construction phase of Cambois connection may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss/disturbance is 17,000,000 m^2 (17.0 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The majority of this disturbance will not spatially overlap with the Proposed Development and where the overlap exist with the Proposed Development array area (previously impacted during the construction of the Proposed Development), it is expected to be highly localised and so the potential for repeat disturbance is considered low and unlikely to lead to an increase in the magnitude than predicted for the Proposed Development alone. The installation of Cambois connection may also result in a total area of long-term subtidal habitat loss (e.g. from cable protection) of 306,000 m^2.

1633 There is also a potential for in-combination effects associated with SSC and associated deposition. However, elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Therefore, it is highly unlikely to have indirect impacts on harbour porpoise from Southern North Sea SAC via changes to prey species.

1634 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 3 projects.

Assessment of in-combination effects during operation and maintenance

Changes in fish and shellfish communities affecting prey availability

Tier 2

1635 There is potential for in-combination effects from changes in prey resources to harbour porpoise from the Southern North Sea SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1, Eastern Link 2, and Eyemouth disposal site.

1636 Operation and maintenance activities at respective projects considered in the Tier 2 in-combination assessment may lead to temporary subtidal habitat loss/disturbance of up to 32,276,397 m^2. Additionally, the projects listed above will reach their decommissioning age during Proposed Development operation and maintenance phase. However, it is important to note that the maximum design scenario for habitat loss from the cumulative projects is precautionary, as operation and maintenance activities will occur intermittently throughout the lifetime of the Proposed Development and the temporal overlap with activities at other projects is unlikely. As described in paragraph 1011, only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time, with disturbed areas are starting to recover immediately after cessation of maintenance activities. Long-term subtidal habitat loss within the Proposed Development fish and shellfish ecology study area will occur during construction (i.e. through placement of infrastructure) although effects will extend throughout the operation and maintenance phase (see paragraph 1627). Areas within the Southern North Sea SAC provide good foraging habitat for harbour porpoise. Given that all operation and maintenance activities associated with the Proposed Development will take place outside the SAC, there will be no adverse effects on the site in-combination with other projects. The condition of supporting habitats and processes within site will not be affected/impaired and the availability of prey will be maintained.

1637 In-combination impacts could arise from EMFs due to the presence of subsea cabling during the operation and maintenance phases of the Proposed Development as well as Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1 and Eastern Link 2. A total length of up to 6,112 km of subsea cabling was estimated for all projects. The effect of EMF was predicted to be of local spatial extent Considering the above, adverse effects on harbour porpoise as a result of changes in prey availability due to EMF are unlikely.

1638 Artificial structures introduced into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. There is a potential for in-combination effects arising from colonisation due to the presence of Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Link 2 with a maximum scenario of up to 15,014,156 m^2 of hard structures from wind turbines, OSP/Offshore convertor station platforms, meteorological masts, of cable protection, and cable crossings. It is anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 10211011 *et seq*, evidence increasingly suggests that foraging opportunities for marine mammals are increased around offshore wind farm structures. Therefore, presence of artificial structures may benefit harbour porpoise population in the long-term.

1639 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 2 projects.

Tier 3

1640 There is potential for in-combination effects from changes in fish and shellfish communities affecting prey availability to harbour porpoise from the Southern North Sea SAC during the operation and maintenance phase of the Proposed Development with activities associated with the operation of Cambois connection.

1641 In terms of temporary subtidal habitat loss/disturbance, there are no specific values for the operation and maintenance phase of Cambois connection which will occur during the operation and maintenance phase of the Proposed Development. However, Cambois connection has the potential to result in cumulative EMF effects from subsea electrical cabling within the Proposed Development. The Cambois connection is understood to comprise 680 km of cable. The effect of EMF was predicted to be of local spatial extent.

1642 The Cambois connection has the potential to create 306,000 m^2 of new hard habitat associated with rock/mattress cable protection, which represents a change in seabed type, the effects of which are described in paragraph 1022 *et seq*. As the cable protection does not extend into the water column the opportunity for colonisation by some species is reduced, nevertheless there is a potential that placement of man-made structures on the seabed will benefit harbour porpoise population.

1643 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Southern North Sea SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 3 projects.

Site conclusion

1644 In conclusion, with reference to the conservation objectives set for the Annex II marine mammal features of the site and the information presented in sections 7.3, 7.4, 7.5 and 7.6.4, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the Southern North Sea SAC in respect of the harbour porpoise qualifying interests.

1645 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

7.6.5 MORAY FIRTH SAC

European site information

1646 The Moray Firth SAC is located approximately 167 km north of the Proposed Development array area and 193 km north of the Proposed Development export cable corridor. The SAC supports the only known resident population of bottlenose dolphin in the North Sea. This SAC covers an area of 1,512 km^2 and extends from the inner firths to Helmsdale on the north coast and Lossiemouth on the south coast (JNCC, 2021c). The site includes areas that are regularly used by the population of bottlenose dolphins occurring along the east coast of Scotland (JNCC, 2021c). The Conservation and Management Advice document (NatureScot, 2021) states that the site reference population is the baseline population from 2005 of 101-250 individuals of bottlenose dolphin, however, NatureScot, further advised in their formal response to the HRA Stage One Screening (February 2022) that an estimated abundance of 224 individuals based on a 5-year average (2015-2019) from Arso Civil *et al*. (2021) should be used.

1647 Data from the site condition monitoring suggest that the proportion of the east coast of Scotland bottle nose dolphin population that use the SAC has declined, although the overall population along the coast is increasing (Cheney *et al.*, 2018) and it is thought that their range is extending (Quick *et al.*, 2014; Cheney *et al.*, 2018; Arso Civil *et al.*, 2019; Arso Civil *et al.*, 2021).

1648 Bottlenose dolphin at the site was last assessed as being in 'favourable maintained' condition in September 2016.

1649 Further information on this European site is presented in appendix A.

Conservation objectives

1650 Conservation objectives for the Moray Firth SAC have been developed by NatureScot and are published as part of the Conservation and Management Advice package (NatureScot, 2021). These are as follows:

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

1651 For bottlenose dolphin:

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

1652 NatureScot (2021) states that all features are in favourable condition at Moray Firth SAC and therefore the conservation objectives seek to maintain this condition.

1653 Supplementary site-specific advice on the conservation objectives is provided in the Conservation and management package (NatureScot, 2021) and referred to in appendix A.

Features and effects for assessment

1654 The potential for adverse effects has been identified for the following Annex II marine mammal features of this site:

- Bottlenose dolphin

1655 The following impacts associated with the construction and decommissioning of the Proposed Development have been identified as having the potential for adverse effects on bottlenose dolphin at this site:

- Injury and disturbance from underwater noise generated by following activities:
  - piling of fixed foundations;
  - clearance of UXO;
  - site investigation surveys; and
  - vessel use and other activities.
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1656 The following impacts associated with the operation and maintenance of the Proposed Development have been identified as having the potential for adverse effects on bottlenose dolphin at this site:

- **Injury and disturbance from underwater noise** generated by site investigation surveys as well as vessel use and other activities;
- **Changes in fish and shellfish communities affecting prey availability** causing potential shifts in distribution, abundance and migration patterns, community structure, susceptibility to disease due to changes in prey availability.

1657 The following assessment is structured to first assess whether the construction and decommissioning impacts will have an adverse effect on the integrity of the bottlenose dolphin feature of the site, and then the impacts associated with operation and maintenance will be assessed. For the purposes of these assessments, the potential effects are considered in relation to the site's conservation objectives.

Construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

1658 Underwater noise could affect the population and distribution of the qualifying species. Underwater noise modelling has been undertaken to estimate the maximum potential injury ranges for underwater noise that could arise during construction and decommissioning in relation to bottlenose dolphin. The modelling was based on the maximum design scenario (as outlined in Table 7.10) with summary of noise modelling provided in paragraph 834 *et seq*.

1659 The maximum range for injury to bottlenose dolphin was estimated as 43 m based on SPL_{pk} and using the 4% reducing to 0.5% conversion factor (see paragraph 892 *et seq*). Taking into account the most conservative scenario, less than one bottlenose dolphin was predicted to be potentially injured, which accounts for <0.5% of the Moray Firth SAC population. Bottlenose dolphins from this SAC have coastal distribution within CES MU and are mostly encountered in waters between 2 m and 20 m and within 2 km from the shore. Their mostly inshore distribution has been corroborated by historic surveys undertaken across wider Firth of Forth and Tay area (Grellier and Lacey, 2011; Sparling, 2012). Therefore, this assessment is highly precautionary because it is unlikely that individuals from this SAC will be present within 43 m from piling location in offshore waters during piling activities across the Proposed Development array area. Additionally, with designed in measures in place (Table 7.11) which are in line with recommended best practice guidelines, the magnitude of the impact would result in a negligible risk of injury to bottlenose dolphin.

1660 In terms of behavioural disturbance, up to five animals were predicted to be potentially disturbed from concurrent piling at a maximum hammer energy of 4,000 kJ (see paragraph 929 *et seq*). These results are considered highly precautionary as there is a number of conservative assumptions in subsea noise model, (i.e. the maximum hammer energy of 4,000 kJ is unlikely to be reached at all piling locations (see paragraph 844 for more details)). This maximum disturbance scenario suggests that 2.2% of the bottlenose dolphin population from Moray Firth SAC have the potential to be disturbed as a result of piling, however, this is highly unlikely to be the case in reality as the assessment is based on highly precautionary densities (see paragraph 807).

1661 There is no potential for overlap of noise disturbance contours with this designated site, however, noise contours have the potential to overlap with the main distributional range of its population. Received noise levels within the 2 m to 20 m depth contour are predicted to reach maximum SEL_{ss} levels of 130 dB. This is equivalent to the outer limit of the US National Marine Fisheries Service threshold (140 dB_{rms}) for mild disturbance (NMFS, 2005) and therefore likely to elicit less severe disturbance reactions compared to higher received levels of 150 dB SEL_{ss} (=160 dB_{rms} for strong disturbance). According to the behavioural response severity matrix suggested by Southall *et al*. (2021) low level disturbance (scoring between 0 to 3 on 0 to 9 scale) could lead to mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement are unlikely to occur. Therefore, up to five animals from the Moray Firth SAC population could experience mild disturbance but this is unlikely to lead to barrier effects as animals are unlikely to be excluded from the coastal areas. Given that noise contours do not extend to the Moray Firth SAC and animals are expected to experience only mild behavioural disturbance within the CES MU, behavioural disturbance is unlikely to alter the distribution of bottlenose dolphin such that recovery cannot be expected, or effects can be considered long term.

1662 Reproductive costs in females may increase mortality, reduce offspring survival, and result in trade-offs between current and future reproduction (NatureScot, 2021). A review of the CES MU data by Quick *et al*. (2014), showed that males appear to spend more time outside the Moray Firth SAC than females, therefore males are more exposed to pressures outside the SAC. Given that there is a small risk that animal potentially affected by PTS will be female, there is low risk to population decline as it is highly unlikely that

reproductive female will be removed from the population. Moreover, since noise contours do not reach Moray Firth SAC site there will be no behavioural disturbance with areas used by dependant mothers and calves. Therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be affected.

1663 As outlined in paragraph 894, the total duration of piling could potentially affect a maximum of three breeding cycles for bottlenose dolphin. Piling activities will be intermittent and will occur over small timespan (372 days) within piling phase (52 months) and therefore can affect bottlenose dolphin over the medium term.

1664 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of underwater noise during piling during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1665 The assessment has concluded that piling activities will not take place within the Moray Firth SAC. Given that noise contours do not extend to the Moray Firth SAC and animals are expected to experience only mild behavioural disturbance within the CES MU, behavioural disturbance will not be significant. There will be no behavioural disturbance within areas used by dependant mothers and calves, therefore it is highly unlikely that the reproductive and recruitment capability of the species will be affected. The population of bottlenose dolphin will remain a viable component of the site. Piling activities will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, bottlenose dolphin, will not be undermined.

1666 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity of the Moray Firth SAC from injury and disturbance due to underwater noise during piling with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during site investigation surveys

1667 The noise modelling demonstrated that ranges within which there is a risk of PTS to bottlenose dolphin as a result of geophysical surveys are relatively low with a maximum impact range of 65 m (due to operation of SSS, SBES, MBES and SBP; Table 7.20 and Table 7.21). For geotechnical survey activities, PTS impact thresholds for bottlenose dolphin are not exceeded (Table 7.21).

1668 There is potential for less than one animal to experience PTS as a result of geophysical and geotechnical site investigation surveys (<0.5% of the Moray Firth SAC population). It should be noted that since sonar-based systems have strong directivity, there is only potential for injury when marine mammals are directly underneath the sound source. In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting bottlenose dolphin is out to approximately 7.5 km during vibro-coring. Given that the vibro-core sampling locations are currently unknown and coastal distribution of bottlenose dolphin is spatially limited, any quantitative assessment of the disturbance to coastal populations would be an overestimation.

1669 As described in paragraph 800, bottlenose dolphin from Moray Firth SAC are most likely to be encountered within 2 km from the shore, therefore, in the case of surveys taking place within the Proposed Development array area, it is unlikely that individuals from this SAC will be present in offshore waters. If site investigation surveys are taking place along Proposed Development export cable corridor and nearby at the landfall at Skateraw on the East Lothian coast, there is a potential for overlap of injury/disturbance ranges with coastal areas. However, the landfall is located at the southern limit of the main distributional range of bottlenose dolphin from the Moray Firth SAC and based on the ECOMMAS study, the C-PODs deployed at closest station at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). Given that the surveys are considered to be short-term (i.e. they will take place over a period of up to three months), the number of animals potentially disturbed would represent a negligible proportion of the population.

1670 With designed in measures in place, which are in line with recommended best practice guidelines (Table 7.11), due to the low risk of PTS occurring and the short-term duration of the geophysical surveys, no adverse effects associated with auditory injury and disturbance to bottlenose dolphin are predicted as a result of site investigations surveys. Therefore, it is highly unlikely that site investigation surveys will influence bottlenose dolphin population trajectory in the long-term. Although there is a potential for behavioural disturbance during vibro-core survey, this survey is expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. As the site investigation surveys will take place largely outside the CES MU, also anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for bottlenose dolphin from the Moray Firth SAC as a result of site investigation surveys.

1671 The site-investigation surveys will be taking place outside the Moray Firth SAC and there is no potential for overlap of injury ranges or noise disturbance contours with the limits of the site. Areas within the SAC are important for breeding and calving. Given that there will be no overlap of the activity with areas used by dependant mothers and calves, site investigation surveys are unlikely to affect bottlenose dolphins within the SAC at a level that would affect their behaviour and cause change in reproduction and survival rates.

1672 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of underwater noise during site investigation surveys during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1673 The assessment has concluded that site investigation surveys will not take place within the Moray Firth SAC. Given that disturbance range do not extend to the Moray Firth SAC and only small number of animals may experience behavioural disturbance within the CES MU, behavioural disturbance will not be significant. There will be no behavioural disturbance with areas used by dependant mothers and calves, therefore it is highly unlikely that the reproductive and recruitment capability of the species will be affected. The population of bottlenose dolphin will remain a viable component of the site. Site investigation surveys will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1674 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity of the Moray Firth SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during UXO clearance

1675 Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that bottlenose dolphin can be potentially affected by PTS at the maximum range of 615 m due to detonation of charge size of 300 kg (Table 7.24). There is potential for less than one animal to experience PTS as a result of UXO clearance using high order detonation (<0.5% of the Moray Firth SAC population). It is anticipated that only 10% of all UXO clearance events will result in high order detonation as low order techniques will be applied as the intended methodology for clearance of UXO. The underwater noise modelling results show that bottlenose dolphin can be potentially affected by PTS at the maximum range of 75 m due to detonation of 0.5 kg clearance shot (Table 7.24).

1676 To reduce the potential of experiencing injury, designed in measures, which are in line with recommended best practice guidelines, will be adopted as part of a MMMP (see Table 7.11). There is a potential to experience auditory injury by bottlenose at a range than can be mitigated by monitoring of the 1 km mitigation zone, however, to further reduce the risk of injury, an ADD will be deployed for a pre-determined length of time to deter marine mammals to a greater distance prior to any detonation. A MMMP will be developed for the purpose of mitigating the risk of auditory injury (PTS) to marine mammals from the proposed UXO clearance activities at the Proposed Development based on an assessment which will be provided as a part of the EPS licence supporting information.

1677 Quick *et al.* (2014) reported that males appear to spend more time outside the Moray Firth SAC than females, therefore males are more exposed to pressures outside the SAC. Given that there is a small risk that animal potentially affected by injury will be female, there is low risk to population decline as it is highly unlikely that reproductive female will be removed from the population The UXO clearance activities will be taking place outside the Moray Firth SAC and there is no potential for overlap of injury ranges with the limits of the site. Areas within the SAC are important for breeding and calving and given that there will be no overlap of the activity with areas used by dependant mothers and calves, UXO clearance activities are unlikely to affect bottlenose dolphins at a level that would cause change in reproduction and survival rates. Therefore, UXO clearance activities are highly unlikely to affect bottlenose dolphin population in long-term.

1678 As described in paragraph 971, the threshold for potential temporary loss of hearing (TTS) was also assessed. Based on the maximum design scenario of high order detonation, the underwater noise modelling results show that bottlenose can be potentially affected by TTS at the maximum range of 1,137 m due to detonation of charge size of 300 kg (Table 7.32).

1679 As described in paragraph 800, bottlenose dolphin from Moray Firth SAC are most likely to be encountered within 2 km from the shore. If the UXO is located within the Proposed Development array area, there is no potential for overlap of maximum injury ranges with coastal areas. If UXO clearance activities are taking place along Proposed Development export cable corridor and nearby at the landfall at Skateraw on the East Lothian coast, there is a potential for overlap of injury ranges with coastal areas. However, the landfall is located at the southern limit of the main distributional range of bottlenose dolphin from the Moray Firth SAC and based on the ECOMMAS study, the C-PODs deployed at closest station at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). Therefore it is highly unlikely that high proportion of individuals from this SAC could be potentially impacted in the vicinity of the Proposed Development export cable corridor and landfall. TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Given that this effect is short in duration and will take place largely outside of the CES MU, it is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for bottlenose dolphin from the Moray Firth SAC as a result of UXO clearance activities.

1680 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of underwater noise during UXO clearance during the construction phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1681 The assessment has concluded that UXO clearance will not take place within the Moray Firth SAC. Given that the TTS range do not extend to the Moray Firth SAC and only small number of animals may experience TTS within the CES MU, disturbance will not be significant. There will be no disturbance with areas used by dependant mothers and calves, therefore it is highly unlikely that the reproductive and recruitment capability of the species will be affected. The population of bottlenose dolphin will remain a viable component of the site. UXO clearance activities will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, bottlenose dolphin, will not be undermined.

1682 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the construction of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1683 With regards to PTS, the modelling shows that for bottlenose dolphin, the threshold for PTS is not exceeded by any vessel with the exception of installation/construction and rock placement vessels, for which an injury range of a maximum of 15 m from the source was established (Table 7.35). PTS ranges for bottlenose dolphin were not exceeded for any other activities except for cable laying, where an injury range of 15 m from the source was assessed. The number of bottlenose dolphin potentially affected within the modelled ranges for PTS from vessels and other activities were found to be less than one individual. For Moray Firth SAC, this equates to <0.5% of the bottlenose dolphin population. Given that vessels will follow a Code of Conduct (including advice to operators to not deliberately approach marine mammals) and NSPVMP, the risk of potential auditory injury will be reduced.

1684 With regard to behavioural disturbance to bottlenose dolphin, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m. Similar ranges for behavioural effects are predicted to occur due to underwater noise from installation and construction vessels as well as rock placement vessels with disturbance ranges of 4,389 m. In comparison, vessels such as excavator, backhoe dredger, pipe laying, geophysical survey vessel and jack up vessel as well as jack-up rig were predicted to result in disturbance ranges out to 300 m.

1685 All vessel movements will take place outside the Moray Firth SAC and there is no potential for overlap of injury or disturbance ranges with the boundaries of the site. Areas within the SAC are important for breeding and calving and given that there will be no overlap of the activity with areas used by dependant mothers and calves, vessel movements are unlikely to affect bottlenose dolphins at a level that would cause change in reproduction and survival rates. Therefore, vessel use and other activities are highly unlikely to affect bottlenose dolphin population in long-term.

1686 As described in paragraph 800, bottlenose dolphin from Moray Firth SAC are most likely to be encountered within 2 km from the shore. As most vessel movements during the construction and decommissioning will be confined within the Proposed Development array area, there is a limited potential for overlap of maximum injury or behavioural disturbance ranges with coastal areas.

1687 However, vessel movements will also be taking place along Proposed Development export cable corridor and nearby at the landfall at Skateraw on the East Lothian coast. The landfall is located at the southern limit of the main bottlenose dolphin distributional range and based on the ECOMMAS study, the C-PODs deployed at closest station at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). Therefore, if individuals are affected by disturbance as a result by vessel movements and other activities in the vicinity of the Proposed Development export cable corridor and landfall, these numbers would represent a negligible proportion of the population from Moray Firth SAC.

1688 Additionally, vessels will be moving to and from ports and harbours and this traffic will intersect with the CES MU and areas of high bottlenose dolphin abundance. The NSPVMP will be produced and will include agreed routes and potential speed restrictions in order to reduce disturbance. The Moray Firth is an area of relatively high vessel traffic due to presence of port of Cromarty Firth which has been supporting the offshore energy industry for decades. The Moray Firth SAC is located within this busy area and yet the population of bottlenose dolphin within the SAC is increasing. Therefore, given the existing levels of vessel activity within the Moray Firth and along the east coast of Scotland, it is expected that bottlenose dolphin could tolerate the effects of vessel presence. Lusseau *et al*. (2011) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth did not have an adverse effect on the local population of bottlenose dolphin, although it did note that

foraging may be disrupted by disturbance from vessels. Vessel movements intersecting the bottlenose dolphin main distributional range will be intermittent and localised and animals could be potentially disturbed from only a small area when compared to available foraging habitat. Therefore, it is anticipated that the availability of suitable foraging grounds for bottlenose dolphin will not be impaired.

1689 Given that increase in vessel movements will take place largely outside the CES MU, it is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for bottlenose dolphin from the Moray Firth SAC.

1690 The magnitude of the impact of the decommissioning phase for both auditory injury and disturbance as a result of elevated underwater noise due to vessel use is not expected to differ or be greater than that assessed for the construction phase (volume 2, chapter 10 of the Offshore EIA Report).

1691 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of underwater noise during vessel use and other activities during the construction and decommissioning phases (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1692 The assessment has concluded that vessel use and other activities will not take place within the Moray Firth SAC. Given that the behavioural disturbance range do not extend to the Moray Firth SAC and only small number of animals may experience it within the CES MU, disturbance will not be significant. There will be no disturbance with areas used by dependant mothers and calves, therefore it is highly unlikely that the reproductive and recruitment capability of the species will be affected. The population of bottlenose dolphin will remain a viable component of the site. Vessel use and other activities will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, bottlenose dolphin, will not be undermined.

1693 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC from injury and disturbance due to underwater noise during vessel use and other activities with respect to the construction and decommissioning of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1694 As outlined in paragraph 1010 *et seq.*, there is potential for changes to prey availability for bottlenose dolphin during construction and decommissioning of the Proposed Development. These impacts include temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration.

1695 There is a potential for temporary habitat loss/disturbance to affect up to 113,974,700 m^2 of seabed during the construction phase, which equates to 9.7% of the fish and shellfish ecology study area. Only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time during the construction phase, with areas starting to recover immediately after cessation of construction activities in the vicinity. Additionally, habitat disturbance during the construction phase will also expose benthic infaunal species from the sediment, potentially offering foraging opportunities to some fish and shellfish species (e.g. opportunistic scavenging species) immediately after completion of works. The presence of infrastructure within the Proposed Development, including foundations and associated scour protection, cable protection, OSP/Offshore convertor station platform interconnector and offshore export cables will result in long term habitat loss of up to 7,798,856 m^2 (0.7% of the Proposed Development fish and shellfish ecology study area; volume 2, chapter 9 of the Offshore EIA Report). Moray Firth SAC and the Tay estuary are known to be important foraging ground for bottlenose dolphins within the CES MU (Arso Civil *et al.,* 2021). It has been reported that seasonal changes in prey presence over variable temporal scales throughout the year may enable dolphins to exploit these areas within their range at different times. Given that neither of these important areas will be affected by temporary habitat loss/disturbance or long term habitat loss, bottlenose dolphin distribution and connectivity with important foraging habitats within and outside the site is unlikely to be impaired.

1696 Based on the analysis of stomach contents (Santos *et al*., 2001) and direct observations of foraging events, Salmonids are known to be important prey for bottlenose dolphins. The assessment presented in the EIA (volume 2, chapter 9 of the Offshore EIA Report) concluded that in terms of underwater noise, due to the distance between the Proposed Development array area and the coast, behavioural impacts are unlikely to cause barrier effects between the Proposed Development fish and shellfish ecology study area. Therefore the migration routes of diadromous species (including salmon *Salmo salar* and sea trout *Salmo trutta*) along the east coast of Scotland are not expected to be impaired, due to the relatively small area around piling events where noise levels are high enough to cause behavioural responses.

1697 Elevations in SSC during the construction phase will be of short duration, returning to background levels relatively quickly. SSC will not reach the concentrations required for an extended period for there to be any effect on survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Given that overlap of Proposed Development with CES MU is limited, only activities taking place along the Proposed Development export cable corridor and landfall have a potential to have indirect impact on bottlenose dolphins via changes to prey species due to an increase in SSC and associated sediment deposition. However, waters along East Lothian coastline were not identified as important bottlenose dolphin foraging ground and due to presence of more important foraging grounds across the CES MU, the availability of suitable food supply for bottlenose dolphin from the Moray Firth SAC is not expected to be impaired.

1698 The magnitude of the indirect impact on marine mammals as a result of changes in fish and shellfish communities during the decommissioning phase is not expected to differ or be greater than that assessed for the construction phase.

1699 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning phases (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1700 The assessment has concluded that the impacts of construction and decommissioning will be highly localised and largely restricted to the boundaries of the Proposed Development. Given that important feeding areas within the CES MU will not be affected, the supporting habitats relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin will be maintained.

1701 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity of the Moray Firth SAC from changes in fish and shellfish communities affecting prey availability with respect to the construction and decommissioning of the Proposed Development acting alone.

Operation and maintenance

Injury and disturbance from elevated underwater noise during site investigation surveys

1702 As discussed in paragraph 945 *et seq.*, the maximum range at which there is a risk of PTS to bottlenose dolphin as a result of site investigation surveys is 65 m. With designed in measures (Table 7.11) implemented for the geophysical surveys, the risk of PTS occurring to bottlenose dolphin will be low. With regard to behavioural disturbance, a maximum potential disturbance range across all survey types is approximately 7.5 km during vibro-coring. Due to the coastal distribution of bottlenose dolphins from the

Moray Firth SAC, if surveys are taking place within the Proposed Development array area, there will be no overlap of injury and disturbance ranges with their distributional range and it is highly unlikely that individuals from this SAC will be present in offshore waters. If site investigation surveys are taking place along Proposed Development export cable corridor and nearby at the landfall at Skateraw on the East Lothian coast, there is a potential for overlap of injury ranges with coastal areas. However, the landfall is located at the southern limit of the main distributional range of bottlenose dolphin from the Moray Firth SAC and based on the ECOMMAS study, the C-PODs deployed at the closest station at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). Given that the surveys are considered to be short-term (i.e. they will take place over a period of up to three months), number of animals potentially disturbed would represent a negligible proportion of the population.

1703 The maximum design scenario for routine geophysical surveys is estimated as a survey every six months for the first two years and annually thereafter. This equates to 37 surveys over the 35-year life cycle of the Proposed Development (Table 7.10). The site-investigation surveys will be taking place outside the Moray Firth SAC and there is no potential for overlap of injury ranges or noise disturbance contours with the limits of the site. Areas within the SAC are important for breeding and calving but given that there will be no overlap of the activity with areas used by dependant mothers and calves, site investigation surveys are unlikely to affect bottlenose dolphins within the SAC at a level that would affect their behaviour and cause change in reproduction and survival rates.

1704 Site investigation surveys are expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Given that the potential disturbance will be localised and short term, it is not considered to cause levels of disturbance that would raise concern. Therefore it is highly unlikely that site investigation surveys will influence bottlenose dolphin population trajectory in the long-term. As the site investigation surveys will take place largely outside the CES MU, it is not anticipated that there will be any introduction of barriers to wider movement or impact to connectivity between different important habitats for bottlenose dolphin from the Moray Firth SAC as a result of site investigation surveys.

1705 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of underwater noise during site investigation surveys during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1706 . The assessment has concluded that site investigation surveys will not take place within the Moray Firth SAC. Given that disturbance range do not extend to the Moray Firth SAC and only small number of animals may experience behavioural disturbance within the CES MU, behavioural disturbance will not be significant. There will be no behavioural disturbance with areas used by dependant mothers and calves, therefore it is highly unlikely that the reproductive and recruitment capability of the species will be affected. The population of bottlenose dolphin will remain a viable component of the site. Site investigation surveys will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, harbour porpoise, will not be undermined.

1707 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity of the Moray Firth SAC from injury and disturbance due to underwater noise during site investigation surveys with respect to the operation of the Proposed Development acting alone.

Injury and disturbance from elevated underwater noise during vessel use and other activities

1708 As described in paragraphs 989 *et seq*., vessel use during the operation and maintenance phase of the Proposed Development is considered to represent a relatively small increase in the context of baseline traffic. Furthermore, the size and noise outputs from vessels will be similar to those used in the construction phase. The number of vessel round trips and their frequency will, however, be much lower compared to the construction phase.

1709 All vessel movements will be taking place outside the Moray Firth SAC and there is no potential for overlap of injury or disturbance ranges with the limits of the site. Areas within the SAC are important for breeding and calving and given that there will be no overlap of the activity with areas used by dependant mothers and calves, vessel movements are unlikely to affect bottlenose dolphins at a level that would cause change in reproduction and survival rates. Therefore, vessel use and other activities are highly unlikely to affect bottlenose dolphin population in long-term.

1710 As described in paragraph 800, bottlenose dolphin from Moray Firth SAC are most likely to be encountered within 2 km from the shore. As most vessel movements during the operation and maintenance phase will be confined within the Proposed Development array area, there is a limited potential for overlap of maximum injury or behavioural disturbance ranges with coastal areas.

1711 However, small number of vessel movements will be also taking place along the Proposed Development export cable corridor and nearby at the landfall at Skateraw on the East Lothian coast. The landfall is located at the southern limit of the main bottlenose dolphin distributional range and based on ECOMMAS study, the C-PODs deployed at closest station at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). Therefore, if individuals are affected by disturbance as a result by vessel movements and other activities in the vicinity of the Proposed Development export cable corridor and landfall, these numbers would represent a negligible proportion of the population from Moray Firth SAC.

1712 Vessels will be moving to and from ports and harbours; this traffic will intersect with the CES MU and areas of high bottlenose dolphin abundance. The NSPVMP will be produced and will include agreed routes and potential speed restrictions in order to reduce disturbance. The Moray Firth is an area of relatively high vessel traffic due to the presence of the port of Cromarty Firth which has been supporting offshore energy industry for decades. The Moray Firth SAC is located within this busy area and yet population of bottlenose dolphin within the SAC is increasing. Therefore, given the existing levels of vessel activity within the Moray Firth and along the east coast of Scotland, it is expected that bottlenose dolphin could tolerate the effects of vessel activity during the operation and maintenance phase. Lusseau *et al*. (2011) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth did not have an adverse effect on the local population of bottlenose dolphin, although it did note that foraging may be disrupted by disturbance from vessels. Vessel movements intersecting the bottlenose dolphin main distributional range will be intermittent and localised and animals could be potentially disturbed from only a small area when compared to available foraging habitat. Therefore, it is anticipated that the availability of suitable foraging grounds for bottlenose dolphin will not be impaired.

1713 Given that increase in vessel movements will take place largely outside the CES MU, it is anticipated that there will be no introduction of barriers to wider movement or impact to connectivity between different important habitats for bottlenose dolphin from the Moray Firth SAC.

1714 Effects on bottlenose dolphin at this SAC are considered to be the same or less than the effects described for vessel use and other activities during the construction and decommissioning phases, previously described in paragraph 1683 *et seq*. It should be noted that operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years) and therefore only a small proportion of vessel movements and other activities will occur at any one time.

1715 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of underwater noise during vessel use and other activities during the operation and maintenance phase (i.e. in relation to maintaining the population, distribution of species within the site, connectivity and disturbance to species).

Conclusion

1716 The assessment has concluded that vessel use and other activities will not take place within the Moray Firth SAC. Given that the behavioural disturbance range do not extend to the Moray Firth SAC and only small number of animals may experience it within the CES MU, disturbance will not be significant. There will be no disturbance with areas used by dependant mothers and calves, therefore it is highly unlikely that the reproductive and recruitment capability of the species will be affected. The population of bottlenose dolphin will remain a viable component of the site. Vessel use and other activities will not affect the condition of supporting habitats and processes. As such, the conservation objectives for Annex II species, bottlenose dolphin, will not be undermined.

1717 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC from injury and disturbance due to underwater noise during vessel use and other activities with respect to the operation of the Proposed Development acting alone.

Changes in fish and shellfish communities affecting prey availability

1718 As outlined in paragraph 1051 *et seq.*, there is potential for changes to prey availability for bottlenose dolphin due to potential impacts on prey species during operation and maintenance of the Proposed Development. These impacts include temporary subtidal habitat loss/disturbance, long-term subtidal habitat loss, increased SSC and associated sediment deposition, EMF from subsea electrical cabling and colonisation of foundations, scour protection and cable protection.

1719 Potential temporary habitat loss/disturbance during the operation and maintenance phase equates to a smaller area than affected during construction (up to 989,000 m^2 which equates to 0.08% of the Proposed Development fish and shellfish ecology area, compared with 9.7% during the construction phase; volume 2, chapter 9 of the Offshore EIA Report). Operation and maintenance activities will occur periodically over the full lifetime of the project (estimated to be 35 years) and therefore only a small proportion of the maximum footprint of habitat loss/disturbance may be occur at any one time (e.g. during offshore export cable repair/reburial or wind turbine replacement events). Affected areas are expected to start recovering immediately after cessation of maintenance activities. The Moray Firth SAC and the Tay estuary are known to be important foraging ground for bottlenose dolphins within the CES MU (Arso Civil *et al*., 2021). It has been reported that seasonal changes in prey presence over variable temporal scales throughout the year may enable dolphins to exploit these areas within their range at different times. Given that neither of these important areas will be affected by temporary habitat loss/disturbance, bottlenose dolphin distribution and connectivity with important foraging habitats within and outside the site is unlikely to be impaired.

1720 Increased SSC could occur as a result of repair or remedial burial activities during the operation and maintenance phase. The maintenance activities will be undertaken at intervals over the 35 years operation and maintenance phase. The assessment presented in volume 2, chapter 9 of the Offshore EIA Report considered that any suspended sediments and associated deposition will be of the same magnitude, or lower as for construction.). Therefore, the availability of suitable food supply for bottlenose dolphin is not expected to be impaired as a result of increase in SSC and associated deposition.

1721 The presence and operation of inter-array, interconnector and offshore export cables will result in emissions of localised electrical and magnetic fields, which could potentially affect the sensory mechanisms of some species of fish and shellfish. The range over which species can detect EMF will be very localised to within a few centimetres of the buried cable, with rapid decay of the EMF with increasing distance. Considering the above, adverse effects on bottlenose dolphin as a result of changes in prey availability due to EMF are unlikely.

1722 Although there will be long term loss of habitat due to the presence of infrastructure associated with the Proposed Development, it is also anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 1021 *et seq*, evidence increasingly suggests that foraging opportunities for marine mammals are increased around offshore wind farm structures. However, due to coastal distribution, bottlenose dolphins from Moray Firth SAC are unlikely to benefit from the presence of artificial structures in offshore waters.

1723 Significant adverse effects on the qualifying Annex II marine mammal feature, bottlenose dolphin of the Moray Firth SAC, are not predicted to occur as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance phase (i.e. in relation to maintaining the cover and abundance of preferred food items required by the species).

Conclusion

1724 The assessment has concluded that the impacts of construction and decommissioning will be highly localised and largely restricted to the boundaries of the Proposed Development. Given that important feeding areas within the CES MU will not be affected, the supporting habitats relevant to bottlenose dolphin and the availability of prey for bottlenose dolphin will be maintained.

1725 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity of the Moray Firth SAC from changes in fish and shellfish communities affecting prey availability with respect to the operation of the Proposed Development acting alone.

Effects in-combination

1726 An assessment of in-combination effects upon the qualifying Annex II marine mammal species of the Moray Firth SAC arising from each identified impact is provided below.

1727 The potential to experience injury in terms of PTS by marine mammal receptors as a result of underwater noise due to piling and vessel use/other activities would be expected to be largely localised within the boundaries of the respective projects (assuming similar ranges of effect as presented for the Proposed Development). It is also anticipated that standard offshore wind industry construction methods (which include soft starts and visual and acoustic monitoring of marine mammals as standard) will be applied, thereby reducing the magnitude of the impact with respect to auditory injury occurring in marine mammals. Therefore, there is no potential for significant cumulative impacts for injury from elevated underwater noise during pilling and vessel use/other activities and the cumulative assessment focuses on disturbance only.

Assessment of in-combination effects during construction and decommissioning

Injury and disturbance from elevated underwater noise during piling

Tier 2

1728 The construction of the Proposed Development, together with the construction of the Tier 2 projects, may lead to injury and/or disturbance to bottlenose dolphin from the Moray Firth SAC from underwater noise during piling. Other projects screened into the in-combination assessment for bottlenose dolphin within the regional marine mammal study area include construction of Inch Cape Offshore Wind Farm, Seagreen 1A Project and Moray West.

1729 All projects screened in for the in-combination assessment for bottlenose dolphin are located within, or close to, the main distributional range of the population, restricted to the Moray Firth and coastal waters of the eastern Scotland (Figure 7.8). Population level modelling predicted that displacement from pile driving at Inch Cape is unlikely to affect the size or growth of the bottlenose dolphin population off the east coast of Scotland. Results of population modelling for Moray West indicated that none of the bottlenose impact scenarios discussed in the EIA resulted in a significant long term population effects (Moray West, 2018).

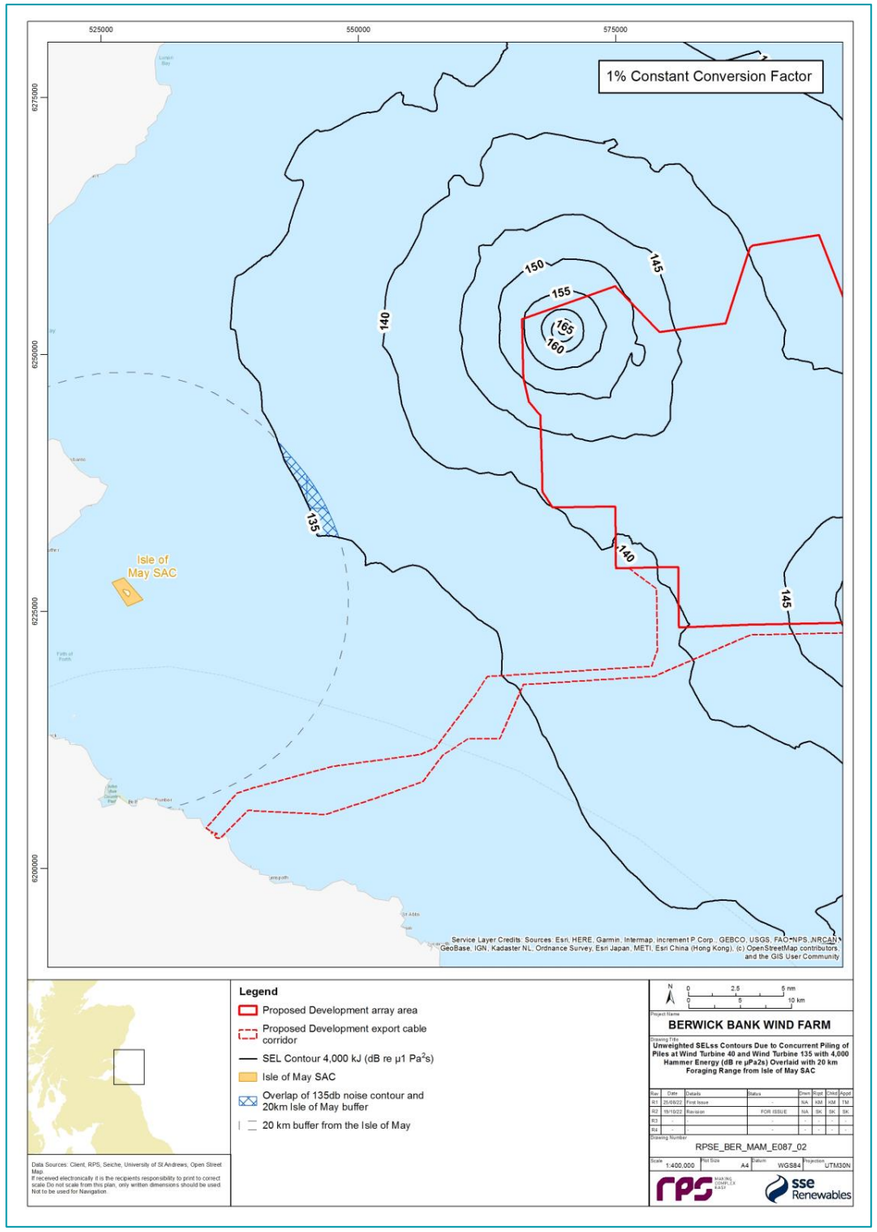

Figure 7.8: Unweighted Single Pulse SEL Contours Due to Concurrent Impact Piling at Maximum Hammer Energy (4,000 kJ) Overlaid with Proposed Development and Projects Located Within a Distributional Range of Bottlenose Dolphin Population

1730 The assessment presented in the Inch Cape EIA (Inch Cape Offshore Limited, 2018), original Seagreen EIA (Seagreen Wind Energy Ltd, 2012) and Moray West EIA (Moray West, 2018) estimated that eight, four and 15 bottlenose dolphins could experience disturbance during piling at respective projects. A spatial maximum adverse scenario would occur where piling activities occur concurrently at the respective projects considered in the in-combination assessment. This is however highly unlikely, as the construction of Moray West Offshore Wind Farm will be completed two years before commencement of piling phase at Proposed Development. Although there is an overlap with the piling operations at Seagreen 1A Project and Inch Cape, construction of these wind farms will be completed prior to commencement of piling at the Proposed Development. Population modelling was carried out to explore the potential of cumulative effects as a result of disturbance during piling to affect the population trajectory over time. Population modelling considered all projects listed in paragraph 1728 and respective numbers of animals potentially impacted against the MU population (see volume 3, appendix 10.4 for methods applied in the model). Results of the cumulative iPCoD modelling for bottlenose dolphin showed that the difference in population trajectory between the impacted and unimpacted population (up to 3.5%) falls within the natural variance of the wider population. Therefore, it was considered that there is no potential for the long-term effects on this species within the wider MU population as a result of cumulative piling at proposed Development and respective projects (see volume 3, appendix 10.4 for more details).

1731 The noise contours resulting from piling at respective projects have the potential to overlap with the main distributional range of Moray Firth SAC population (CES MU). Although the construction of projects considered in in-combination assessment will be completed prior to commencement of piling at the Proposed Development, there is a potential that animals in the vicinity of the Firth of Forth and Tay will experience disturbance consecutively as piling at different projects progresses. Moray West is located at a closest distance to the Moray Firth SAC. As mentioned above, the gap between construction phase of Moray Firth and piling at Proposed Development is two years. It is anticipated that if bottlenose dolphins experienced any disturbance as a result of piling at Moray West, individuals would return to previous activities once the impact had ceased and therefore no in-combination effects with Proposed Development are predicted.

1732 For the Proposed Development alone, received noise levels within the 2 m to 20 m depth contour are predicted to reach maximum SEL_{ss} levels of 130 dB and could lead to mild disruptions of normal behaviours but prolonged or sustained behavioural effects, including displacement, are unlikely to occur. Piling activities will take place intermittently over several years and there is a potential for bottlenose dolphins close to key foraging area in the Firth of Tay to experience mild disturbance. Results of studies on bottlenose dolphins in Moray Firth suggest that impulsive noise generated during piling at the offshore wind farms does not cause any displacement of bottlenose dolphins from their population range (Fernadex-Betelu *et al.*, 2021). Although foraging activities may be temporarily disrupted if piling will occur closer to the coast, bottlenose dolphins will still have access to sufficient food resources within the wider CES MU. Therefore, behavioural disturbance is unlikely to alter the distribution of bottlenose dolphin within the SAC such that recovery cannot be expected, or effects can be considered long term.

1733 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of underwater noise during piling during construction with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1734 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to bottlenose dolphin from the Moray Firth SAC during the construction phase of the Proposed Development with the construction and operation and maintenance Eastern Link 1 and Eastern Link 2.

1735 The construction as well as operation and maintenance phases of Eastern Link 1 and Eastern Link 2, located respectively 14 km and 28 km from the Proposed Development array area, will overlap with the construction phase of the Proposed Development. Based on the Environmental Appraisals for both projects, the only underwater sound noise sources that are within hearing range of marine mammals and have potential to have an effect, are the operation of the USBL and the SBP (AECOM, 2022a; 2022b). The disturbance ranges for bottlenose dolphin were estimated as 63 m for USBL and 4,642 m for SBP. The detailed assessment of impacts as a result of underwater noise during the operation of SBP for both projects was presented for installation phase only. There are no disturbance ranges presented for the USBL for the Proposed Development alone but the disturbance range for SBP has been assessed as 2,045 m. Nevertheless, the assessment presented in paragraph 945 *et seq*. is based on the maximum disturbance range estimated as 7,459 m for vibro-coring. Given that the vibro-core sampling locations are currently unknown and coastal distribution of bottlenose dolphin is spatially limited, any quantitative assessment of the disturbance to coastal populations would be an overestimation.

1736 Based on the distance from the Proposed Development to both projects, the overlap of disturbance ranges is highly unlikely. The potential for an overlap exist only for site-investigation surveys taking place in the northern part of the Eastern Link 1, close to the Proposed Development export cable corridor and nearby at the landfall at Skateraw on the East Lothian coast (Figure 7.3). However, the landfall is located at the southern limit of the main bottlenose dolphin distributional range and based on ECOMMAS study, the C-PODs deployed at closest station at St. Abbs had very low (<5%) broadband occupancy rates for all survey years (2013 to 2015). Given that the surveys are considered to be short-term (i.e. they will take place over a period of up to three months), number of animals potentially disturbed would represent a negligible proportion of the population.

1737 Additionally, as outlined in paragraph 1719 *et seq*, within the CES MU, the Moray Firth SAC and the Tay estuary are known to be important foraging ground for bottlenose dolphins (Arso Civil *et al*., 2021). Given that neither of these important areas will be affected by disturbance as a result of site investigation surveys at either of the projects, bottlenose dolphin distribution and connectivity with important foraging habitats within and outside the site is unlikely to be impaired.

1738 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of site investigation surveys during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during UXO clearance

Tier 2

1739 There is potential for in-combination effects from injury and/or disturbance from underwater noise during UXO clearance to bottlenose dolphin from the Moray Firth SAC during the construction phase of the Proposed Development with activities associated with the following projects Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm.

1740 Projects screened in for this cumulative assessment are expected to involve similar construction activities to those described for the Proposed Development alone, including UXO clearance activities. It is anticipated that, for all projects, impacts associated with these activities will require additional assessment under EPS licensing, however such applications are not yet available in the public domain.

1741 For the Proposed Development alone, the maximum range across which bottlenose dolphin have the potential to experience PTS due to high order detonation of 300 kg charge was assessed as approximately 615 m. PTS onset ranges for Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm are currently unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is not greater than assessed for the Proposed Development alone. Depending on the type of detonation and size of UXO, UXO clearance activities may have residual effects in respect to marine mammals and PTS injury. In November 2021, the UK government published a joint interim statement advising to use low noise alternatives to high order detonations where possible and it is anticipated that future developments will follow this guidance. However, due to a small inherent risk with these clearance methods that the UXO will detonate or deflagrate violently, accidental high order detonation can be expected as a maximum adverse scenario. Taking into account high order detonation of 300 kg charge and appropriate designed in and secondary mitigation measures, there will be no residual risk of injury (see paragraph 961 *et seq*.) and therefore, it is highly unlikely that the reproductive and recruitment capability of the species will be affected.

1742 In terms of TTS, for the Proposed Development alone, the range across which bottlenose dolphin have the potential to experience TTS due to high order detonation of a 300 kg charge was as approximately 1,137 m (see paragraph 971 *et seq*.). TTS onset ranges for Inch Cape Offshore Wind Farm and Moray West Offshore Wind Farm are currently unknown, but for the purpose of this assessment we can assume that the maximum adverse scenario is no greater than assessed for the Proposed Development alone. A spatial maximum adverse scenario would occur where UXO clearance activities occur concurrently at the respective projects considered in the cumulative assessment. This is however highly unlikely, as due to safety reasons the UXO clearance activities takes place before other construction activities commence, and both projects considered in the CEA start their construction activities two years before commencement of construction at Proposed Development. Temporally however, sequential UXO clearance at respective projects could lead to a longer duration of effect. Since each clearance event results in no more than a one second ensonification event and since TTS is a recoverable injury, the potential for cumulative effects with respect to TTS is considered to be very limited. Given that effect of TTS is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired.

1743 Quick *et al.* (2014) reported that males appear to spend more time outside the Moray Firth SAC than females, therefore males are more exposed to pressures outside the SAC. Given that there is a small risk that any animals potentially injured will be female, there is low risk to population decline as it is highly unlikely that reproductive female will be removed from the population. The UXO clearance activities at respective projects will be taking place outside the Moray Firth SAC and the potential for overlap of injury ranges with the limits of the site is highly unlikely. Areas within the SAC are important for breeding and calving and given that no overlap of the UXO clearance activity with areas used by dependant mothers and calves is anticipated, UXO clearance activities are unlikely to affect bottlenose dolphins at a level that would cause change in reproduction and survival rates. Therefore, UXO clearance activities are highly unlikely to affect bottlenose dolphin population in long-term.

1744 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of underwater noise during UXO clearance during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1745 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to bottlenose dolphin from the Moray Firth SAC during the construction and decommissioning phase of the Proposed Development with activities associated with the following projects: Eyemouth, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Neart na Gaoithe and Blyth Demo 2.

1746 Whilst there is no quantitative information available for noise disturbance ranges for offshore wind farms included in the in-combination assessment, it is anticipated that there will be a similar scale of effects with respect to noise effects as those described for Proposed Development alone (paragraph 995 *et seq*.). In terms of behavioural disturbance, the noise modelling for the Proposed Development alone predicted a maximum range of approximately 4 km for construction activities such as cable laying (described in detail in volume 3, appendix 10.1). Although there is a potential for disturbance effects to occur cumulatively,

these will be localised to the vessel routes to and from ports and harbours, intersecting the CES MU. The highest number of vessels movements was predicted during the construction phase of each offshore wind farm. There would potentially be a relatively small temporal overlap of the construction phases, with only one year of overlap with Inch Cape as well as Seagreen 1A Project and the Proposed Development. There will be no overlap with construction phase at Moray West. Therefore, the potential cumulative effect during construction phases of the respective projects and the proposed Development will be short-term (no more than one year).

1747 It is an industry standard that vessels follow a Code of Conduct, which includes advice not to approach marine mammals and it is anticipated that vessels at all relevant projects will follow these guidelines. Given the existing levels of vessel activity within the Moray Firth and along the east coast of Scotland, it is expected that bottlenose dolphin could tolerate the effects of vessel presence. Although foraging activities may be temporarily disrupted when vessel movements occur closer to the coast, it is expected that bottlenose dolphins will still have access to sufficient food resources within the wider CES MU. Therefore, behavioural disturbance is unlikely to alter the distribution of bottlenose dolphin within the SAC such that recovery cannot be expected, or effects can be considered long term.

1748 Most vessel movements will be confined within the array areas of respective projects as well as routes to and from ports, therefore there is limited potential for overlap of behavioural disturbance ranges with coastal areas. Although connectivity between the SAC and vessel traffic associated with Moray West can't be discounted, most vessel movements from respective projects considered in in-combination assessment will be taking place outside the Moray Firth SAC. The predicted levels of increase in vessel activity resulting from the Moray West project alone will not represent a significant increase above baseline levels of ship activity in the Moray Firth and is not expected to increase the potential for disturbance above that already experienced in the region (Moray West, 2018). As such, vessel movements are unlikely to affect bottlenose dolphins at a level that would cause change in reproduction and survival rates.

1749 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of underwater noise during vessel use and other activities during the construction phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1750 There is potential for in-combination effects from changes in the prey resources available for bottlenose dolphin from the Moray Firth SAC as a result of changes to the fish and shellfish community during the construction and decommissioning phases of the Proposed Development with activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1 Offshore Wind Farm, Seagreen 1A Project, Seagreen Eastern Link 1, Seagreen 1A Export Cable Corridor, Eastern Link 2 and Eyemouth disposal site.

1751 The construction phases and/or operation and maintenance phases of projects screened into in-combination assessment may lead to in-combination temporary subtidal habitat loss/disturbance. The total in-combination temporary subtidal habitat loss is 145,325,450 m^2 (=145.3 km^2), however this number is highly conservative as the temporal overlap in construction activities between projects will be small and therefore there will only be a small area of temporary habitat loss happening at any one time. The magnitude of long-term habitat loss caused by the presence of all structures on the seabed has been considered for the construction as well as operation and maintenance phases. The impacts have been assessed in-combination with Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, and Seagreen 1, Seagreen 1A Project and Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Links 2 and may lead to long term subtidal habitat loss of up to 15,014,156 m^2 (=15.0 km^2). As outlined in paragraph 1719 *et seq*, Moray Firth SAC and the Tay estuary are known to be important foraging ground for bottlenose dolphins within the CES MU (Arso Civil *et al*., 2021). Given that neither of these important areas will be affected by temporary habitat loss/disturbance or long term habitat loss, bottlenose dolphin distribution and connectivity with important foraging habitats within and outside the site is unlikely to be impaired. It is therefore highly unlikely that construction works resulting in habitat loss/disturbance will influence bottlenose dolphin population trajectory in the long-term.

1752 increase in SSC and associated sediment deposition as a result of the construction as well as operation of projects screened into the in-combination assessment may result in short-term avoidance of affected areas by fish and shellfish which may have an indirect effect on bottlenose dolphin. Elevations in SSC are expected to be of short duration, returning to background levels relatively quickly. SSC are not expected to reach the concentrations required for an extended period for there to be any effect on fish and shellfish adult/larvae survival. Additionally, deposited sediments are expected to be removed quickly by the currents resulting in small amount of sediment being deposited. Given the localised extent of this effect, the availability of suitable food supply for bottlenose dolphin within the wider area is not expected to be impaired.

1753 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of changes in fish and shellfish communities affecting prey availability during construction and decommissioning with respect to the Proposed Development acting in-combination with Tier 3 projects.

<u>Assessment of in-combination effects during operation and maintenance</u>

Injury and disturbance from elevated underwater noise during site investigation surveys

Tier 2

1754 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to site investigation surveys to bottlenose dolphin during the operation and maintenance phase of the Proposed Development with the operation and maintenance Eastern Link 1 and Eastern Link 2.

1755 The maximum design scenario for Proposed Development alone comprises of routine geophysical surveys estimated to occur every six months for first two years and annually thereafter. This equates to up to 37 surveys over the 35-year life cycle of Proposed Development (Table 5.2). As presented in paragraph 1735, the detailed assessment of impacts on marine mammals as a result of underwater noise due to geophysical surveys during the operation and maintenance phase of the Eastern Link 1 and Eastern Link 2 is unavailable.

1756 An overview of potential impacts from as a result of behavioural disturbance due to elevated underwater noise during geophysical site investigation surveys is described in paragraph 1734 *et seq*. for the construction phase and has not been reiterated here for the operation and maintenance phase. The magnitude of the impact of underwater noise from geophysical surveys during operation and maintenance phase in combination with other projects considered in cumulative assessment could result in a negligible alteration to the distribution of bottlenose dolphin in the short-term only where it overlaps with their main distributional range. Surveys are anticipated to be short-term in nature (weeks to a few months) and occur intermittently over the operation and maintenance phase.

1757 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of site investigation surveys during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Injury and disturbance from elevated underwater noise during vessel use and other activities

Tier 2

1758 There is potential for in-combination effects from injury and/or disturbance from underwater noise due to vessel use and other activities to bottlenose dolphin from the Moray Firth SAC during the operation and maintenance phase of the Proposed Development with activities associated with the following projects: the Eyemouth disposal site, Inch Cape Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Blyth Demo 2, Neart na Gaoithe Offshore Wind Farm and Moray West.

1759 Vessels involved in the operation and maintenance of other wind farms will include a similar suite of vessels as those described for the Proposed Development alone (see paragraph 1044 *et seq.*), such as vessels used during routine inspections, repairs and replacement of equipment, major component replacement, painting or other coatings, removal of marine growth and replacement of access ladders. Given that the number of vessel round trips and their frequency is much lower for the operation and maintenance phases compared to construction phases of the respective projects, the magnitude of the impact for disturbance as a result of elevated underwater noise due to vessel use and other activities is expected to be less than that assessed for the construction phase. However, the duration of the effect will be longer (over the 35-year operating lifetime of the Proposed Development). During the operation and maintenance phase of the Proposed Development, the wind farms listed in paragraph 1758 will reach their decommissioning age before the Proposed Development reaches its decommissioning age in 2066. The environmental statements for respective projects predicted the number and type of vessels associated with decommissioning are expected to be, at worst, similar to construction.

1760 Most vessel movements will be confined within the array areas of respective projects as well as routes to and from ports, therefore there is limited potential for overlap of behavioural disturbance ranges with coastal areas. Although connectivity between the SAC and vessel traffic associated with Moray West can't be discounted, most vessel movements from respective projects considered in in-combination assessment will be taking place outside the Moray Firth SAC. The predicted levels of increase in vessel activity resulting from the Moray West project alone will not represent a significant increase above baseline levels of ship activity in the Moray Firth and is not expected to increase the potential for disturbance above that already experienced in the region (Moray West, 2018). As such, vessel movements are unlikely to affect bottlenose dolphins at a level that would cause change in reproduction and survival rates. Therefore, vessel use and other activities are highly unlikely to affect bottlenose dolphin population in long-term.

1761 Additionally, given the existing levels of vessel activity within the Moray Firth and along the east coast of Scotland and the fact that at the time of operation and maintenance of Proposed Development, construction activities within the Firth of Forth will be happening for over 10 years, it is expected that bottlenose dolphin will be able to tolerate the effects of vessel presence. Lusseau *et al*. (2011) undertook a modelling study which predicted that increased vessel movements associated with offshore wind development in the Moray Firth did not have an adverse effect on the local population of bottlenose dolphin, although it did note that foraging may be disrupted by disturbance from vessels. Vessel movements across the bottlenose dolphin main distributional range will be intermittent and localised and animals could be potentially disturbed from only a small area when compared to available foraging habitat. Therefore, it is anticipated that the availability of suitable foraging grounds for bottlenose dolphin will not be impaired.

1762 As presented in volume 2, chapter 13 of the Offshore EIA Report, the commercial vessel numbers in the vicinity of the Proposed Development are expected to remain reasonably consistent in the future. In the longer term, there may be increases in wind farm related traffic associated with the ScotWind developments north and east of the Proposed Development. However, given the low data confidence associated with these developments it was not possible to make any quantitative assumptions. It has been assumed that future case traffic growth is likely to fluctuate depending on seasonality and cargo and industry trends. The Scotwind developments will be located offshore and therefore the extent to which bottlenose dolphins may be affected will depend on the location of the port/harbour that the vessels will be travelling to/from. It is an industry standard that vessels follow a Code of Conduct and Vessel Management Plan, which include advice not to approach marine mammals and it is anticipated that vessels at all relevant projects will follow these guidelines.

1763 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of underwater noise during vessel use and other activities during the operation and maintenance phase with respect to the Proposed Development acting in-combination with Tier 2 projects.

Changes in fish and shellfish communities affecting prey availability

Tier 2

1764 There is potential for in-combination effects from changes in prey resources to bottlenose dolphin from the Moray Firth SAC during the operation and maintenance phase of the Proposed Development with maintenance activities associated with the following projects: Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1, Eastern Link 2, and Eyemouth disposal site.

1765 Operation and maintenance activities at respective projects considered in in-combination assessment may lead to temporary subtidal habitat loss/disturbance of up to 32,276,397 m^2. Additionally, Offshore Wind Farms listed above will reach their decommissioning age during Proposed Development operation and maintenance phase. However, it is important to note that the maximum design scenario for habitat loss from the cumulative projects is precautionary, as operation and maintenance activities will occur intermittently throughout the lifetime of the Proposed Development and the temporal overlap with activities at other projects is unlikely. As described in paragraph 1011, only a small proportion of the maximum footprint of habitat loss/disturbance may be affected at any one time, areas are starting to recover

1766 immediately after cessation of maintenance activities. The Moray Firth SAC and the Tay estuary are known to be important foraging ground for bottlenose dolphins from Moray Firth SAC (Arso Civil *et al*., 2021). Given that neither of these important areas will be affected by temporary habitat loss/disturbance or long term habitat loss, bottlenose dolphin distribution and connectivity with important foraging habitats within and outside the site is unlikely to be impaired. It is therefore highly unlikely that operation and maintenance works resulting in habitat loss/disturbance will influence bottlenose dolphin population trajectory in the long-term. In-combination impacts could arise from EMFs due to the presence of subsea cabling during the operation and maintenance phases of the Proposed Development as well as Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable, Eastern Link 1 and Eastern Link 2. A total length of up to 6,112 km of subsea cabling was estimated for all projects. The effect of EMF was predicted to be of local spatial extent. Considering the above, adverse effects on bottlenose dolphin as a result of changes in prey availability due to EMF are unlikely.

1767 Artificial structures introduced into areas of predominantly soft sediments has the potential to alter community composition and biodiversity. There is a potential for in-combination effects arising from colonisation due to the presence of Inch Cape Offshore Wind Farm, Neart na Gaoithe Offshore Wind Farm, Seagreen 1, Seagreen 1A Project, Seagreen 1A Export Cable Corridor, Eastern Link 1 and Eastern Link 2 with a maximum scenario of up to 15,014,156 m^2 of hard structures from wind turbines, OSP/Offshore convertor station platforms, meteorological masts, of cable protection, and cable crossings. The cumulative effect was predicted to be of local spatial extent. It is anticipated that artificial structures will provide hard settlement opportunities and provide a valuable food source for fish. As discussed in paragraph 1021 *et seq*, evidence increasingly suggests that foraging opportunities for marine mammals are increased around offshore wind farm structures. However, due to coastal distribution, bottlenose dolphins from Moray Firth SAC are unlikely to benefit from presence of artificial structures in offshore waters.

1768 Therefore, it can be concluded that there is no risk of an Adverse Effect on Integrity on the Moray Firth SAC as a result of changes in fish and shellfish communities affecting prey availability during operation and maintenance with respect to the Proposed Development acting in-combination with Tier 2 projects.

Site conclusion

1769 In conclusion, with reference to the conservation objectives set for the Annex II marine mammal features of the site and the information presented in section 7.3, 7.4, 7.5 and 7.6.5, it can be concluded beyond all reasonable scientific doubt that there will be no Adverse Effect on Integrity on the Moray Firth SAC in respect of the bottlenose dolphin qualifying interests.

1770 This finding is in relation to potential impacts associated with the Proposed Development during construction, decommissioning and operation and maintenance, acting alone and or in-combination.

8 CONCLUSION OF THE ASSESSMENT

1771 A summary of the assessment presented in this Part Two of the RIAA, considering SACs, is provided below and in Table 8.1. Table 8.1 presents the conclusions of Adverse Effects on Integrity in relation to the Proposed Development alone and in-combination with other plans and projects.

Berwickshire and North Northumberland Coast SAC

1772 Based on the information presented in sections 5 and 7, no Adverse Effect on Integrity on the Berwickshire and North Northumberland Coast SAC, with specific regard to the qualifying Annex I habitats and Annex II marine mammals for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

Tweed Estuary SAC

1773 Based on the information presented in section 6, no Adverse Effect on Integrity on the Tweed Estaury SAC, with specific regard to the qualifying Annex II diadromous fish for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

River Tweed SAC

1774 Based on the information presented in section 6, no Adverse Effect on Integrity on the River Tweed SAC, with specific regard to the qualifying Annex II diadromous fish for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

River South Esk SAC

1775 Based on the information presented in section 6, no Adverse Effect on Integrity on the River Tweed SAC, with specific regard to the qualifying Annex II diadromous fish, and dependant qualifying species (i.e. freshwater pearl mussel), for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

River Tay SAC

1776 Based on the information presented in section 6, no Adverse Effect on Integrity on the River Tay SAC, with specific regard to the qualifying Annex II diadromous fish for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

River Dee SAC

1777 Based on the information presented in section 6, no Adverse Effect on Integrity on the River Dee SAC, with specific regard to the qualifying Annex II diadromous fish, and dependant qualifying species (i.e. freshwater pearl mussel), for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

River Tay SAC

1778 Based on the information presented in section 6, no Adverse Effect on Integrity on the River Teith SAC, with specific regard to the qualifying Annex II diadromous fish for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

Isle of May SAC

1779 Based on the information presented in section 7, no Adverse Effect on Integrity on the Isle of May SAC, with specific regard to the qualifying Annex II marine mammals for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

Firth of Tay and Eden Estuary SAC

1780 Based on the information presented in section 7, no Adverse Effect on Integrity on the Firth of Tay and Eden Estuary SAC, with specific regard to the qualifying Annex II marine mammals for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

Southern North Sea SAC

1781 Based on the information presented in section 7, no Adverse Effect on Integrity on the Southern North Sea SAC, with specific regard to the qualifying Annex II marine mammals for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

Moray Firth SAC

1782 Based on the information presented in section 7, no Adverse Effect on Integrity on the Southern North Sea SAC, with specific regard to the qualifying Annex II marine mammals for which LSE could not be excluded, is predicted as a result of the Proposed Development, either alone or in-combination with other plans and projects.

Table 8.1: Summary of Conclusions of Adverse Effect on Integrity for SACs

Site	Feature	Likely Significant Effect	Phase			Conclusions – Proposed Development Alone	Conclusions – Proposed Development In-combination with Other Projects
			C	O	D		
Berwickshire and North Northumberland Coast SAC	Mudflats and sandflats not covered by seawater at low tide Large shallow inlets and bays Reefs Submerged or partially submerged seacaves	Increased suspended sediment concentrations and associated sediment deposition (Proposed Development export cable corridor only)	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Alteration of seabed habitats arising from effects of physical processes	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
Tweed Estuary SAC	Sea lamprey River lamprey	Injury and/or disturbance from underwater noise	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Increased suspended sediment concentrations and associated sediment deposition	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		EMF from subsea electrical cabling	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Colonisation of foundations, scour protection and cable protection	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
River Tweed SAC	Sea lamprey River lamprey Atlantic salmon	Injury and/or disturbance from underwater noise	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Increased suspended sediment concentrations and associated sediment deposition	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		EMF from subsea electrical cabling	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Colonisation of foundations, scour protection and cable protection	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
River South Esk SAC	Atlantic salmon	Injury and/or disturbance from underwater noise	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Increased suspended sediment concentrations and associated sediment deposition	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		EMF from subsea electrical cabling	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Colonisation of foundations, scour protection and cable protection	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
	Freshwater pearl mussel	Indirect effects via host species (Atlantic salmon)	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
River Tay SAC	Sea lamprey	Injury and/or disturbance from underwater noise	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site

	River lamprey Atlantic salmon	Increased suspended sediment concentrations and associated sediment deposition	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		EMF from subsea electrical cabling	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Colonisation of foundations, scour protection and cable protection	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
River Dee SAC	Atlantic salmon	Injury and/or disturbance from underwater noise	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Increased suspended sediment concentrations and associated sediment deposition	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		EMF from subsea electrical cabling	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Colonisation of foundations, scour protection and cable protection	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
	Freshwater pearl mussel	Indirect effects via host species (Atlantic salmon)	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
River Teith SAC	Sea lamprey River lamprey Atlantic salmon	Injury and/or disturbance from underwater noise	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Increased suspended sediment concentrations and associated sediment deposition	✓	×	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		EMF from subsea electrical cabling	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Colonisation of foundations, scour protection and cable protection	×	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
Berwickshire and North Northumberland Coast SAC	Grey seal	Injury and disturbance from elevated underwater noise during piling	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	✓	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
Isle of May SAC	Grey seal	Injury and disturbance from elevated underwater noise during piling	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	✓	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site

		Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
Firth of Tay and Eden Estuary SAC	Harbour seal	Injury and disturbance from elevated underwater noise during piling	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	✓	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
Southern North Sea SAC	Harbour porpoise	Injury and disturbance from elevated underwater noise during piling	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	✓	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
Moray Firth SAC	Bottlenose dolphin	Injury and disturbance from elevated underwater noise during piling	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys	✓	✓	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance	✓	×	×	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site
		Changes in fish and shellfish communities affecting prey availability	✓	✓	✓	No Adverse Effect on Integrity of the site	No Adverse Effect on Integrity of the site

9 INTEGRITY MATRICES

1783 This section presents the HRA integrity matrices for the Proposed Development and summarises the information presented in Part Two of the RIAA for SACs. Section 9.1 presents the integrity matrices for SACs designated for Annex I (coastal and subtidal) habitats, section 9.2 presents the integrity matrices for SACs designated for Annex II diadromous fish and section 9.3 presents the integrity matrices for SACs designated for Annex II marine mammals.

9.1 INTEGRITY MATRICES FOR SITES DESIGNATED FOR ANNEX I HABITATS

Table 9.1: Integrity Matrix for Annex I Habitats of the Berwickshire and North Northumberland Coast SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Increases in SSC and Associated Sediment Deposition			Alteration of Seabed Habitats Arising from Effects of Physical Processes			In-combination effects		
	C	O	D	C	O	D	C	O	D
Mudflats and sandflats not covered by seawater at low tide	×a	×b	×a		×c		×d	×d	×d
Large shallow inlets and bays	×a	×b	×a		×c		×d	×d	×d
Reefs	×a	×b	×a		×c		×d	×d	×d
Submerged or partially submerged sea caves	×a	×b	×a		×c		×d	×d	×d

a: **Increases in SSC and sediment deposition** – the Berwickshire and North Northumberland Coast SAC is located 4.1 km from the Proposed Development export cable corridor at the closest point, therefore the effects resulting from changes to water quality and light smothering and siltation rate change, arising from pre-installation sand wave clearance and installation of the offshore export cables, are likely to be reduced due to dilution. Additionally, the qualifying Annex I habitats mudflats and sandflats not covered by seawater at low tide, and large shallow inlets and bays are concentrated in the English part of the SAC beyond the limit of the predicted maximum extent (10 km) for fine sediment. Sedimentation at the coastline is predicted to be low and typically <3 mm. Suspended sediment concentrations are predicted to reduce to background levels on slack tides. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II habitat qualifying interest features of the site during the construction and decommissioning phases.

b: **Increases in SSC and sediment deposition** – the impact of increased SSC and associated sediment deposition resulting from offshore export cable maintenance activities will be the same or less than those predicted for construction and decommissioning. Additionally, the qualifying Annex I habitats mudflats and sandflats not covered by seawater at low tide, and large shallow inlets and bays are concentrated in the English part of the SAC beyond the limit of the predicted maximum extent (10 km) for fines. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II habitat qualifying interest features of the site during the operation and maintenance phase.

c: **Changes in Physical Processes** – modelling has demonstrated that effects on tidal flows will not reach the Berwickshire and North Northumberland Coast SAC. Any impacts on tidal flow and wave climate are predicted to be localised around the array structures. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II habitat qualifying interest features of the site during the operation and maintenance phase.

d: **In-combination** – the in-combination assessment considered the potential for increases in SSC and associated sediment deposition, and alteration of seabed habitats arising from effects of physical processes, arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. Any increases in SSC from these projects are unlikely to interact or be of negligible magnitude and changes in physical processes are within the immediate vicinity of each of the developments and it is not expected that there would be changes to the far field sediment regimes. It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II habitat qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

9.2 INTEGRITY MATRICES FOR SITE DESIGNATED FOR ANNEX II DIADROMOUS FISH

Table 9.2: Integrity Matrix for Annex II Diadromous Fish Species of the Tweed Estuary SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and/or Disturbance from Underwater Noise			SSC and Associated Sediment Deposition			EMF from Subsea Electrical Cabling			Colonisation of Foundations, Scour Protection and Cable Protection			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Sea lamprey (*Petromyzon marinus*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
River lamprey (*Lampetra fluviatilis*)	×a		×a	×b		×b		×c			×d		×e	×e	×e

a: **Injury and/or disturbance from underwater noise** – For peak pressure noise levels when piling energy is at its maximum (i.e.4,000 kJ), mortal injury and recoverable injury ranges for sea lamprey and river lamprey may occur within approximately 138 m of the piling. For cumulative SEL, injury ranges calculated for piling activities indicate that, with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels. Thresholds for mortality and recoverable injury for sea lamprey and river lamprey for both the maximum energy scenario and realistic hammer energy scenario were not exceeded. During UXO clearance, mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. In the event of a high-order detonation event mortality would occur within 410-680 m of the noise source. The use of soft start piling procedures, allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on sea lamprey and river lamprey. Behavioural impacts, whilst expected over a larger range, are unlikely to cause a barrier to the migration routes of sea lamprey along the east coast of Scotland. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning phases as a result of underwater noise.

b: **SSC and associated sediment deposition** – modelling has indicated that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development. As such, no barriers to the migratory patterns of sea lamprey are expected. River lamprey have a preference for estuarine waters, so it is unlikely that this species lamprey will interact with SSC and sediment deposition arising from the construction and decommissioning of the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning phases as a result of SSC and associated sediment deposition.

c: **EMF** – emission of localised EMFs from the operation of cables could potentially interfere with the navigation of diadromous fish species. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables. Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient. Given river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with cables associated with the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the operation and maintenance phases as a result of EMF.

d: **Colonisation of foundations, scour protection and cable protection** – colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species. Sea lamprey are parasitic in their marine phase, feeding off larger fish and marine mammals, so it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected. Given river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the operation and maintenance phases as a result of colonisation of structures.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise, increases in SSC and associated sediment deposition, EMF and colonisation of structures arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and other projects. In-combination effects as a result of increased SSC and sediment deposition during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the fact that activities associated with other projects would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development. In-combination effects as a result of colonisation of hard structures during the operation of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone as diadromous fish spend little time in coastal waters, they are unlikely to utilise the increase in hard substrate for feeding or shelter opportunities, and are therefore at low risk from increased predation, It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.3: Integrity Matrix for Annex II Diadromous Fish Species of the River Tweed SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and/or Disturbance from Underwater Noise			SSC and Associated Sediment Deposition			EMF from Subsea Electrical Cabling			Colonisation of Foundations, Scour Protection and Cable Protection			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Atlantic salmon (*Salmo salar*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
Sea lamprey (*Petromyzon marinus*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
River lamprey (*Lampetra fluviatilis*)	×a		×a	×b		×b		×c			×d		×e	×e	×e

a: **Injury and/or disturbance from underwater noise** – For peak pressure noise levels when piling energy is at its maximum (i.e.4,000 kJ), mortal injury and recoverable injury ranges for sea lamprey and river lamprey may occur within approximately 138 m of the piling and within 228 m for Atlantic salmon. For cumulative SEL, injury ranges calculated for piling activities indicate that, with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels. Thresholds for mortality and recoverable injury for sea lamprey and river lamprey for both the maximum energy scenario and realistic hammer energy scenario were not exceeded and were predicted to extent to 19 m for Atlantic salmon with a recoverable injury range of 67 m under the maximum energy scenario. TTS, from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Atlantic salmon, sea lamprey and river lamprey. For concurrent piling, TTS ranges for Atlantic salmon, sea lamprey and river lamprey may be increased to up to 7.1 km from the piling location for the maximum energy scenario. During UXO clearance, mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. In the event of a high-order detonation event mortality would occur within 410-680 m of the noise source. The use of soft start piling procedures, allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on Atlantic salmon, sea lamprey and river lamprey. Behavioural impacts, whilst expected over a larger range, are unlikely to cause a barrier to the migration routes of Atlantic salmon or sea lamprey along the east coast of Scotland. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning phases as a result of underwater noise.

b: **SSC and associated sediment deposition** – modelling has indicated that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon and sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development. As such, no barriers to the migratory patterns of Atlantic salmon or sea lamprey are expected. River lamprey have a preference for estuarine waters, so it is unlikely that this species lamprey will interact with SSC and sediment deposition arising from the construction and decommissioning of the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning phases as a result of SSC and associated sediment deposition.

c: **EMF** – emission of localised EMFs from the operation of cables could potentially interfere with the navigation of diadromous fish species. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables. Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient. Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Any changes in salmonid behaviour, will be temporary and will not interfere with migration success or population health. Given river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with cables associated with the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the operation and maintenance phases as a result of EMF.

d: **Colonisation of foundations, scour protection and cable protection** – colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species. Sea lamprey are parasitic in their marine phase, feeding off larger fish and marine mammals, so it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected. Atlantic salmon smolts spend little time in the coastal waters and make their way to feeding grounds in the north quickly. Evidence also suggests that Atlantic salmon tend not to forage in the coastal waters of Scotland so it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators. Given river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the operation and maintenance phases as a result of colonisation of structures.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise, increases in SSC and associated sediment deposition, EMF and colonisation of structures arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and other projects. In-combination effects as a result of increased SSC and sediment deposition during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the fact that activities associated with other projects would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development. In-combination effects as a result of colonisation of hard structures during the operation of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed

Development alone as diadromous fish spend little time in coastal waters, they are unlikely to utilise the increase in hard substrate for feeding or shelter opportunities, and are therefore at low risk from increased predation, It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.4: Integrity Matrix for Annex II Diadromous Fish (and dependent) Species of the River South Esk SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and/or Disturbance from Underwater Noise			SSC and Associated Sediment Deposition			EMF from Subsea Electrical Cabling			Colonisation of Foundations, Scour Protection and Cable Protection			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Atlantic salmon (*Salmo salar*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
Freshwater pearl mussel (*Margaritifera margaritifera*)	×a		×a	×b		×b		×c			×d		×e	×e	×e

a: **Injury and/or disturbance from underwater noise** – For peak pressure noise levels when piling energy is at its maximum (i.e.4,000 kJ), mortal injury and recoverable injury ranges for sea lamprey and river lamprey may occur within approximately 228 m of the piling for Atlantic salmon. For cumulative SEL, injury ranges calculated for piling activities indicate that, with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels. For cumulative SEL, the modelling indicated a mortality range of 19 m and a recoverable injury range of 67 m under the maximum energy scenario for Atlantic salmon). TTS, from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Atlantic salmon from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m) TTS ranges for may be increased to up to 7.1 km from the piling location for the maximum energy scenario. During UXO clearance, mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. In the event of a high-order detonation event mortality would occur within 410-680 m of the noise source. The use of soft start piling procedures, allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on Atlantic salmon. Behavioural impacts, whilst expected over a larger range, are unlikely to cause a barrier to the migration routes of Atlantic salmon along the east coast of Scotland. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the construction and decommissioning phases as a result of underwater noise

b: SSC and associated sediment deposition – modelling has indicated that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development. As such, no barriers to the migratory patterns of Atlantic salmon are expected. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the construction and decommissioning phases as a result of SSC and associated sediment deposition.

c: EMF – emission of localised EMFs from the operation of cables could potentially interfere with the navigation of diadromous fish species. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables. Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Any changes in salmonid behaviour, will be temporary and will not interfere with migration success or population health. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the operation and maintenance phases as a result of EMF.

d: Colonisation of foundations, scour protection and cable protection – colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species. Atlantic salmon smolts spend little time in the coastal waters, and make their way to feeding grounds in the north quickly. Evidence also suggests that Atlantic salmon tend not to forage in the coastal waters of Scotland so it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the operation and maintenance phases as a result of colonisation of structures.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise, increases in SSC and associated sediment deposition, EMF and colonisation of structures arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and other projects. In-combination effects as a result of increased SSC and sediment deposition during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the fact that activities associated with other projects would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development. In-combination effects as a result of colonisation of hard structures during the operation of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone as diadromous fish spend little time in coastal waters, they are unlikely to utilise the increase in hard substrate for feeding or shelter opportunities, and are therefore at low risk from increased predation, It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.5: Integrity Matrix for Annex II Diadromous Fish Species of the River Tay SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and/or Disturbance from Underwater Noise			SSC and Associated Sediment Deposition			EMF from Subsea Electrical Cabling			Colonisation of Foundations, Scour Protection and Cable Protection			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Atlantic salmon (*Salmo salar*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
Sea lamprey (*Petromyzon marinus*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
River lamprey (*Lampetra fluviatilis*)	×a		×a	×b		×b		×c			×d		×e	×e	×e

a: **Injury and/or disturbance from underwater noise** – For peak pressure noise levels when piling energy is at its maximum (i.e.4,000 kJ), mortal injury and recoverable injury ranges for sea lamprey and river lamprey may occur within approximately 138 m of the piling and within 228 m for Atlantic salmon. For cumulative SEL, injury ranges calculated for piling activities indicate that, with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels. Thresholds for mortality and recoverable injury for sea lamprey and river lamprey for both the maximum energy scenario and realistic hammer energy scenario were not exceeded and were predicted to extent to 19 m for Atlantic salmon with a recoverable injury range of 67 m under the maximum energy scenario. TTS, from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Atlantic salmon, sea lamprey and river lamprey. For concurrent piling, TTS ranges for Atlantic salmon, sea lamprey and river lamprey may be increased to up to 7.1 km from the piling location for the maximum energy scenario. During UXO clearance, mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. In the event of a high-order detonation event mortality would occur within 410-680 m of the noise source. The use of soft start piling procedures, allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on Atlantic salmon, sea lamprey and river lamprey. Behavioural impacts, whilst expected over a larger range, are unlikely to cause a barrier to the migration routes of Atlantic salmon or sea lamprey along the east coast of Scotland. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning phases as a result of underwater noise.

b: **SSC and associated sediment deposition** – modelling has indicated that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon and sea lamprey are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development. As such, no barriers to the migratory patterns of Atlantic salmon or sea lamprey are expected. River lamprey have a preference for estuarine waters, so it is unlikely that this species lamprey will interact with SSC and sediment deposition arising from the construction and decommissioning of the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning phases as a result of SSC and associated sediment deposition.

c: **EMF** – emission of localised EMFs from the operation of cables could potentially interfere with the navigation of diadromous fish species. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables. Due to sea lamprey's parasitic nature at sea, attaching to the body of larger, highly mobile species, well above the seafloor also means that they can be expected to rarely be exposed to the EMF at the lowest levels from AC undersea power cables buried in the seafloor. Therefore, any impacts would be localised and transient. Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Any changes in salmonid behaviour, will be temporary and will not interfere with migration success or population health. Given river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with cables associated with the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the operation and maintenance phases as a result of EMF.

d: **Colonisation of foundations, scour protection and cable protection** – colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species. Sea lamprey are parasitic in their marine phase, feeding off larger fish and marine mammals, so it is not expected that they will be particularly attracted to structures associated with offshore wind developments. Sea lamprey that are likely to interact with the Proposed Development are only likely to do so whilst passing through the area during migrations to and from rivers located on the east coast of Scotland. As such significant predation on sea lamprey is not expected. Atlantic salmon smolts spend little time in the coastal waters and make their way to feeding grounds in the north quickly. Evidence also suggests that Atlantic salmon tend not to forage in the coastal waters of Scotland so it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators. Given river lamprey's preference for estuarine waters, it is unlikely that river lamprey will interact with structures associated with the Proposed Development. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the operation and maintenance phases as a result of colonisation of structures.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise, increases in SSC and associated sediment deposition, EMF and colonisation of structures arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and other projects. In-combination effects as a result of increased SSC and sediment deposition during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the fact that activities associated with other projects would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development. In-combination effects as a result of colonisation of hard structures during the operation of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone as diadromous fish spend little time in coastal waters, they are unlikely to utilise the increase in hard substrate for feeding or shelter opportunities, and are therefore at low risk from increased predation, It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.6: Integrity Matrix for Annex II Diadromous Fish (and dependent) Species of the River Dee SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and/or Disturbance from Underwater Noise			SSC and Associated Sediment Deposition			EMF from Subsea Electrical Cabling			Colonisation of Foundations, Scour Protection and Cable Protection			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Atlantic salmon (*Salmo salar*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
Freshwater pearl mussel (*Margaritifera margaritifera*)	×a		×a	×b		×b		×c			×d		×e	×e	×e

a: **Injury and/or disturbance from underwater noise** – For peak pressure noise levels when piling energy is at its maximum (i.e.4,000 kJ), mortal injury and recoverable injury ranges for sea lamprey and river lamprey may occur within approximately 228 m of the piling for Atlantic salmon. For cumulative SEL, injury ranges calculated for piling activities indicate that, with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels. For cumulative SEL, the modelling indicated a mortality range of 19 m and a recoverable injury range of 67 m under the maximum energy scenario for Atlantic salmon). TTS, from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Atlantic salmon from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m) TTS ranges for may be increased to up to 7.1 km from the piling location for the maximum energy scenario. During UXO clearance, mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. In the event of a high-order detonation event mortality would occur within 410-680 m of the noise source. The use of soft start piling procedures, allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on Atlantic salmon. Behavioural impacts, whilst expected over a larger range, are unlikely to cause a barrier to the migration routes of Atlantic salmon along the east coast of Scotland. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the construction and decommissioning phases as a result of underwater noise.

b: SSC and associated sediment deposition – modelling has indicated that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development. As such, no barriers to the migratory patterns of Atlantic salmon are expected. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the construction and decommissioning phases as a result of SSC and associated sediment deposition.

c: EMF – emission of localised EMFs from the operation of cables could potentially interfere with the navigation of diadromous fish species. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables. Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Any changes in salmonid behaviour, will be temporary and will not interfere with migration success or population health. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the operation and maintenance phases as a result of EMF.

d: Colonisation of foundations, scour protection and cable protection – colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species. Atlantic salmon smolts spend little time in the coastal waters and make their way to feeding grounds in the north quickly. Evidence also suggests that Atlantic salmon tend not to forage in the coastal waters of Scotland so it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the operation and maintenance phases as a result of colonisation of structures.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise, increases in SSC and associated sediment deposition, EMF and colonisation of structures arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and other projects. In-combination effects as a result of increased SSC and sediment deposition during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the fact that activities associated with other projects would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development. In-combination effects as a result of colonisation of hard structures during the operation of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone as diadromous fish spend little time in coastal waters, they are unlikely to utilise the increase in hard substrate for feeding or shelter opportunities, and are therefore at low risk from increased predation, It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.7: Integrity Matrix for Annex II Diadromous Fish Species of the River Teith SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and/or Disturbance from Underwater Noise			SSC and Associated Sediment Deposition			EMF from Subsea Electrical Cabling			Colonisation of Foundations, Scour Protection and Cable Protection			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Atlantic salmon (*Salmo salar*)	×a		×a	×b		×b		×c			×d		×e	×e	×e
Freshwater pearl mussel (*Margaritifera margaritifera*)	×a		×a	×b		×b		×c			×d		×e	×e	×e

a: **Injury and/or disturbance from underwater noise** – For peak pressure noise levels when piling energy is at its maximum (i.e.4,000 kJ), mortal injury and recoverable injury ranges for sea lamprey and river lamprey may occur within approximately 228 m of the piling for Atlantic salmon. For cumulative SEL, injury ranges calculated for piling activities indicate that, with the implementation of soft start initiation, the mortality and recoverable injury ranges are considerably smaller than those predicted for peak sound pressure levels. For cumulative SEL, the modelling indicated a mortality range of 19 m and a recoverable injury range of 67 m under the maximum energy scenario for Atlantic salmon). TTS, from which animals will recover, was predicted to occur out to a maximum range of 4,161 m for Atlantic salmon from piling operations. For concurrent piling, whilst mortality and recoverable injury ranges were unchanged (i.e. 228 m) TTS ranges for may be increased to up to 7.1 km from the piling location for the maximum energy scenario. During UXO clearance, mortality/mortal injury for all fish would occur within a range of 30-45 m from the source following low order detonation. In the event of a high-order detonation event mortality would occur within 410-680 m of the noise source. The use of soft start piling procedures, allowing individuals in close proximity to piling to flee the ensonified area, further reduces the likelihood of injury and mortality on Atlantic salmon. Behavioural impacts, whilst expected over a larger range, are unlikely to cause a barrier to the migration routes of Atlantic salmon along the east coast of Scotland. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the construction and decommissioning phases as a result of underwater noise.

b: SSC and associated sediment deposition – modelling has indicated that increases in SSC are predicted to be temporary, short-lived and at levels well below those naturally experienced in estuarine environments. Additionally, Atlantic salmon are expected to have some tolerance to naturally high SSC, given their migration routes typically pass through estuarine habitats which have background SSC which are considerably higher than those expected in the offshore areas of the Proposed Development. As such, no barriers to the migratory patterns of Atlantic salmon are expected. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the construction and decommissioning phases as a result of SSC and associated sediment deposition.

c: EMF – emission of localised EMFs from the operation of cables could potentially interfere with the navigation of diadromous fish species. However, the limited available evidence suggests that disturbance to sea lamprey from EMF occurs at intensities considerably higher than those expected from AC subsea cables. Given that Atlantic salmon is a pelagic species, it is unlikely to swim at depths sufficient to detect levels of EMF that would cause behavioural changes during migration. Any changes in salmonid behaviour, will be temporary and will not interfere with migration success or population health. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the operation and maintenance phases as a result of EMF.

d: Colonisation of foundations, scour protection and cable protection – colonisation of foundations, scour protection and cable protection, has the potential to result in increased predation on diadromous fish species by marine mammal species. Atlantic salmon smolts spend little time in the coastal waters and make their way to feeding grounds in the north quickly. Evidence also suggests that Atlantic salmon tend not to forage in the coastal waters of Scotland so it is unlikely that they will spend time foraging around wind turbine foundations and therefore are at low risk of impact from increased predation from seals and other predators. Adult freshwater pearl mussel are confined to freshwater habitats, so there is no pathway for direct effects to this species during construction and decommissioning as a result of underwater noise impacts. Indirect adverse effects on the larval stage of freshwater pearl mussel are not predicted on the basis of the absence of adverse effects on individual salmon host species. As such, it is concluded that there is no potential for Adverse Effects on Integrity on the Annex II diadromous fish qualifying interest feature of the site, or the freshwater pearl mussel qualifying interest feature, during the operation and maintenance phases as a result of colonisation of structures.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise, increases in SSC and associated sediment deposition, EMF and colonisation of structures arising from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects as a result of injury and/or disturbance from underwater noise and vibration during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the limited range over which injury effects may occur due to piling activities (i.e. tens to hundreds of metres), mitigation to minimise the potential for injury and the minor overlap in construction phases of the Proposed Development and other projects. In-combination effects as a result of increased SSC and sediment deposition during the construction phase of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone due to the fact that activities associated with other projects would be of limited spatial extent and frequency and unlikely to interact with sediment plumes from the Proposed Development. In-combination effects as a result of colonisation of hard structures during the operation of the Proposed Development in-combination with other projects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone as diadromous fish spend little time in coastal waters, they are unlikely to utilise the increase in hard substrate for feeding or shelter opportunities, and are therefore at low risk from increased predation, It is therefore concluded that there is no potential for Adverse Effects on Integrity on Annex II diadromous fish qualifying interest features of the site during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

9.3 INTEGRITY MATRICES FOR SITES DESIGNATED FOR ANNEX II MARINE MAMMALS

Table 9.8: Integrity Matrix for Annex II Marine Mammal Species of the Berwickshire and North Northumberland Coast SAC

× - no Adverse Effect on Integrity

✓ - Potential Adverse Effects on Integrity

European Site Qualifying Interest Features	Injury and Disturbance from Elevated Underwater Noise During Piling			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During Site Investigation Surveys			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During UXO Clearance			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise due to Vessel Use and Other Activities			Changes in Fish and Shellfish Communities Affecting Prey Availability			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Grey seal	×a			×b	×b		×c			×d	×d	×d	×e	×e	×e	×f	×f	×f

a: **Injury and disturbance from elevated underwater noise during piling** – The maximum range for injury to grey seal as a result of underwater noise due to piling was estimated as 118 m. However, with application of designed in measures, including visual and acoustic monitoring as well as secondary measures (the use of ADD), risk of injury to grey seal will be reduced to negligible. In terms of behavioural disturbance, a maximum of 532 animals from Berwickshire and North Northumberland SAC could potentially experience mild disturbance or barrier effects within the foraging range from the SAC. However, there will be no overlap of noise disturbance contours with important breeding areas within this SAC (Farne Islands) and therefore piling activities are highly unlikely to disrupt normal behaviours of grey seals or negatively affect maintenance of the supporting habitats within the site. During piling, there is the potential for some animals to be temporarily deterred from the offshore areas. Grey seals although initially displaced due to pile-driving, are likely to return to the same area on subsequent trips following cessation of piling and therefore it is anticipated that piling will not result in any long-lasting changes in the distribution of adult seals from this SAC and the connectivity with areas of high importance within and outside the site is not expected to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction phase as a result of underwater noise during piling.

b: **Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys** – The maximum range for injury to grey seal as a result of underwater noise during site-investigation surveys was estimated as 65 m, however, with application of designed in measures, risk of injury to grey seal will be reduced to negligible. In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting grey seal is out to approximately 7.5 km during vibro-coring. The surveys will take place over a period of up to three months during the construction phase and routinely over 35 year life cycle of project. Although there is a potential for grey seal to experience behavioural disturbance during the site-investigation surveys (mainly in areas outside of the SAC), the surveys are expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Underwater noise during site investigation surveys is unlikely to affect grey seal from Berwickshire and North Northumberland SAC at a level that would substantially affect their behaviour and cause change in reproduction and survival rates. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction and operation phases as a result of underwater noise during site investigation surveys.

c: **Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance** – The maximum range for injury to grey seal as a result of underwater noise due to UXO clearance was estimated as 2,085 m due to detonation of charge size of 300 kg, however, with application of designed in as well as secondary measures (including the use of ADD), risk of injury to grey seal will be reduced to low. In terms of fleeing response, up to 156 animals were predicted at risk to experience TTS at a maximum range of 6,430 m due to detonation of charge size of 300 kg. Although high-order detonation is assessed as a maximum design scenario, low order techniques will be applied as the intended methodology for clearance of UXO. Underwater noise modelling predicted that grey seal can potentially experience TTS at the maximum range of 455 m due to detonation of 0.5 kg clearance shot following low order clearance with up to one grey seal potentially affected. TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Therefore, effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from Berwickshire and North Northumberland Coast SAC. Given that this effect is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction phase as a result of underwater noise during UXO clearance.

d: **Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities** – The threshold for injury is not exceeded by any vessel with the exception of rock placement vessel, for which an injury range of 5 m from the source was reported. With regard to behavioural disturbance to grey seals, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m. Grey seal is likely to be sensitive to disturbance from vessel traffic, however, most of the vessel traffic associated with construction and decommissioning will take place within the Proposed Development array area and Proposed Development export cable corridor, at a distance where overlap of noise disturbance contours with the southern half of the SAC (an important breeding site) is unlikely. Construction and decommissioning activities will be carried out over a medium term. Operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years), however, only a small proportion of vessel use and other activities will occur at any one time. Since the behavioural effect is considered to be highly reversible, it is highly unlikely that it will influence grey seal population trajectory in the long-term. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction, operation and maintenance and decommissioning phases as a result of underwater noise due to vessel noise and other activities.

e: **Changes in fish and shellfish communities affecting prey availability** – Changes to the prey species may occur due to temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration. However, given that the impacts will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. It is expected that grey seal population would be able to tolerate the effect without any impact on reproduction and survival rates. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction, operation and maintenance and decommissioning phases as a result of changes in fish and shellfish communities affecting prey availability.

f: **In-combination** – the in-combination assessment considered the potential for underwater noise during piling, UXO clearance, site-investigation surveys, vessel use and other activities and changes in fish and shellfish communities affecting prey availability from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

It is therefore concluded that there is no potential for Adverse Effects on Integrity on the Annex II marine mammal qualifying interest feature of the site, grey seal, during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.9: Integrity Matrix for Annex II Marine Mammal Species of the Isle of May SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and Disturbance from Elevated Underwater Noise During Piling			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During Site Investigation Surveys			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During UXO Clearance			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise due to Vessel Use and Other Activities			Changes in Fish and Shellfish Communities Affecting Prey Availability			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Grey seal	×a			×b	×b		×c			×d	×d	×d	×e	×e	×e	×f	×f	×f

a: **Injury and disturbance from elevated underwater noise during piling** – The maximum range for injury to grey seal as a result of underwater noise due to piling was estimated as 118 m. However, with application of designed in measures, including visual and acoustic monitoring as well as secondary measures (use of ADD), risk of injury to grey seal will be reduced to negligible. In terms of behavioural disturbance, a maximum of 18 animals from Isle of May SAC could potentially experience mild disturbance. However, the behavioural disturbance contours do not reach the coast and hence do not overlap with the Isle of May SAC. Therefore, grey seals present within the SAC are unlikely to experience disturbance and piling activities are highly unlikely to disrupt normal behaviours of grey seals or adversely affect maintaining supporting habitats within the site. During piling, there is the potential for some animals to be temporarily deterred from the offshore areas. Grey seals although initially displaced due to pile-driving, are likely to return to the same area on subsequent trips following cessation of piling and therefore it is anticipated that piling will not result in any long-lasting changes in the distribution of adult seals from this SAC and the connectivity with areas of high importance within and outside the site is not expected to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction phase as a result of underwater noise during piling.

b: **Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys** – The maximum range for injury to grey seal as a result of underwater noise during site-investigation surveys was estimated as 65 m, however, with application of designed in measures, risk of injury to grey seal will be reduced to negligible. In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting grey seal is out to approximately 7.5 km during vibro-coring. Due to the distance from the Isle of May SAC, the overlap of behavioural disturbance ranges with site boundaries is unlikely. The surveys will take place over a period of up to three months during the construction phase and routinely over 35 year life cycle of project. Although there is a potential for grey seal to experience behavioural disturbance during the site-investigation surveys (outside of the SAC), the surveys expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Underwater noise during site investigation surveys is unlikely to affect grey seal from Isle of May SAC at a level that would substantially affect their behaviour and cause change in reproduction and survival rates. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction and operation phases as a result of underwater noise during site investigation surveys.

c: **Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance** – The maximum range for injury to grey seal as a result of underwater noise due to UXO clearance was estimated as 2,085 m due to detonation of charge size of 300 kg, however, with application of designed in as well as secondary measures (including the use of ADD), risk of injury to grey seal will be reduced to low. In terms of fleeing response, up to 156 animals were predicted at risk to experience TTS at a maximum range of 6,430 m due to detonation of charge size of 300 kg. Although high-order detonation is assessed as a maximum design scenario, low order techniques will be applied as the intended methodology for clearance of UXO. Underwater noise modelling predicted that grey seal can potentially experience TTS at the maximum range of 455 m due to detonation of 0.5 kg clearance shot following low order clearance with up to one grey seal potentially affected. TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Therefore, effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from the Isle of May SAC. Given that this effect is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction phase as a result of underwater noise during UXO clearance.

d: **Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities** – The threshold for injury is not exceeded by any vessel with the exception of rock placement vessels, for which an injury range of 5 m from the source was reported. With regard to behavioural disturbance to grey seals, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m. Grey seal is likely to be sensitive to disturbance from vessel traffic, however, most of the vessel traffic associated with construction and decommissioning will take place within the Proposed Development array area and Proposed Development export cable corridor and the overlap of noise disturbance contours with the boundaries of the Isle of May SAC is unlikely. Construction and decommissioning activities will be carried out over a medium term. Operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years), however, only a small proportion of vessel use and other activities will occur at any one time. Since the behavioural effect is considered to be highly reversible, it is highly unlikely that it will influence grey seal population trajectory in the long-term. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction, operation and maintenance and decommissioning phases as a result of underwater noise due to vessel noise and other activities.

e: **Changes in fish and shellfish communities affecting prey availability** – Changes to the prey species may occur due to temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration. However, given that the impacts will be highly localised and largely restricted to the boundaries of the Proposed Development, only a small area will be affected when compared to available foraging habitat for grey seals in the northern North Sea. It is expected that grey seal population would be able to tolerate the effect without any impact on reproduction and survival rates. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, grey seal, during the construction, operation and maintenance and decommissioning phases as a result of changes in fish and shellfish communities affecting prey availability.

f: **In-combination** – the in-combination assessment considered the potential for underwater noise during piling, UXO clearance, site-investigation surveys, vessel use and other activities and changes in fish and shellfish communities affecting prey availability from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone. It is therefore concluded that there is no potential for Adverse Effects on Integrity on the Annex II marine mammal qualifying interest feature of the site, grey seal, during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.10: Integrity Matrix for Annex II Marine Mammal Species of the Firth of Tay and Eden Estuary SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effects on Integrity

European Site Qualifying Interest Features	Injury and Disturbance from Elevated Underwater Noise During Piling			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During Site Investigation Surveys			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During UXO Clearance			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise due to Vessel Use and Other Activities			Changes in Fish and Shellfish Communities Affecting Prey Availability			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Harbour seal	×a			×b	×b		×c			×d	×d	×d	×e	×e	×e	×f	×f	×f

a: **Injury and disturbance from elevated underwater noise during piling** – The maximum range for injury to harbour seal as a result of underwater noise due to piling was estimated as 118 m. However, with application of designed in measures, including visual and acoustic monitoring as well as secondary measures (the use of ADD), risk of injury to grey seal will be reduced to negligible. In terms of behavioural disturbance, a maximum of three animals could be potentially affected. The population of harbour seals in Firth of Tay and Eden Estuary SAC is known to be in decline since the early 2000s and therefore this population is deemed sensitive to any additional anthropogenic disturbance, especially during the breeding season. The outer behavioural disturbance noise contours as a result of piling do not overlap with Firth of Tay and Eden Estuary SAC. Harbour seal in inshore waters could experience mild disturbance where these areas overlap with 135 dB disturbance contour, but prolonged or sustained behavioural effects, including displacement, are unlikely to occur. During piling, there is the potential for some animals to be temporarily deterred from the offshore areas. Harbour seals although initially displaced due to pile-driving, are likely to return to the same area on subsequent trips following cessation of piling and therefore it is anticipated that the connectivity with areas of high importance within and outside the site will not be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour seal, during the construction phase as a result of underwater noise during piling.

b: **Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys** – The maximum range for injury to harbour seal as a result of underwater noise during site-investigation surveys was estimated as 65 m, however, with application of designed in measures, risk of injury to harbour seal will be reduced to negligible. In terms of behavioural disturbance, the largest distance over which disturbance could occur is out to approximately 7.5 km during vibro-coring. Due to the distance from the Firth of Tay and Eden Estuary SAC, the overlap of behavioural disturbance ranges with site boundaries is unlikely. The surveys will take place over a period of up to three months during the construction phase and routinely over 35 year life cycle of project. Although there is a potential for harbour seal to experience behavioural disturbance during the vibro-core survey (outside of the SAC), the surveys are expected to be very short in duration with animals returning to baseline levels soon after surveys have ceased. Underwater noise during site investigation surveys is unlikely to affect harbour seal from Firth of Tay and Eden Estuary SAC at a level that would substantially affect their behaviour and cause change in reproduction and survival rates. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour seal, during the construction and operation phases as a result of underwater noise during site investigation surveys.

c: **Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance** – The maximum range for injury to harbour seal as a result of underwater noise due to UXO clearance was estimated as 2,085 m due to detonation of charge size of 300 kg, however, with application of designed in as well as secondary measures (including the use of ADD), risk of injury to grey seal will be reduced to low. In terms of behavioural disturbance, up to one animal was predicted at risk to experience TTS at a maximum range of 6,430 m due to detonation of charge size of 300 kg. Although high-order detonation is assessed as a maximum design scenario, low order techniques will be applied as the intended methodology for clearance of UXO and as a result the impact range will be reduced to 455 m due to detonation of 0.5 kg clearance shot following low order clearance. TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Therefore, effects caused by UXO clearance are considered unlikely to cause a change in reproduction and survival rates or alteration in the distribution of the population from the Firth of Tay and Eden Estuary SAC. Given that this effect is short in duration, connectivity with important habitats within and outside the site is also unlikely to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour seal, during the construction phase as a result of underwater noise during UXO clearance.

d: **Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities** – The threshold for injury is not exceeded by any vessel with the exception of rock placement vessels, for which an injury range of 5 m from the source was reported. With regard to behavioural disturbance to harbour seals, cable laying activities result in the greatest modelled disturbance ranges out to 4,389 m. Harbour seal is likely to be sensitive to disturbance from vessel traffic, however, most of the vessel traffic associated with construction and decommissioning will take place within the Proposed Development array area and Proposed Development export cable corridor and the overlap of noise disturbance contours with the boundaries of the Firth of Tay and Eden Estuary SAC is unlikely. Construction and decommissioning activities will be carried out over a medium term. Operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years), however, only a small proportion of vessel use and other activities will occur at any one time. Since the behavioural effect is considered to be highly reversible, it is highly unlikely that it will influence harbour seal population trajectory in the long-term. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour seal, during the construction, operation and maintenance and decommissioning phases as a result of underwater noise due to vessel noise and other activities.

e: **Changes in fish and shellfish communities affecting prey availability** – Changes to the prey species may occur due to temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration. The impacts will be highly localised and largely restricted to the boundaries of the Proposed Development. Areas within the Proposed Development array area and Proposed Development export cable corridor are not characterised by high densities of harbour seal telemetry tracks and therefore these areas are highly unlikely to represent important foraging grounds for this species. However, for these individuals visiting Proposed Development to find prey, it is expected that harbour seal could come back to forage within areas previously disturbed after cessation of works and therefore their distribution and connectivity with important habitats within and outside the site is unlikely to be impaired in long term. It is expected that harbour seal population would be able to tolerate the effect without any impact on reproduction and survival rates. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour seal, during the construction, operation and maintenance and decommissioning phases as a result of changes in fish and shellfish communities affecting prey availability.

f: **In-combination** – the in-combination assessment considered the potential for underwater noise during piling, UXO clearance, site-investigation surveys, vessel use and other activities and changes in fish and shellfish communities affecting prey availability from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone.

It is therefore concluded that there is no potential for Adverse Effects on Integrity on the Annex II marine mammal qualifying interest feature of the site, harbour seal, during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.11: Integrity Matrix for Annex II Marine Mammal Species of the Southern North Sea SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effects on Integrity

European Site Qualifying Interest Features	Injury and Disturbance from Elevated Underwater Noise During Piling			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During Site Investigation Surveys			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During UXO Clearance			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise due to Vessel Use and Other Activities			Changes in Fish and Shellfish Communities Affecting Prey Availability			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Harbour porpoise	×a			×b	×b		×c						×d	×d	×d	×e	×e	×e

a: **Injury and disturbance from elevated underwater noise during piling** – The maximum range for injury to harbour porpoise as a result of underwater noise due to piling was estimated as 449 m. However, with application of designed in measures, including visual and acoustic monitoring as well as secondary measures (the use of ADD), risk of injury to harbour porpoise will be reduced to negligible. There will be no overlap of noise disturbance contours with the Southern North Sea SAC, however, there is a potential for individuals from this SAC to be present within noise disturbance contours with up to 2,822 animals potentially affected. However, considering the distance from the Proposed Development to the SAC, it is a highly precautionary assumption that 100% of disturbed animals will come from this SAC. The Firth of Forth and Tay area is unlikely to represent important breeding or foraging habitat for harbour porpoise that would not be available elsewhere within the species' home range over the North Sea. If individuals are deterred from the foraging grounds in the vicinity of the Proposed Development, it can be anticipated that harbour porpoise can compensate for any resulting loss in energy intake by increasing foraging activities beyond impact zone. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour porpoise, during the construction phase as a result of underwater noise during piling.

b: **Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys** – The maximum range for injury to harbour porpoise as a result of underwater noise during site-investigation surveys was estimated as 360 m, however, with application of designed in measures, risk of injury to harbour porpoise will be reduced to negligible. In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting harbour porpoise is out to approximately 7.5 km during vibro-coring. Site investigation surveys are expected to be short in duration with animals returning to baseline levels soon after surveys have ceased. Site investigation activities will not take place within or nearby to the SAC and therefore will not exclude harbour porpoise from relevant proportion from the SAC. It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on Southern North Sea SAC population can be considered long term. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour porpoise, during the construction and operation phases as a result of underwater noise during site investigation surveys.

c: **Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance** – The maximum range for injury to harbour porpoise as a result of underwater noise due to UXO clearance was estimated as 10,630 m due to detonation of charge size of 300 kg. Given that there is a potential to experience auditory injury by nominal number of individuals at a greater range than can be mitigated by application of an ADD and soft-start charges, prior to the commencement of UXO clearance works, a more detailed assessment will be produced as a part of the EPS licence supporting information for the UXO clearance works. Appropriate mitigation measures will be agreed with stakeholders as a part of a UXO specific MMMP. In terms of behavioural disturbance, animals were predicted at risk to experience TTS at a maximum range of 19 km due to detonation of charge size of 300 kg. UXO clearance activities will not take place within or nearby to the Southern North Sea SAC and therefore will not exclude harbour porpoise from the relevant area of the site up to the threshold limit (20% in any given day or 10% over a season). It will not alter the distribution of harbour porpoise such that recovery cannot be expected or effects on Southern North Sea SAC population can be considered long term. Additionally, TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour porpoise, during the construction phase as a result of underwater noise during UXO clearance.

d: **Changes in fish and shellfish communities affecting prey availability** – Changes to the prey species may occur due to temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration. The impacts will be highly localised and restricted to the boundaries of the Proposed Development. Firth of Forth and Tay area is unlikely to represent important breeding or foraging habitat that would not be available elsewhere within the species home range over the North Sea. It is therefore anticipated that the availability of suitable foraging grounds for harbour porpoise will not be impaired and availability of prey will be maintained within the wider distributional range. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, harbour porpoise, during the construction, operation and maintenance and decommissioning phases as a result of changes in fish and shellfish communities affecting prey availability.

e: **In-combination** – the in-combination assessment considered the potential for underwater noise during piling, UXO clearance, site-investigation surveys, vessel use and other activities and changes in fish and shellfish communities affecting prey availability from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone. It is therefore concluded that there is no potential for Adverse Effects on Integrity on the Annex II marine mammal qualifying interest feature of the site, harbour porpoise, during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

Table 9.12: Integrity Matrix for Annex II Marine Mammal Species of the Moray Firth SAC

× - no Adverse Effect on Integrity

✓ - Adverse Effect on Integrity

European Site Qualifying Interest Features	Injury and Disturbance from Elevated Underwater Noise During Piling			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During Site Investigation Surveys			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise During UXO Clearance			Injury and Disturbance to Marine Mammals from Elevated Underwater Noise due to Vessel Use and Other Activities			Changes in Fish and Shellfish Communities Affecting Prey Availability			In-combination Effects		
	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D	C	O	D
Bottlenose dolphin	×a			×b	×b		×d			×d	×d	×d	×e	×e	×e	×f	×f	×f

a: **Injury and disturbance from elevated underwater noise during piling** – The maximum range for injury to bottlenose dolphin as a result of underwater noise due to piling was estimated as 43 m. However, with application of designed in measures, including visual and acoustic monitoring as well as secondary measures (including the use of ADD), risk of injury to bottlenose dolphin will be reduced to negligible. There is no potential for overlap of noise disturbance contours with this designated site, however, noise contours have the potential to overlap with the main distributional range of its population. Up to five animals from the Moray Firth SAC population could experience mild disturbance but this is unlikely to lead to barrier effects as animals are unlikely to be excluded from the coastal areas. Therefore, behavioural disturbance is unlikely to alter the distribution of bottlenose dolphin such that recovery cannot be expected or effects can be considered long term. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, bottlenose dolphin, during the construction phase as a result of underwater noise during piling.

b: **Injury and disturbance to marine mammals from elevated underwater noise during site investigation surveys** – The maximum range for injury to bottlenose dolphin as a result of underwater noise during site-investigation surveys was estimated as 65 m, however, with application of designed in measures, risk of injury to bottlenose dolphin will be reduced to negligible. In terms of behavioural disturbance, the largest distance over which disturbance could occur potentially affecting bottlenose dolphin is out to approximately 7.5 km during vibro-coring. There is no potential for overlap of noise disturbance contours with the boundary of the SAC. Due to the distance from the coast, if surveys are taking place within the Proposed Development array area, bottlenose dolphins are unlikely to be affected. If site investigation surveys are taking place along Proposed Development array area and export cable corridor, located in the southern limit of the main distributional range of bottlenose dolphin, there is a potential for overlap of disturbance ranges with coastal areas. However, the results of ECOMMAS study suggest that the abundance of bottlenose dolphin in the southern part of the CES (in proximity to St Abbs) is low. Given that the surveys are considered to be short-term, the number of animals potentially disturbed would represent a negligible proportion of the population. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, bottlenose dolphin, during the construction and operation phases as a result of underwater noise during site investigation surveys.

c: **Injury and disturbance to marine mammals from elevated underwater noise during UXO clearance** – The maximum range for injury to bottlenose dolphin as a result of underwater noise due to UXO clearance was estimated as 615 m due to detonation of charge size of 300 kg, however, with application of designed in as well as secondary measures (including the use of ADD), risk of injury to bottlenose dolphin will be reduced to low. In terms of fleeing response, animals were predicted at risk to experience TTS at a maximum range of 1,137 m due to detonation of charge size of 300 kg. Although high-order detonation is assessed as a maximum design scenario, low order techniques will be applied as the intended methodology for clearance of UXO and as a result the impact range will be reduced to 135 m due to detonation of 0.5 kg clearance shot. Due to the distance from the coast, if UXO clearance is taking place within the Proposed Development array area, bottlenose dolphins are unlikely to be affected. If UXO clearance is taking place along Proposed Development array area and export cable corridor, located in the southern limit of the main distributional range of bottlenose dolphin, there is a potential for overlap of disturbance ranges with coastal areas. However, the results of ECOMMAS study suggest that the abundance of bottlenose dolphin in the southern part of the CES (in proximity to St Abbs) in low. Additionally, TTS is a temporary hearing impairment and therefore animals are likely to fully recover from the effect. Given that this effect is short in duration, connectivity with important habitats outside the SAC is also unlikely to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, bottlenose dolphin, during the construction phase as a result of underwater noise during UXO clearance.

d: **Injury and disturbance to marine mammals from elevated underwater noise due to vessel use and other activities** – The threshold for injury is not exceeded by any vessel with the exception of installation/construction and rock placement vessels, for which an injury range of 15 m from the source was reported. With regard to behavioural disturbance to bottlenose dolphin, the greatest modelled disturbance range is out to 4,389 m. All vessel movements will take place outside the Moray Firth SAC and there is no potential for overlap of injury or disturbance ranges with the boundaries of the site. As most vessel movements will be confined within the Proposed Development array area, there is a limited potential for overlap of maximum injury or behavioural disturbance ranges with coastal areas. For vessel use and other activities taking place along Proposed Development array area and export cable corridor, located the southern limit of the main distributional range of bottlenose dolphin, there is a potential for overlap of disturbance ranges with coastal areas. However, the results of ECOMMAS study suggest that the abundance of bottlenose dolphin in the southern part of the CES (in proximity to St Abbs) in low. Therefore, if individuals are affected by disturbance as a result by vessel movements and other activities in the vicinity of the Proposed Development export cable corridor and landfall, these numbers would represent a negligible proportion of the population from Moray Firth SAC. Construction and decommissioning activities will be carried out over a medium term. Operation and maintenance activities will occur over the full lifetime of the project (estimated to be 35 years), however, only a small proportion of vessel use and other activities will occur at any one time. Since the behavioural effect is considered to be highly reversible, it is highly unlikely that it will influence bottlenose dolphin population trajectory in the long-term. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, bottlenose dolphin, during the construction, operation and maintenance and decommissioning phases as a result of underwater noise due to vessel noise and other activities.

e: **Changes in fish and shellfish communities affecting prey availability** – Changes to the prey species may occur due to temporary and long-term habitat loss/disturbance, increased SSC and associated sediment deposition, and injury and/or disturbance from underwater noise and vibration. The impacts will be highly localised and restricted to the boundaries of the Proposed Development. Since the Moray Firth SAC and the Tay estuary are known to be important foraging ground for bottlenose dolphins within the CES MU and neither of these important areas will be affected by impacts considered in the assessment, bottlenose dolphin distribution and connectivity with important foraging habitats within and outside the site is unlikely to be impaired. As such, it is concluded that there is no potential for Adverse Effects on Integrity on Annex II marine mammal qualifying interest features of the site, bottlenose dolphin, during the construction, operation and maintenance and decommissioning phases as a result of changes in fish and shellfish communities affecting prey availability.

f: **In-combination** – the in-combination assessment considered the potential for underwater noise during piling, UXO clearance, site-investigation surveys, vessel use and other activities and changes in fish and shellfish communities affecting prey availability from the Proposed Development alone to interact with similar effects arising from other projects included in the Tier 2 and Tier 3 assessments. In-combination effects are not predicted to result in effects of greater significance than as assessed for the Proposed Development alone. It is therefore concluded that there is no potential for Adverse Effects on Integrity on the Annex II marine mammal qualifying interest feature of the site, bottlenose dolphin, during the construction and decommissioning or operation and maintenance phases in-combination with other projects.

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