Hornsea Project Four: Reports

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B2.2: Report to Inform Appropriate Assessment Part 1

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Summary

The Hornsea Project Four Offshore Wind Farm (hereafter 'Hornsea Four') is being promoted byOrsted Hornsea Project Four Limited (hereafter 'the Applicant'), as the fourth project within the former Hornsea Zone. The wind farm array area will be situated to the north west of the existing Hornsea Project One and Hornsea Project Two wind farms and the consented Hornsea Three wind farm. The export cable corridor will run from the array area and make landfall near Fraisthorpe, with the onshore cables continuing to the connection point with the National Grid at the existing Creyke Beck substation.

This Report to Inform Appropriate Assessment (RIAA) has been drafted to provide the Secretary of State the information necessary to undertake an Appropriate Assessment (AA) as part of the determination process for the Development Consent Order (DCO). As such, this RIAA (and associated appendices) presents the conclusions for the potential for the proposed project to result in a Likely Significant Effect (LSE) and where a LSE cannot be ruled out, whether or not an Adverse Effect on the Integrity (AEoI) can be ruled out for the project alone and in-combination with other plans and projects.

The document has been set out to mirror the HRA process, with a number of introductory chapters detailed relevant information used to inform the assessment (including the **Section 6: Project Overview** and **Section 7: Commitments**), followed by the assessment sections which are set out as follows:

- **Section 8: Screening Alone and In-Combination**. Summarises the conclusions on screening for potential LSE;
- **Section 9: Summary of Designated Sites**. Summarises site-specific information for all designated sites screened in;
- **Section 10: Assessment of Adverse Effect Alone**. Determination of whether the project alone will result in an AEoI on any designated sites screened in;
- **Section 11: Assessment of Adverse Effect In-Combination**. Determination of whether the project in-combination with other plans and projects will result in an AEoI on any designated sites screened in;
- **Section 12: Transboundary statement**; and
- **Section 13: Conclusion of the Assessment**. Summarising the conclusions on AEoI, alone and in-combination.

The screening section of the report provides a summary of the LSE screening phase undertaken for Hornsea Four, with full details of the screening presented in **Appendix A** of this RIAA and summarised in the Screening Matrix in **Appendix B**.

Those sites for which an LSE cannot be screened out, have been subsequently taken forward for further consideration of the potential for an AEoI. A summary of the site information for those sites is presented in **Section 9** and **Appendix D** of the RIAA, with this information (designated features, status of the site, status of the features) being used to inform the assessment of potential effects from Hornsea Four alone and in-combination.

The assessment of the potential for an AEoI is carried out in two parts, the first being an assessment of the potential for the Hornsea Four development alone to result in an adverse effect, drawing on the Maximum Design Scenario (**Section 6.4**) for Hornsea Four. The assessment alone (presented in

Section 10) concluded that, with the application of appropriate mitigation as detailed in Section 7 and Section 10, there would be no AEoI as a result of the construction, operation and decommissioning of Hornsea Four.

Following the assessment of the project alone, Section 11 presents the assessment of the potential for an AEoI from Hornsea Four in-combination with other relevant plans and projects which may impact on each relevant site. This assessment concluded that there would be no AEoI as a result of the construction, operation and decommissioning of Hornsea Four in-combination with other plans and projects.

Consideration of transboundary sites is made in Section 12, with no AEoI concluded following the assessment. For ease of reference, a summary of the conclusions is provided in Section 13.

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Glossary

Term	Definition
Appropriate Assessment (AA)	An assessment to determine the implications of a plan or project on a European site in view of the site's Conservation Objectives. An AA forms part of the Habitats Regulations Assessment and is required when a plan or project likely to have a significant effect on a European site.
Annex I Habitat	Natural habitat types of community interest whose conservation requires the designation of Special Areas of Conservation (SAC).
Annex II Species	Animal and plant species of community interest whose conservation requires the designation of SACs.
Barrier Effect	The potential for birds to fly around an array of turbines causing an increase in the overall distance flown than would otherwise have been the case if the wind turbines had not been present.
Birds Directive	Directive 2009/147/EC of the European Parliament and of the Council of 30th November 2009 on the Conservation of Wild Birds.
Collision Risk	A potential risk that birds collide with wind turbine or its blades.
Commitment	A term used interchangeably with mitigation and enhancement measures. The purpose of Commitments is to reduce and/or eliminate Likely Significant Effects (LSEs), in EIA terms. Primary (Design) or Tertiary (Inherent) are both embedded within the assessment at the relevant point in the HRA (i.e. mitigation is not included for Screening, but is included within the RIAA, see mitigation below). Secondary commitments are incorporated to reduce potential for effect to environmentally acceptable levels following initial assessment i.e. so that residual effects are acceptable.
Cumulative Effect	The combined effect of Hornsea Four in combination with the effects from a number of different projects, on the same single receptor/resource.
Development Consent Order (DCO)	An order made under the Planning Act 2008 granting development consent for one or more Nationally Significant Infrastructure Projects (NSIPs).
Displacement	The potential for birds and other animals to avoid an area due to the presence of the wind turbines or from vessel activity.
Environmental Impact Assessment (EIA)	A statutory process by which certain planned projects must be assessed before a formal decision to proceed can be made. It involves the collection and consideration of environmental information, which fulfils the assessment requirements of the EIA Directive and the EIA Regulations, including the publication of an Environmental Statement (ES).
European Site	A Special Area of Conservation (SAC) or candidate SAC (cSAC), a Special Protection Area (SPA) or potential SPA (pSPA), a site listed as a Site of Community Importance (SCI) or a Ramsar site.
Habitats Regulations Assessment	A process which helps determine likely significant effects and (where appropriate) assesses adverse impacts on the integrity of European sites and Ramsar sites. The process consists of up to four stages of assessment: screening, appropriate assessment, assessment of alternative solutions and assessment of imperative reasons of over-riding public interest (IROPI) and compensatory measures.
High Voltage Alternating Current (HVAC)	High voltage alternating current is the bulk of electricity by alternating current, whereby the flow of electric charge periodically reverses direction.

Term	Definition
High Voltage Direct Current (HVDC)	The bulk transmission of electricity by direct current, whereby the flow of electric charge is in one direction.
Hornsea Project Four Offshore Wind Farm	The term covers all elements of the project (i.e. both the offshore and onshore). Hornsea Four infrastructure will include offshore generating stations (wind turbines), electrical export cables to landfall, and connection to the electricity transmission network. Hereafter referred to as Hornsea Four.
In-Combination Effect	The combined effect of Hornsea Four in-combination with the effects from a number of different projects on the same feature/receptor.
Landfall	The generic term applied to the entire landfall area between Mean Low Water Spring (MLWS) tide and the Transition Joint Bay (TJB) inclusive of all construction works, including the offshore and onshore ECC, intertidal working area and landfall compound. Where the offshore cables come ashore east of Fraisthorpe.
Marine Mammal Mitigation Protocol (MMMP)	A document detailing the protocol to be implemented in the event that driven or part-driven pile foundations are proposed to be used. The protocol identifies the methods for detection, potential mitigation and monitoring/reporting protocols for marine mammals.
Mean High Water Springs (MHWS)	The height of mean high water during spring tides in a year.
Mean Low Water Springs (MLWS)	The height of mean low water during spring tides in a year.
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA or HRA (e.g. at Scoping, PEIR, or ES). Note that in response to the People over Wind decision, mitigation has not been taken into account in the RIAA during Screening.
Orsted Hornsea Project Four Ltd.	The Applicant for the proposed Hornsea Project Four Offshore Wind Farm Development Consent Order (DCO).
Planning Inspectorate (PINS)	The agency responsible for operating the planning process for Nationally Significant Infrastructure Projects (NSIPs).
Preliminary Environmental Information Report (PEIR)	Defined in the EIA regulations as information referred to in Part 1, Schedule 4 information for inclusion in environmental statements which has been compiled by the applicant and is reasonably required to assess the environmental effects of the development.
Project Description	A summary of the engineering design elements of Hornsea Four.
Ramsar Site	Wetlands of international importance, designated under the Ramsar Convention.
Sites of Community Importance	Sites that have been adopted by the European Commission in accordance with the Habitats Directives but not yet formally designated by the government of each country.
Special Area of Conservation	Strictly protected sites designated under Article 3 of the Habitats Directive for habitats listed on Annex I and animals listed on Annex II of the directive.
Special Protection Area	Strictly protected sites designated under Article 4 of the Birds Directive for species listed on Annex I of the Directive and for regularly occurring migratory species.
Transboundary	Crossing into other European Economic Area (EEA) states.

Acronyms

Acronym	Definition
AA	Appropriate Assessment
ADD	Acoustic Deterrent Device
AEoI	Adverse Effect on Integrity
AfL	Agreement for Lease
AoS	Area of Search
BEIS	Department of Business, Energy and Industrial Strategy
CD	Chart Datum
Cefas	Centre for Fisheries and Aquaculture Science
CfD	Contract for Difference
CIEEM	Chartered Institute for Ecology and Environmental Management
CMS	Construction Method Statement
CoCP	Code of Construction Practice
CRM	Collision Risk Modelling
cSAC	Candidate SAC
CTV	Crew Transfer Vessel
DAA	Developable Area Approach
DCO	Development Consent Order
DIN	Dissolved Inorganic Nitrogen
DO	Dissolved Oxygen
DECC (now (BEIS))	Department of Energy and Climate Change (now Business, Energy and Industrial Strategy
dML	Deemed Marine Licence
EA	Environment Agency
EBI	Electrical Balancing Infrastructure
EC	European Commission
ECR	Export Cable Route
ECJ	European Court of Justice
EDR	Effect Distance Radius
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EP	Evidence Plan
EPS	European Protected Species
ES	Environmental Statement
HDD	Horizontal Direction Drill
HRA	Habitats Regulations Assessment
HVAC	High Voltage Alternating Current
HVDC	High Voltage Direct Current
IFCA	Inshore Fisheries Conservation Authority
INNS	Invasive and Non-Native Species
IROPI	Imperative Reasons of Overriding Public Interest
JNCC	Joint Nature Conservation Committee
JUV	Jack-Up Vessel
LAT	Lowest Astronomical Tide
LSE	Likely Significant Effect

Acronym	Definition
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario
MFE	Mass Flow Excavator
MHWS	Mean High Water Springs
MLWS	Mean Low Water Springs
MMMP	Marine Mammal Mitigation Protocol
MMO	Marine Management Organisation
MSL	Mean Sea Level
MU	Management Unit
Natural England	Natural England
NN	Nutrient Nitrogen
NOX	Nitrogen Oxides
O&M	Operation and Maintenance
OnSS	Onshore Substation
OSS	Offshore Substation
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PEMMP	Project Environmental Management and Monitoring Plan
PINS	The Planning Inspectorate
pSPA	Potential Special Protection Area
PTS	Permanent Threshold Shift
RIAA	Report to Inform Appropriate Assessment
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SCI	Site of Community Importance
SIP	Site Integrity Plan
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage
SNS	Southern North Sea
SoCG	Statement of Common Ground
SoS	Secretary of State
SPA	Special Protection Area
SSC	Suspended Sediment Concentration
SSSI	Site of Special Scientific Interest
TCE	The Crown Estate
TJB	Transition Joint Bay
TPO	Tree Preservation Order
TTS	Temporary Threshold Shift
UD	Utilisation Distribution
UK	United Kingdom
UXO	Unexploded Ordnance
WTG	Wind Turbine Generator
ZAP	Zone Appraisal and Planning process

Units

Unit	Definition
dB	Decibel
kJ	Kilojoule
km	Kilometre
km^2	Square kilometre
l	Litre
m	Metre
m^2	Square metre
m^3	Cubic metre
mg/l	Milligrams per litre
nm	Nautical mile

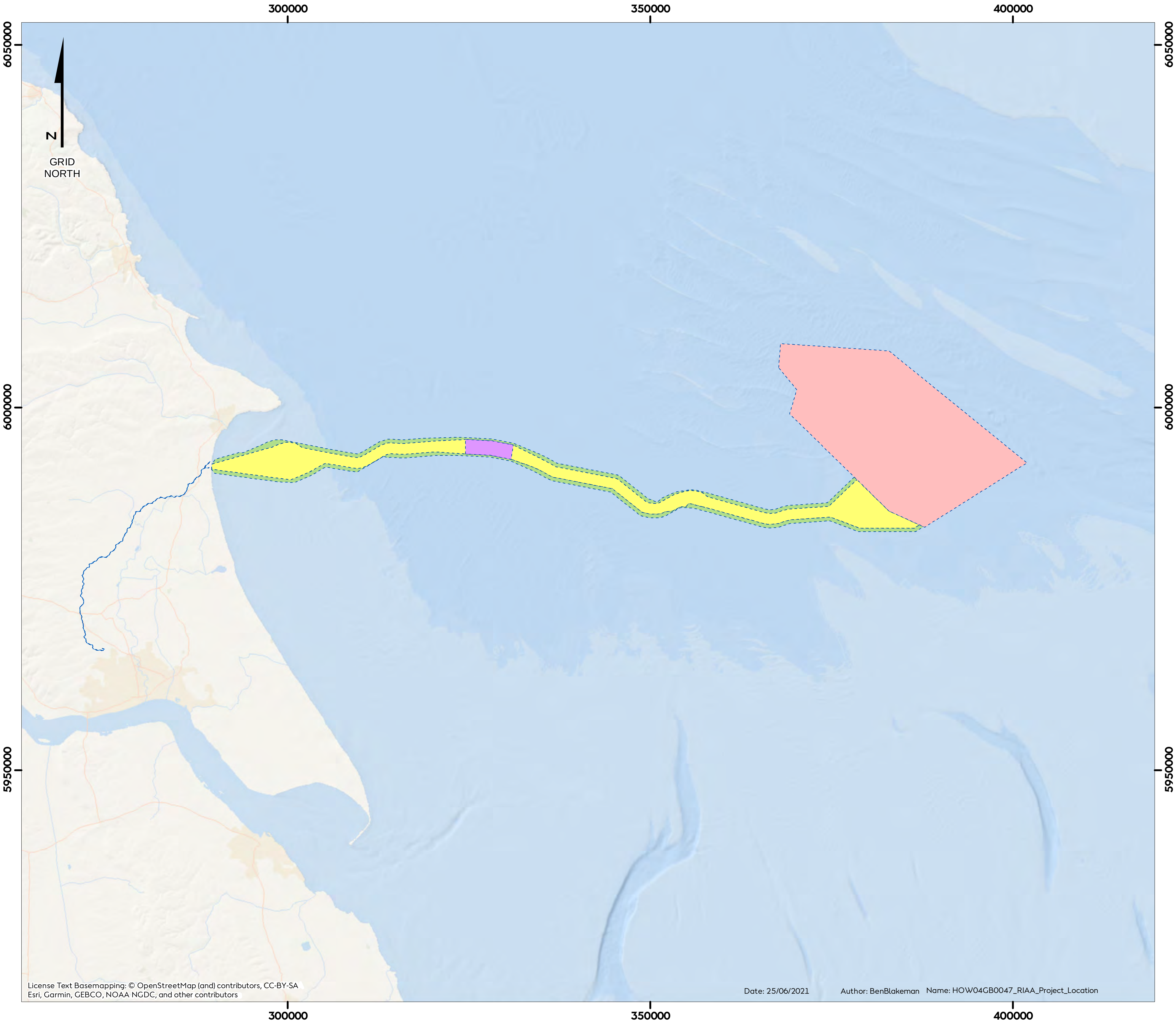
1 Introduction

1.1 Background to the Project

1.1.1.1 This document comprises the Report to Inform Appropriate Assessment (RIAA) for the Hornsea Project Four Offshore Wind Farm (hereafter 'Hornsea Four') promoted by Orsted Hornsea Project Four Limited (hereafter 'the Applicant'). The project will be comprised of a number of onshore and offshore elements, with the wind turbine array being located approximately 69 km east of Flamborough Head off the Yorkshire coast, within the UK's Exclusive Economic Zone (EEZ) (**Figure 1**). A full project description is provided in **Volume A1, Chapter 4: Project Description**.

1.1.1.2 The power from the Hornsea Four array area to the UK National Grid will be transmitted using High Voltage Alternating Current (HVAC) or High Voltage Direct Current (HVDC) with up to six cable circuits installed within the export cable corridor. The offshore export cables will make landfall near Fraisthorpe. Electricity generated will be transported via a maximum of six onshore export cable circuits (each circuit comprised three cables) buried in up to six trenches and an onshore HVDC converter/HVAC substation to allow the power to be transferred to the National Grid via the existing Creyke Beck National Grid substation.

1.1.1.3 The former Hornsea Zone is situated in the southern North Sea east of the Yorkshire Coast. The Hornsea Zone was one of several offshore wind generation zones around the UK coast identified by The Crown Estate (TCE) during the third round of wind licensing. Hornsea Four is the fourth proposed project in the former Hornsea Zone being brought forward by the Applicant.



Hornsea Four

Figure 1

Hornsea Four development area

- Array Area
- HVAC Booster Station Works Area
- Offshore Temporary Works Area
- Offshore Export Cable Corridor
- Onshore Export Cable Corridor

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:500,000

0 10 20 Kilometres

0 5 10 Nautical Miles

REV	REMARK	DATE
....	First Issue	16/05/2019
A	Updated following PEIR consultation, for DCO	25/06/2021

RIAA
Project Location
Document no: HOW04GB0047
Created by: BPHB
Checked by: SK
Approved by: LK

1.2 Purpose of the RIAA

1.2.1.1 This report, together with the Appendices (the updated Screening Report (**Appendix A**) together with the Screening and Integrity Matrices (**Appendix B** and **Appendix C**)) provides an update to the draft RIAA that was issued in August 2019 for consultation together with the Hornsea Four Preliminary Environmental Information Report (PEIR). The updates have been made following consultation (see **Table 1** and **Table 2**) and the availability of the final Environmental Statement (ES). The current report accompanies the ES, as submitted as part of the Development Consent Order (DCO) Application to the Planning Inspectorate (PINS).

1.2.1.2 The European Commission's guidance on the assessment of plans and projects significantly affecting Natura 2000 sites, identifies a staged process to the assessment. Together, these stages are referred to as the Habitats Regulations Assessment (HRA), in order to clearly distinguish the whole process from the second stage within it, which is referred to as the 'Appropriate Assessment' (AA).

1.2.1.3 This document has been produced as part of the overall HRA process for Hornsea Four and draws on the Screening Report (**Appendix A**). Screening was originally undertaken in 2018, and issued to consultees on 8th October 2018, to accompany the Hornsea Four Scoping Report. A subsequent update to screening was issued to Natural England following their request on 28th May 2019 (receptors other than offshore ornithology) and 18th June 2019 (offshore ornithology). For clarity and to enable further changes such as updates to key references to be fully included, an updated Screening Report was produced in May 2020 to accompany this document; that report included all relevant consultation and the conclusions on screening at that time (**Appendix A**). Any further update with respect to screening after May 2020 is noted here in **Section 8**. A summary of the consultation process post-screening, including comments received and how/where these are addressed, is provided in **Section 5**.

1.2.1.4 This document summarises the conclusions on the potential for a Likely Significant Effect (LSE), as drawn in the Screening Report, with respect to the conservation objectives of the screened in European and Ramsar sites, and applies these where potential for LSE cannot be ruled out to determine the potential for an Adverse Effect on Integrity (AEoI) alone and/ or in-combination. It is the information on the potential for an AEoI that is required by the competent authority (in this case the Secretary of State (SoS) for Business, Energy and Industrial Strategy (BEIS)), although all potential LSE, including any that may be regulated by other competent authorities, have been addressed in order to undertake the AA (hence the document title 'Report to Inform Appropriate Assessment', or RIAA, applied here).

1.3 Project Literature

1.3.1.1 This RIAA has not been prepared in isolation, but instead follows a suite of documents prepared as part of the ES and issued with the DCO Application. Key documents issued include technical reports (both for site-specific surveys but also modelling and desk-based studies), with many of these being the key source documents for the information presented here. For ease of reference, and to minimise repetition, the main sources of project literature (including relevant ES chapters, technical reports etc.) for the current report are as follows:

- Volume A1, Chapter 1: Introduction;
- Volume A1, Chapter 2: Planning and Policy Context;
- Volume A1, Chapter 3: Site Selection and Consideration of Alternatives;
- Volume A1, Chapter 4: Project Description;
- Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes;
- Volume A2, Chapter 2: Benthic and Intertidal Ecology;
- Volume A2, Chapter 3: Fish and Shellfish Ecology;
- Volume A2, Chapter 4: Marine Mammals;
- Volume A2, Chapter 5: Offshore and Intertidal Ornithology;
- Volume A3, Chapter 3: Ecology and Nature Conservation;
- Volume A3, Chapter 8: Noise and Vibration;
- Volume A3, Chapter 9: Air Quality;
- Volume A4, Annex 4.5: Subsea Noise Technical Report;
- Volume A5, Annex 1.1: Marine Processes Technical Report;
- Volume A5, Annex 2.1: Benthic and Intertidal Ecology Technical Report;
- Volume A5, Annex 3.1: Fish and Shellfish Ecology Technical Report;
- Volume A5, Annex 4.1: Marine Mammals Technical Report;
- Volume A5, Annex 5.1: Offshore Ornithology Baseline Characterisation Report;
- Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis;
- Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling;
- Volume A5, Annex 5.4: Offshore Ornithology Population Viability Analysis;
- Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report;
- Volume A5, Annex 5.6: Offshore Ornithology MRSea Report;
- Volume A6, Annex 3.1: Extended Phase 1 Habitat Survey Report;
- Volume A6, Annex 3.2: Target Note Tables;
- Volume A6, Annex 3.3: Onshore Ornithology – Wintering and Migratory Birds Survey Report;
- Volume A6, Annex 3.4 Breeding Bird Survey Report;
- Volume A6, Annex 3.5: Great Crested Newt Survey Report;
- Volume A6, Annex 3.6: Water Vole Survey Report;
- Volume A6, Annex 3.7: Otter Survey Report;
- Volume A6, Annex 3.8: Bat Static Detector Survey Report Part A;
- Volume A6, Annex 3.9: Bat Static Detector Survey Report Part B;
- Volume A6, Annex 3.10: Bat Activity Transect Survey Report Part A;
- Volume A6, Annex 3.11: Bat Activity Transect Survey Report Part B;
- Volume A6, Annex 3.12: Bat Emergence and Re-entry Survey Report Part A;
- Volume A6, Annex 3.13: Bat Emergence and Re-entry Survey Report Part B;
- Volume A6, Annex 3.14: Hedgerow and Arboricultural Survey Report; and
- Volume A6, Annex 3.15: Badger Survey Report.

1.3.1.2 It is noted in Advice Note 10 (PINS 2017) that the EIA and HRA apply differently to decision making, with the ES informing the decision (its findings must be taken into consideration) whereas the DCO can only be made if the decision-maker has followed the stages prescribed by the 2017 Habitats Regulations (see Figure 2). Therefore, the information contained in the above chapters and documents has been used to inform the decisions made here in the RIAA, but with the RIAA following the prescribed stages and with the distinct legal and evidentiary requirements of the Habitats Regulations firmly in mind.

1.4 Hornsea Three Decision

1.4.1.1 Hornsea Four is the fourth project in the Hornsea Zone. Hornsea One is fully operational, with Hornsea Two under construction. The SoS granted development consent for Hornsea Three on 31st December 2020[1]. The particulars of that consent are noted here, specifically in relation to HRA and how it relates to Hornsea Four.

1.4.1.2 Paragraph 20.6 of the SoS decision letter states the following:

'… the Development, in combination with other plans or projects, would have an adverse effect on the integrity of the Flamborough and Filey Coast [FFC] Special Protection Area [SPA] for kittiwake. The Secretary of State also concludes that the Development alone and in combination with other projects would give rise to impacts on sandbanks that are slightly coved by seawater all the time, which are a qualifying feature of North Norfolk Sandbanks and Saturn Reef SAC and The Wash and North Norfolk Coast SAC: these impacts would adversely impact the integrity of those SACs'

1.4.1.3 Of the three sites referenced above, only FFC SPA is relevant to Hornsea Four (**Appendix A**). The SoS conclusion on kittiwake resulted from the potential for kittiwake collision mortality during the operation of Hornsea Three in-combination with other plans and projects (i.e. no AEoI was concluded for Hornsea Three alone). As a result, the DCO for Hornsea Three includes a requirement for compensation. The SoS decision letter continues in Paragraph 6.60 to say:

'Given the updated compensation measures for kittiwake provided by the Applicant and the sandbank compensation measures outlined above, the Secretary of State is confident that adequate compensation is proposed and will be in place to offset any impacts to features of Natura 2000 sites from the Development.'

1.4.1.4 Subsequent to the Hornsea Three decision, a number of projects have been advancing through planning, with reference where relevant to the assessment of potential for AEoI to the kittiwake feature of the FFC SPA in-combination. For example, with respect to the East Anglia One North and East Anglia Two Examination at Deadline 8[2], the relevant Statement of Common Ground with Natural England confirmed agreement on no AEoI on kittiwake at FFC SPA for the project alone. This was followed at Deadline 9, when Natural England submitted a number of documents including their position on cumulative and in-combination collision risk[3]. Specific to FFC SPA and kittiwake, they found that the 'contribution from Hornsea Three is considered to be compensated for'. Effectively, for the assessment for FFC SPA kittiwake in-combination, the contribution from Hornsea Three can be discounted, with that approach taken here.

1.4.1.5 The effective removal of the contribution made by Hornsea Three to the in-combination totals for collision risk of kittiwake at the FFC SPA provides an opportunity to revisit these in-combination totals without that contribution by Hornsea Three, and determine

[1] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003265-EN010080%20Hornsea%20Three%20-%20Secretary%20of%20State%20Decision%20Letter.pdf
[2] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010077/EN010077-004483-ExA.SoCG-15.D8.V2%20EA1N&EA2%20Statement%20of%20Common%20Ground%20with%20Natural%20England%20(offshore%20ornithology).pdf
[3] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010077/EN010077-004847-EN010077%20348181%20EA1N%20Appendix%20A16b%20-%20Natural%20England%20Comments%20on%20Cumulative%20and%20In-combination%20Collision%20Risk%20%5bREP8-035%5d%20Deadline%209.pdf

if an AEoI should apply alone and in-combination. The case is presented alone in **Section 10** and in-combination in **Section 11**, both conclusions being no AEoI.

1.4.1.6 However, as a consequence of ongoing consultation (**Table 1** and **Table 2**), and to enable full discussion through the subsequent Hornsea Four Examination if required, a series of documents have been drafted to accompany the Application, forming the basis of the Applicant's 'without prejudice' Derogation Case. The information is contained within **B2.5: Without Prejudice HRA Derogation Case.** The document does not form part of the RIAA and instead forms the next stage of the HRA process (should that stage be triggered) (HRA Stage 3 and Stage 4 as referenced in **Section 3.3**).

2 Structure of the RIAA

2.1.1.1 This document is set out in a number of stages that mirror the HRA process, with the overall structure of the document summarised below:

- **Section 1: Introduction**. Providing a background to the project, including the purpose of the project and where additional project related information (including baseline environment and impact assessment) can be found;
- **Section 2: Structure of the RIAA**. Providing an overview of the structure of the document and section headings;
- **Section 3: Legislation, Policy and Guidance**. To identify the legislation driving the need for the report, together with the policy and guidance defining the structure and content;
- **Section 4: Roles and Responsibilities**. Identifying key individuals and organisations with a role in the HRA process;
- **Section 5: Consultation**. Summarising the consultation undertaken, with whom, when, the issues raised, how and where these have been addressed. Including the Evidence Plan and need for transboundary consultation;
- **Section 6: Project Overview**. Drawing on the information presented in relevant chapters of the ES, providing the maximum adverse scenario for each receptor group including temporal and spatial aspects;
- **Section 7: Commitments**. To include project specific mitigation included per receptor group;
- **Section 8: HRA Screening**. Summarising the conclusions on screening;
- **Section 9: Summary of Designated Sites**. Summarising site-specific information for all designated sites screened in;
- **Section 10: Assessment of Adverse Effect Alone**. Determination of whether the project alone will result in an adverse effect;
- **Section 11: Assessment of Adverse Effect In-Combination**. Determination of whether the project in-combination with other plans and projects will result in an adverse effect;
- **Section 12: Transboundary Statement**;
- **Section 13: Conclusion of the Assessment**. Summarising the conclusions on adverse effect, alone and/ or in-combination; and
- **Section 14: References**.

3 Legislation, Policy and Guidance

3.1 Legislative Context and Government Policy

3.1.1.1 The Habitats Directive (92/43/EEC) on the conservation of natural habitats and of wild fauna and flora, protects habitats and species of European nature conservation importance. Together with the Council Directive (2009/147/EC) on the conservation of wild birds (the 'Birds Directive'), the Habitats Directive established a network of internationally important sites, designated for their ecological status: Special Areas of Conservation (SACs), under the Habitats Directive and promote the protection of flora, fauna and habitats; and Special Protection Areas (SPAs), under the Birds Directive in order to protect rare, vulnerable and migratory birds. These sites combined to create a Europe-wide 'Natura 2000' network of designated sites, which are referred to as 'European sites'.

3.1.1.2 The above Directives were transposed into UK legislation through a series of Regulations. Terrestrial areas of the UK, and territorial waters out to 12 nautical miles (nm), are covered under The Conservation of Habitats and Species Regulations 2017, with waters beyond 12 nm, to the extent of the British Fishery Limits and UK Continental Shelf Designated Area, covered under The Conservation of Offshore Marine Habitats and Species Regulations 2017 (collectively referred to here as the Habitats Regulations). The Habitats Regulations incorporate all SPAs into the definition of 'European sites' and, consequently, the protections afforded to European sites under the Habitats Directive apply to SPAs designated under the Birds Directive.

3.1.1.3 In addition, UK Government policy (ODPM Circular 06/2005) states that internationally important wetlands designated under the Convention on Wetlands 1971, called the Ramsar Convention (Ramsar sites) are afforded the same protection as SPAs and SACs for the purpose of considering development proposals that may affect them. The Government also affords the same level of protection to potential SPAs (pSPAs) and candidate SACs (cSACs) and to sites identified, or required, as compensatory measures for adverse effects on any of the above sites.

3.1.1.4 The UK left the European Union (Brexit) on Exit day, 31st January 2020, followed by Completion Day on 31st December 2020. The EU Exit Regulations (2019) establish any EU Exit-related changes to the Habitats Regulations (2017), with these considered to have no material implications on the requirement or process for a HRA of Hornsea Four (noting that the HRA process will now look to the National Site Network and not Natura 2000).

3.1.1.5 Of note are recent rulings by the European Court of Justice (ECJ), referred to here as Sweetman II or 'People over Wind'[4], and Holohan[5]. The People over Wind ruling relates to how screening for potential LSE is carried out, specifically that mitigation cannot be taken into account at that stage (but remains applicable for the determination of adverse effect). The Holohan ruling relates to the importance of species and habitats which are not a reason for the designation of the site but are relevant to the conservation objectives of the site (e.g. prey items of a designated species). Both these rulings have been taken into consideration during preparation of the HRA Screening Report and the

[4] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A62017CJ0323

[5] http://curia.europa.eu/juris/liste.jsf?language=en&td=ALL&num=C-461/17

RIAA. The recent Decision Letter for Hornsea Three and final HRA[6] are considered in **Section 1.4**.

3.2 Guidance Documents

3.2.1.1 A number of guidance documents are available regarding the HRA process and associated topics. Some of these have been issued at European level, others at UK level (or constituent country). Documents are available that provide guidance on the whole HRA process, part of that process, or are relevant to a particular receptor. A list of the available HRA guidance, as relevant to the current RIAA, is provided in **Appendix E**; documents issued by the EC, UK Government (or devolved administrations) or statutory bodies are provided first, with documents issued by other agencies or organisations together with other relevant but not HRA specific guidance listed separately.

3.3 The HRA Process

3.3.1.1 The Habitats Regulations require that whenever a project that is not directly connected to, or necessary for the management of a Natura 2000 site (post-Brexit, replaced by the term 'National Site Network'), is likely to have a significant effect on the conservation objectives of the site (directly, indirectly, alone and/ or in-combination with other plans or projects), then an AA must be undertaken by the Competent Authority (Regulation 63 of the Habitats Regulations). The AA must be carried out before consent or authorisation can be given for the project.

3.3.1.2 PINS Advice Note 10 'Habitat Regulations Assessment relevant to national significant infrastructure projects' (Version 8, November 2017), defines HRA as a step by step process which determines potential LSE and (where appropriate) assesses adverse impacts on the integrity of a European site, examines alternative solutions, and provides justification of IROPI (including compensatory measures). HRA includes a four-stage process, as summarised below and illustrated in **Figure 2**.

- **HRA Stage 1 – Screening**: Screening for potential LSE (alone and/ or in-combination with other projects or plans);
- **HRA Stage 2 – Appropriate Assessment**: Assessment of implications of identified potential LSEs on the conservation objectives of a European site to ascertain if the proposal will adversely affect the integrity of a European site;
- **HRA Stage 3 – Assessment of Alternatives**: Where it cannot be ascertained that the proposal will not adversely affect the integrity of a European site, alternative solutions must be considered; and
- **HRA Stage 4 – Assessment of IROPI and Compenasatory Measures**: Where it can be demonstrated that there are no alternative solutions to the project, the project may still be carried out if the competent authority is satisfied that the scheme must be carried out for IROPI.

3.3.1.3 All four stages of the process are referred to as the HRA to clearly distinguish the whole process from the one step within it referred to as the 'AA'. The first stage (Screening), as noted above in **Section 3**, has been completed for Hornsea Four alone and a summary of the conclusions available in **Section 8**. The full updated HRA screening is available in

[6] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-003267-EN010080%20Hornsea%20Three%20-%20Habitats%20Regulations%20Assessment.pdf

Appendix A of this report. Where the Screening process concludes the potential for a LSE, then there is a requirement for an AA (Stage 2). Stage 1 Screening for Hornsea Four has identified the possibility of LSE for certain features and effects. The required Stage 2 AA will be conducted by the SoS, with the information necessary to inform that assessment provided here in the RIAA. It is the Applicant's position that there is no requirement to progress beyond Stage 2, as the conclusion in all cases (see Table 62 and Table 63) is no AEoI.

3.3.1.4 Included within Advice Note 10 is the need for two matrices to be completed; the Screening Matrix and the Integrity Matrix. These have been completed in the required format and are included in Appendix B and Appendix C of this report.

3.3.1.5 The integrity of a site has been defined in guidance as the coherence of the site's main ecological structure and function across the whole of its area, which enables it to sustain the habitat, complex of habitats and/ or populations of species for which the site has been designated (EC 2001). An adverse effect on integrity is likely to be one which prevents the site from making the same contribution to favourable conservation status as it did at the time of designation.

3.3.1.6 PINS Advice Note 10 includes a number of points to be considered under Stage 2 and as such they have been considered in this RIAA. These are defined as follows (including the section where each is considered):

- Evidence about the project's impacts on the integrity of protected sites (consideration of adverse effect alone is presented in Section 10);
- A description of any mitigation measures proposed which avoid or reduce each impact, and any residual effect (mitigation measures, which apply to the assessment of integrity but not during screening, are set out in Section 7, with conclusions on adverse effect summarised in Section 13);
- A schedule indicating the timing of mitigation measures in relation to the progress of the development (timing of mitigation measures, where relevant, is included in Section 7), with conclusions on adverse effect summarised in Section 13;
- Cross references to the relevant DCO requirements and provisions that secure these mitigation measures, and identification of any factors that might affect the certainty of their implementation (as highlighted in Section 7 on mitigation);
- A statement as to which (if any) effects constitute an adverse impact on the integrity of European sites either alone and/ or in combination with other plans or projects and therefore need to be included within the AA (a summary of the conclusions on the potential for an adverse effect alone and/ or in-combination is provided in Section 13); and
- Evidence to demonstrate that the applicant has fully consulted and had regard to comments received by the relevant Statutory Nature Conservation Bodies (SNCBs) during pre-application consultation (consultation is described in Section 5).

3.3.1.7 Stages 3 and 4, as outlined within Figure 2, are only required where a conclusion of adverse effect on integrity is drawn following Stage 2. As noted above, it is the Applicant's position that there is no requirement to progress past Stage 2; however in response to consultation undertaken (Table 1), the Application is accompanied by a 'without prejudice' Derogation Case as referenced above (B2.5: Without Prejudice HRA Derogation Case).

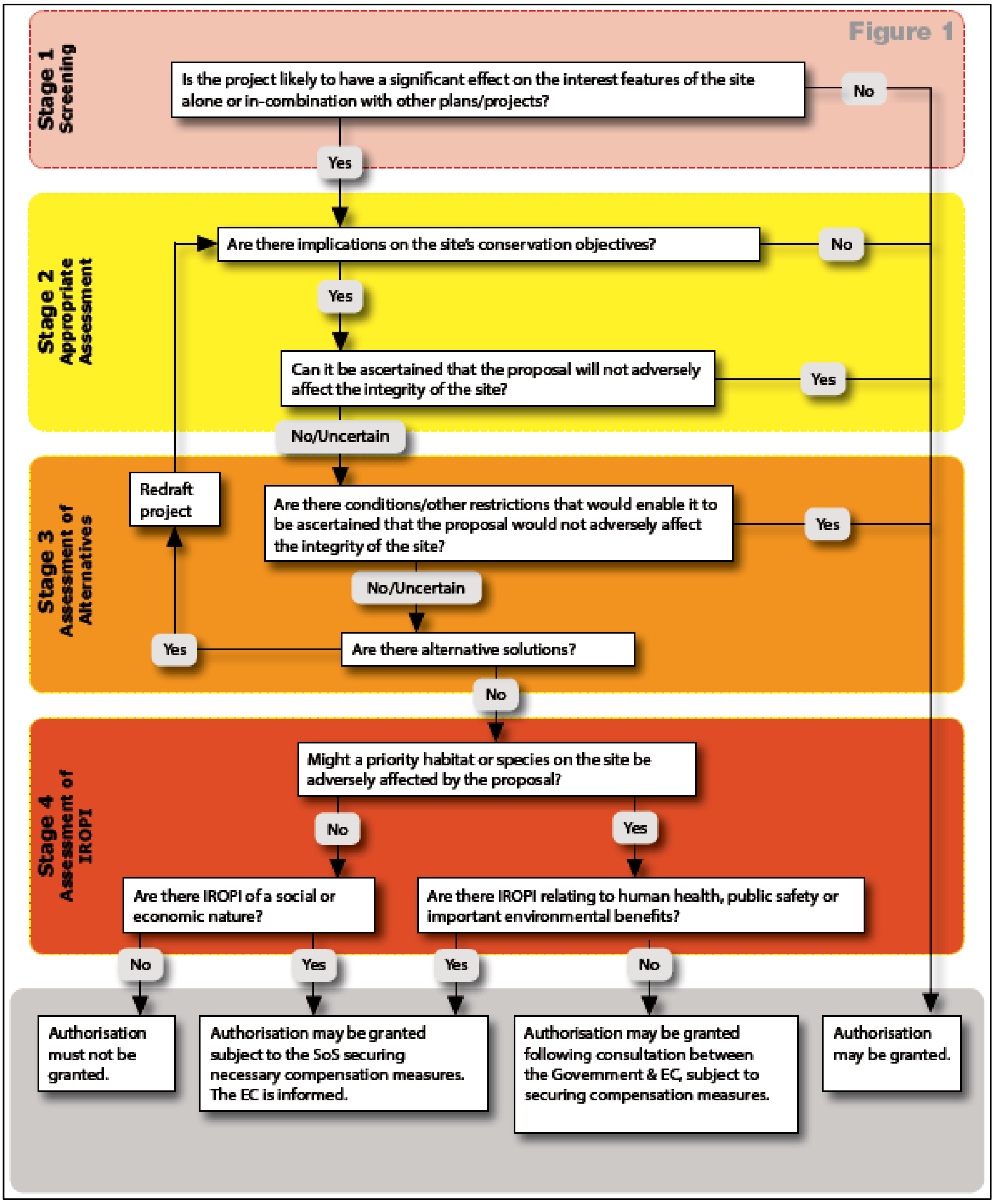


Figure 2: HRA Stages (from PINS 2017).

4 Roles and responsibilities

4.1.1.1 The purpose of a RIAA is to provide the information to the Competent Authority (in this case the SoS for BEIS), in consultation with the relevant SNCB (in this case Natural England and JNCC), required to enable them to undertake the AA. Consultation with SNCBs (and other relevant bodies) prior to Application provides the process through which assurances can be sought that all potential effects have been addressed appropriately and in sufficient detail. Consultation during Examination will result in Statements of Common Ground (SoCG) that identify areas of agreement and disagreement between Applicant and SNCBs (and other relevant bodies). Wider consultation (including the role of the Evidence Plan Process) is discussed below in **Section 5**.

4.1.1.2 This RIAA (and any supporting documentation, notably the attached appendices) produced as part of the application for a DCO for Hornsea Four provides the information required by the competent authority to enable it to undertake an AA of the implications of the project on the integrity of designated interests of relevant European sites (in accordance with Article 6(3) of the Habitats Directive) and any relevant Ramsar sites (relevant site designations defined in **Section 3** above).

5 Consultation

5.1.1.1 Extensive consultation has been ongoing for Hornsea Four since the Scoping Report was originally issued in October 2018, as summarised within **B1.1: Consultation Report**. Consultation undertaken specifically with regard to the HRA process has been managed through the following:

- Consultation on the Scoping Report (Complete, with consultation relevant to the HRA process summarised in the Screening Report in **Appendix A** or this RIAA in **Table 1** and taken into account as referenced);
- Consultation on Screening (Complete, with all comments received summarised within the Screening Report in **Appendix A** or this RIAA in **Table 1**);
- Meetings of the Hornsea Four Evidence Plan (Complete, with all comments received until Application summarised and taken into account within the RIAA in **Table 1**, **Table 2**, **Sections 8, 10** and **11**);
- Consultation on the draft RIAA issued in August 2019 (Complete, with all comments received until Application summarised and taken into account within the RIAA in **Table 1**); and
- Preparation of SoCGs (submissions finalised during Examination).

5.1.1.2 The above is therefore consistent with the 'live document' approach adopted to the RIAA, in that screening and assessment has been updated during the course of the assessment and consultation process.

5.1.1.3 All stakeholders who were issued the draft RIAA in August 2019, together with the updated Screening Report on 29 May 2020 (**Appendix A**) are listed below (in alphabetical order):

- Eastern Inshore Fisheries & Conservation Authority (IFCA);
- East Riding of Yorkshire Council (ERYC);
- Environment Agency;

- JNCC;
- Marine Management Organisation (MMO);
- Marine Scotland;
- Natural England;
- Natural Resources Wales;
- Northern Ireland Environment Agency;
- Northumberland IFCA;
- North Eastern IFCA;
- PINS;
- Royal Society for the Protection of Birds (RSPB);
- Scottish Natural Heritage (SNH);
- The Wildlife Trusts;
- York Consort; and
- Yorkshire Wildlife Trust.

5.1.1.4 A summary of consultation responses on Screening received to May 2020 is provided in Section 3 of the updated Screening Report **Appendix A**), with screening comments following that date and consultee responses directly related to the RIAA provided in **Table 1**. Consutation relevant to the 'without prejudice' Derogation Case is contained within **B2.5: Without Prejudice HRA Derogation Case**.

5.2 Transboundary Consultation

5.2.1.1 PINS Advice Note 10 (PINS 2017) notes that where an application is 'likely to have a significant effect (either alone and/ or in-combination) on a Natura 2000 site in another Member State, the applicant should obtain and provide all relevant information, as reasonably practicable with their DCO application'. That position is reiterated by DECC in their 2015 guidance on transboundary impacts on Natura 2000. DECC (2015) went on to say that 'the format and extent of transboundary consultation is for the applicant to agree with the Planning Inspectorate'.

5.2.1.2 It is understood that PINS commenced Transboundary consultation in October 2019. Copies of notifications made are available on PINS[7], with these consisting to December 2020[8] of a notice placed in the Gazette on 11th October 2019 and a notice of Tranboundary screening (with the member states notified listed as The Netherlands, Germany, Belgium, Denmark, Norway, France, Iceland, Republic of Ireland and Sweden). It should be noted that the updated Screening Report (appended here at **Appendix A**) undertook screening for all sites/features, regardless of the member state within which they occur; where transboundary sites were screened in for potential LSE, these are included within the RIAA.

5.2.1.3 The RIAA (and appended updated Screening Report - **Appendix A**) provides the information necessary for transboundary consultation on HRA matters for the application, initially through the identification of transboundary sites where potential LSE applies in relation to the project alone in the Screening Report, followed by consideration of potential LSE in-combination (drawing on recent Examination stages of similar projects in the region and the transboundary projects identified during that process) and the determination of adverse effect alone and/ or in-combination made

[7] https://infrastructure.planninginspectorate.gov.uk/projects/yorkshire-and-the-humber/hornsea-project-four-offshore-wind-farm-generating-stations/?ipcsection=docs
[8] Confirmed June July 2021 that no further transboundary consultation has been uploaded post this date

here within the RIAA. That information is provided to inform the AA, to be undertaken by the SoS.

5.2.1.4 Consutation relevant to the 'without prejudice' Derogation Case is contained within **B2.5: Without Prejudice HRA Derogation Case**.

5.3 The Evidence Plan Process

5.3.1.1 The Evidence Plan process has been followed during the drafting of the RIAA and includes a number of relevant authorities and stakeholders, although not all provide comment directly on the HRA process. All stakeholders that have been involved in the Evidence Plan Process (as relevant to the RIAA) are listed below:

- Natural England;
- ERYC;
- MMO;
- The Wildlife Trust (and the Yorkshire Wildlife Trust);
- Whale and Dolphin Conservation;
- Environment Agency;
- Cefas; and
- RSPB.

5.3.1.2 The Evidence Plan process has been managed through a series of Technical Panel meetings, with meetings held until Application and with comment on the RIAA summarised in **Table 1** below. Comments aimed at the PEIR and ES more widely have been incorporated into those documents, on which the RIAA draws, and have therefore been taken into account during the preparation of the RIAA where relevant. Such comments are therefore not repeated here but are summarised within the following documents (including reference to where and how each comment has been addressed):

- Comments made in relation to subtidal and intertidal benthic ecology are summarised in Table 2.4 of **Volume A2, Chapter 2: Benthic and Intertidal Ecology**;
- Comments made in relation to marine mammals are summarised in Table 4.3 of **Volume A2, Chapter 4: Marine Mammals**;
- Comments made in relation to offshore ornithology are summarised in Table 5.3 of **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**;
- Comments made in relation to onshore ecology are summarised in Table 3.4 of **Volume A3, Chapter 3: Ecology and Nature Conservation**; and
- Comments made in relation to migratory fish are summarised in Table 3.5 of **Volume A2, Chapter 3: Fish and Shellfish Ecology**.

Table 1: Summary of Consultation Relating to the HRA Process.

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
Scoping Opinion – November 2018	PINS	HRA will be required	Noted
	MMO (contained within PINS)	The MMO notes that Unexploded Ordnance (UXO) clearance will not be included in the application at this stage, however a high-level assessment will be provided. A detailed assessment of UXO clearance will be developed for a separate marine licence at a later stage. The MMO considers that this is a reasonable approach.	UXO assessed alone (**Section 10**) and in-combination (**Section 10.2.3.11**)
		The MMO notes the proposals of soft start procedures and a Marine Mammal Mitigation Protocol (MMMP) as part of noise mitigation. The MMO acknowledges that these are the standard measures typically proposed for offshore wind farm (OWF) developments and support that a MMMP will be implemented.	Mitigation identified in **Section 7**.
		Noise mitigation at source should be considered as a primary means of reducing the potential acoustic impact of pile driving operations.	Mitigation is included as necessary to ensure compliance (see **Section 7**).
		The MMO recommends the JNCC guidance to use a threshold approach for assessing potential impacts of underwater noise in the Southern North Sea cSAC, and subsequent management, of noise disturbance in the harbour porpoise cSACs.	Threshold approach applied alone (**Section 10**) and in-combination (**Section 11)**.
		The MMO wish to make the applicant aware a European Protected Species licence application should accompany a marine licence application for UXO works.	Noted.
		The MMO agree that the impacts in relation to noise, accidental release of pollutants and indirect disturbance from electromagnetic fields (EMFs) generated by cables to benthic communities can be scoped out based on the available literature and the mitigation proposed.	Noted.
		The Environment Agency carry out fisheries surveys to monitor coastal and transitional waters, including the river Humber. Data can be downloaded via;	Dataset accessed and referenced in **Appendix D**

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		https://data.gov.uk/dataset/41308817-191b-459d-aa39-788f74c76623/trac-fishcounts-for-all-species-for-all-estuaries-and-all-years	
	Natural England (contained within PINS)	In accordance with the 2010 Habitats Regulations (as amended) 61(2) anyone applying for development consent for an NSIP must provide the competent authority with such information as may reasonably be required "for the purposes of the assessment" or "to enable them to determine whether an appropriate assessment is required". The SNCBs advise that this information should therefore be provided and appraised as part of the EIA process.	Noted. Relevant information is contained within this RIAA and Annexes.
		Key environmental issues: Potential effects on birds: displacement, indirect effects (prey species) and collision mortality –alone and/ or in-combination. Potential effects on marine mammals: construction noise– alone and/ or in-combination. Potential impacts on designated site features along the offshore export cable route – alone and/ or in-combination. Potential impacts at the landfall location both alone and/ or in-combination/cumulative other sea defence and coastal infrastructure projects.	Effects considered for Screening (**Section 8**), assessment alone (**Section 10**) and in-combination (**Section 11**).
		Possible modelling of UXOs is mentioned. An assessment albeit a simple one, will be required to assess the impact of UXOs alone and/ or in combination with other underwater noise producing activities.	Effects considered alone (**Section 10**) and in-combination (**Section 11**).
		Existing benthic data do not cover the whole of the Hornsea Four array area (c. 20% has not been surveyed), most of the Array Export Cable Corridor Funnel and the whole of the Marine Export Cable Corridor (ECC), with some coverage on the Nearshore ECC Funnel. There is a certain degree of uncertainty regarding these unsurveyed areas. Additionally, there is limited detail on cable installation and potential for cable protection.	Noted. However, the ECC has been amended to avoid physical overlap with sites designated for benthic features. Mitigation is detailed in **Section 7**, with the assessment alone (**Section 10**) and in-combination (**Section 11**).

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		Natural England is unable to agree that the mitigation measures described are suitable to manage and mitigate all potential effects of Hornsea Four on marine mammal receptors.	Noted. Mitigation measures have been identified in line with best practice. Mitigation has subsequently been progressed in consultation with Natural England including through the SoCG process.
		Natural England has been discussing the lack of evidence on operational noise levels of large turbines with others in order to develop a scope of work to gather that empirical evidence. We recommend that this remains scoped in until further evidence has been generated to show that the risk is low.	Noted. Operational noise screened in for potential LSE for sites with physical overlap with the Hornsea Four array area.
		We advise that the developer use data collected from tracking studies from Bempton Cliffs and other colonies, for example Langston *et al*. (2013) and Wakefield *et al*. (2017), as well as sensitivity analyses such as SeaMAST, to fully characterise the importance of the Hornsea Four site for SPA species.	Noted. These data sources and others were used to characterise the baseline for Hornsea Four and where applicable in assessments within this RIAA.
		There is little mention of impacts during migration. This will apply both to migrating seabirds (e.g. gannets in autumn and spring) and to migrating waterbirds travelling to/from breeding areas to winter in SPAs. This might particularly apply to waterbird features of east coast SPAs such as the Humber Estuary SPA, Hornsea Mere SPA, The Wash SPA, and the Greater Wash SPA for little gull.	Consideration of migratory seabirds and non-seabirds has been afforded within the assessment of all designated sites included in this RIAA. With respect to the SPAs noted by Natural England these are included in assessments for Hornsea Four alone (**Section 10.4.4**) and in-combination (**Section 11.4.3**).
		We do not agree that disturbance / displacement issues (in any period) requires only 'simple' assessment, particularly in the context of impacts on SPA waterbirds or seabirds. We also note that displacement effects from different phases of the development (especially construction – operation) should be considered cumulatively rather than in isolation.	Consideration of displacement is provided, where necessary, for potentially effected species from all designated sites within this RIAA for both the construction (**Section 10.4.3**) and operational & maintenance (**Section 10.4.4**) phases alone and in-combination (**Section 11.4.2** and **11.4.3**).
		The potential inter-related effects on offshore ornithology do not appear to have been robustly considered. For example, marine process impacts on the	Potential for inter-related effects have been included throughout the RIAA, with specific

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		Flamborough-Helgoland Front have the potential to affect prey availability for breeding seabirds.	account of the Flamborough Front within (**Section 10.4.4**).
		There will be plenty of colony-specific data from Flamborough & Filey Coast SPA to inform the seasonal definitions for breeding features. Natural England advises the use of the full breeding seasons set out in Furness (2015) rather than the 'migration-free' breeding seasons, unless compelling evidence to do otherwise is produced.	Use of the most recent colony counts from Aitken *et al* (2017 and 2019) have been referenced within this RIAA, whilst the generic bio-seasons from Furness (2015) have been relied upon for the assessments.
		The ES should present a more comprehensive assessment of the potential impacts on passage little gull, as 'snapshot' DAS may not detect main movements. Previous Hornsea projects have used the migratory Collision Risk Modelling (CRM) to consider such impacts, whilst Norfolk Vanguard have explicitly assessed the impacts to the Greater Wash SPA, now a fully classified site.	Consideration of migratory seabirds and non-seabirds has been afforded within the assessment of all designated sites included in this RIAA (including the Greater Wash SPA), with supporting evidence on little gull provided in (**Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**) used to determine the level of effects frm Hornsea Four alone (**Section 10.4.4**) and in-combination (**Section 11.4.3**).
		The EIA should consider barrier effects across the breeding season for relevant species, including adult guillemot and razorbill swimming with their chicks from the colony to offshore waters. The modelling work carried out by CEH for the Firth of Forth and Tay windfarms should be considered as a potential method to quantify the impacts of barrier effects and also displacement as regards SPA productivity and adult mortality.	Consideration of barrier effect on seabirds has been completed in the assessment of all relevant species / designated sites included in this RIAA (**Section 10.4.4**).
		Cable maintenance should be considered cumulatively with the construction and operation/maintenance of the array for sensitive receptors, such as Greater Wash SPA red-throated diver, rather than scoped out. Mitigating the impacts is likely to require more than selecting a route avoiding high concentrations of the species (though that is welcomed): other standard mitigation measures have been proposed and adopted for other offshore wind projects.	Consideration of potential disturbance and displacement effects on red-throated diver from the Greater Wash are included in **Section 10.4.3**.

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		A buffer zone around the export cable corridor to assess red-throated diver disturbance will need to be used, as disturbance reactions to boats can occur at ~2 km. All available data sources should be used to characterise the use of inshore waters by red-throated diver and inform the likely impact to the Greater Wash SPA, for example the JNCC report informing SPA classification (Lawson *et al.* 2015), SeaMaST, and Marine Ecosystems Research Programme density maps. We note that the inshore waters to the north of the Greater Wash SPA (not surveyed in Lawson *et al* 2015), are also known to support appreciable numbers of red-throated divers in the winter.	
		The onshore scoping document does not include reference to Internationally designated sites (Ramsar, SAC, SPA). Natural England advise that sites of international importance are scoped into the assessment in order to allow consideration of alone and/ or in combination effects. In particular the Greater Wash SPA, which overlaps with the potential landfall corridor, should be within the scope.	Onshore screening has been revisited in the appended Screening Report (**Appendix A**). The export cable corridor and landfall no longer have physical overlap with the Greater Wash SPA (being > 1.5 km at the nearest point, noting that **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Process** found works at landfall to be a small-scale, highly localised and intermittent activity limited to the short-term during construction). No features were screened in via the Impact Risk Zone (IRZ) approach and therefore the site remains screened out for onshore and benthic ecology, but remains screened in for birds (the designated features).
Comments on draft RIAA issued at PEIR, 23rd September 2019	The Wildlife Trusts and Yorkshire Wildlife Trust	Comments on PEIR	Addressed within the **Volume A2, Chapter 4: Marine Mammals**.
		Welcome the commitments to avoid marine protected areas.	Noted.
		Note that the guidance on piling MMMP is out of date. Note no commitment for a UXO MMMP – commitment for one must be made.	The piling MMMP (**F2. Outline Marine Mammal Mitigation Protocol)** has been drafted in

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
			consultation and takes account both of the existing guidance but also current best practice. No licence application is being submitted for UXO at this time. Should one be required in the future, a UXO MMMP will be drafted.
		No commitment made for disturbance impacts in the SNS SAC – e.g. through a Site Integrity Plan (SIP). Such documents should be in the commitments register.	Noted. An Outline Southern North Sea Special Area of Conservation Site Integrity Plan (Outline SNS SAC SIP) (**F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) has been produced and submitted as part of the Application. The draft DCO includes the SIP as a condition. (Condition 13(1)(j)).
		Agree that to avoid an AEoI on the SNS SAC, mitigation is required. Expect an in principle SIP to be produced. Expect the in principle SIP to include UXO as well as piling.	Noted. An Outline SNS SAC SIP (**F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) has been produced and submitted as part of the Application. The draft DCO includes the SIP as a condition. (Condition 13(1)(j)).
		Strategic management of in-combination impacts – underwater noise disturbance in the SNS SAC. Accepts this is outside the control of Hornsea Four.	Noted.
		Unmitigated UXO clearance could have an adverse effect on harbour porpoise in EPS terms and HRA terms. Suggest that UXO clearance should be included in the DCO, including EPS licensing. Notes existing uncertainty over mitigation measures.	Noted. No licence for UXO clearance is required or being applied for at this time - the need for UXO clearance will be determined at a later date. Should UXO clearance be required, the relevant licensing will be addressed at that time.
Comments on draft RIAA issued	Natural England	Based on the draft RIAA and supporting documents, Natural England cannot agree no AEoI on a number of sites at present. A number of the comments require comments on PEIR chapters to be addressed.	Comments on PEIR chapters have been addressed within those chapters – with the RIAA drawing on the relevant ES chapters (and

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
at PEIR, 11th October 2019			therefore taking into account comments made more widely on PEIR).
		The relevant IFCA for this project is North Eastern IFCA and not Northern IFCA and Eastern IFCA as indicated in the consultation section of the RIAA (5.3.1.1).	The draft RIAA was issued to the North Eastern IFCA, Eastern IFCA and Northumberland IFCA.
		Rochdale Envelope	The RIAA takes account of the worst case scenario within the project design envelope in each case.
		Natural England question HRA Screening in terms of coastal processes and sediment transport, particularly in relation to the intertidal habitats of the Humber Estuary. Comments on PEIR should be addressed and Screening revisited to confirm screening for benthic habitats. The 16km buffer for benthic habitats noted previously seemed appropriate at the time, however this requires a revisit once modelling completed. On reviewing the PEIR, Natural England would advise that interruption of sediment flow/coastal process would have the greatest zone of influence (not suspended sediment/deposition), and therefore a much larger buffer would be required.	Noted. Following issue of the draft RIAA, Screening has been revisited in full including screening for benthic habitats (see **Appendix A**). The original screening for benthic habitats relied on 16km range (derived from suspended sediment and deposition as part of previous Hornsea projects, applied for consistency) to screen designated benthic habitats in/out. The final modelling that underpins the ES has included consideration of wider coastal processes and sediment transport (in **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**). The assessment concluded no impact on longshore drift or cliff erosion rates. The assessment also concluded that any changes in nearshore pathways would be small and expected to remain localised to any infrastructure. Therefore, no change to the benthic screening is required as the 16 km screening range remains precautionary.
		For the marine mammal assessment, the maximum design scenario should apply not the most likely scenario.	Noted. The RIAA draws on the ES and therefore includes the MDS as its worst case.

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		Change in prey availability and behaviour – screened out from the draft RIAA on the basis of habitat loss from piles. It is not clear if it has considered in-combination habitat loss from cable protection.	Long term physical loss of habitat within the SNS SAC screened out as no LSE for the project alone, but screened in for the project in-combination in response to this comment (**Section 8.2**).
		Clarification required for grey seal impacts and conclusions.	Further detail on the potential for impact on grey seals is provided in the attached **Appendix G**, with a more detailed assessment provided in **Section 10.3**.
		Natural England note that the RIAA states UXO clearance and piling will not occur simultaneously. Suggest that this is included as a condition in the DCO and that if the situation changes, the assessment should be revisited.	The Outline SNS SAC SIP **F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) is included within the DCO as a condition. One of the purposes of the SIP is to confirm whether the assumptions made in the RIAA (as regards the project alone as well as in-combination) remain valid. If the project alone worst case scenario changes (for example as suggested by Natural England), the SIP will require confirmation that any such changes would not alter the RIAA conclusions of no AEoI. Clarification is provided in **Section 8.2.3**.
		Natural England comment that cross referencing through needs checking (some tables referenced in the RIAA do not include the correct PEIR table number).	Cross referencing checked throughout.
		Natural England commented on Table 14 – the plans and projects to consider in-combination for marine mammals should be updated, for example Thanet Extension.	The timeframe for piling at Hornsea Four has been updated following revisions to **Volume A1, Chapter 4: Project Description** (**Figure 3**). The in-combination assessment that follows has also

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
			been updated to reflect these changes (**Section 11**).
		Commented that no timeframe is provided for issue of the draft SIP	The Outline SNS SAC SIP (**F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) has been drafted and issued with the Application. The Outline SNS SAC SIP includes a timeframe for subsequent updates to the SIP, and is included here in **Section 8.2.3**. The Outline SNS SAC SIP is provided for in Condition 13(1)(j) of the draft DCO (**C1.1: Draft DCO Including Draft DML**).
		Comment that Tier 1d projects in Tables 16 and 17 do not have percentages attached, with a need to double check some of the calculations.	The in-combination assessment for the SNS SAC has been updated following the revised project timescales and new information on timescales for in-combination projects where published.
		The risk attached to the in-combination assessment for the SNS SAC is noted.	Noted. The assessment has been updated, with the Outline SNS SAC SIP (**F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) providing certainty that the thresholds will not be exceeded and that no AEoI will result from the project alone and/ or in-combination.
		Paragraph 12.3.2.43 relates to the potential for an in-combination effect on supporting habitats of harbour porpoise and their prey, noting that no reference is made to habitat lost to cable protection alone and in-combination.	Long term physical loss of habitat within the SNS SAC screened out as no LSE for the project alone, but screened in for the project in-combination (**Section 8.2**).
		Table 22 – Dogger Bank Projects may need to be added to the in-combination assessment for the Humber Estuary SAC and Ramsar sites, or justification for why if not.	The in-combination assessment for benthic habitats has been revisited and updated in line with the ES **Volume A2, Chapter 2: Benthic and Intertidal Ecology**.

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			With respect to Humber Estuary Grey seal, relevant projects have been identified in **Section 11.3**, which in turn draws on **Table 7**.
		The in-combination assessment needs to include other noisy activities, such as oil and gas, pipelines etc. It is acknowledged that it may be too early to include these, but acknowledgement is required.	The potential for other noisy activities is acknowledged in **paragraph 8.2.3.12**, with **paragraph 8.2.3.14** finding that the RIAA can only take account of planned/consented works and not extrapolate from historic activity levels. The Outline SNS SAC SIP (**F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) includes provision for inclusion of such activity going forward as relevant.
		Natural England do not agree with the assessment on herring made at PEIR and therefore the effect on marine mammal prey requires updating to reflect this once the issues are resolved.	The draft RIAA drew on the PEIR, with the relevant PEIR chapters updated since then. The RIAA has been updated thoughout (as relevant) following those wider updates within the ES. Therefore, the concerns about marine mammal prey have been addressed here. No change to the existing conclusions of no LSE or no AEoI (as relevant).
		Clarity on the onshore ecology reports provided required at PEIR and ES.	Relevant project literature provided at Application confirmed in **Section 1.3**.
		Disagree on the conclusion of no LSE for the Humber Estuary SAC, SPA and Ramsar for air quality. Therefore, Appropriate Assessment required. Small, temporary, minor impacts can still be significant.	Air quality screened in for potential LSE for the Humber Estuary SAC, SPA and Ramsar saltmarsh and assessed alone in **Section 10.2** and in-combination in **Section 11.2.1**.
		Natural England suggest that any assessment of protected sites must assess predicted impacts to features against the relevant conservation objectives. For most SPAs, Natural England has published detailed conservation advice,	Noted. The assessments for designated sites within this RIAA consider the different

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		including Supplementary Advice on Conservation Objectives (SACOs). These SACOs include attributes of site integrity which should be considered against predicted impacts. Natural England do not consider it sufficient to look at bird abundance alone. Note that Flamborough and Filey Coast (FFC) SPA advice is currently available in draft, due to be formalised in March 2020.	components of the conservation advice available.
		Displacement matrices should be shown in full so that the full range of impacts can be transparently presented. Matrices based on upper and lower confidence limits should also be provided.	Matrices are provided in full within **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis**, with a selection included within **Section 10.4.4** (alone) and **Section 11.4.3** (in-combination). All abundance and density data (with upper and lower 95% confidence interval values) are provided within **Volume A5, Annex 5.1: Offshore and Intertidal Ornithology Baseline Characterisation Report**, but not within separate displacement matrices or the assessments of displacement, as sufficient precaution is included within the assessment process.
		There is frequently little detail provided to support statements about apportioning impact to different SPAs.	Additional details on the apportionment process and breakdown for individual species and SPAs, including the use of foraging ranges are provided for all species within the relevant assessments for Hornsea Four alone (**Section 10.4.4**) and in-combination (**Section 11.4.3**). Additional details are provided for apportionment of species attributed to the FFC SPA subject to PVA modelling in **B2.2 Appendix H Offshore Ornithology FFC SPA Population Viability Analysis**.

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		Gannet displacement and collision mortality does not seem to be summed to understand total impact to FFC SPA gannets.	Consideration is given to Natural England's proposed method in Section 11.4.3 though it must be noted that in doing so it is recognised that an element of double counting occurs (as it is not possible to be subject to collision risk as well as being displaced at the same time) resulting in an over-inflated potential impact when combining multiple seasonal impacts. A second element of over-inflation of potential impacts occurs as assessing annual impacts against a single seasonal population does not account for the mixing of birds between seasons, so assesses against a population that is underestimated.
		Natural England suggest that where features experience impacts in different seasons, the total impact should be summed across seasons to understand total effects on relevant features.	Consideration is given to Natural England's request in all assessments of both construction and operation & maintenance (Sections 10.4.3 and 10.4.4) and in-combination (Sections 11.4.2 and 11.4.3), though it must be noted that in doing so it is recognised that this results in an over-inflated potential impact when combining multiple seasonal impacts when assessing annual impacts against a single seasonal population, as this does not account for the mixing of birds between seasons, so assesses against a population that is underestimated.
		Natural England encourage the use of site-specific data when defining foraging ranges for SPA features – some information in Thaxter et al. (2012) is outdated.	Following the publication of Woodward et al. (2019) paper on foraging ranges for the purpose of HRA screening, that Natural England were

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			part of the peer review process for, a review of all species has been completed for this RIAA.
		SNH will need to be consulted for impacts to SPAs in Scotland.	SNH have been consulted separately.
		Qualifying features of SPAs predicted to experience no AEoI alone should still be taken through to in combination assessment.	The Applicant notes Natural England's opinion on this matter. With respect to offshore ornithology, however, where Hornsea Four contributes a level of effect considered to be de minimis to overall in-combination totals these potential effects are not assessed in detail, as is standard practice. This decision-making, providing transparency on the process of considering qualifying features alone and in-combination, is presented in **Section 10.4** and **Section 11.4.**
		The Humber Estuary SPA / Ramsar site and Hornsea Mere SPA are the only sites where an LSE has been identified for impacts on migratory waterbirds. The RIAA does not provide any narrative regarding why there is no LSE for other, potentially relevant sites in the 'shadow' of Hornsea Four.	A review of migratory waterbird species and designated sites was undertaken in response to Natural England's request. The details of the screening selection process and resultant number of birds passing through the array area are presented in (**Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**), with accompanying explanations and Humber Estuary SPA / Ramsar migratory CRM results presented within **Section 10.4.4.**
		As previously noted, the approach of screening sites/features out in advance of relevant assessments that might then lead to those sites/features being screened back in at a later stage does not reflect the nature of the LSE test as a 'coarse filter'.	An updated HRA Screening Report (**Appendix A**) was completed ahead of this RIAA that accounted for Natural England's request to consider a coarse filter in the approach to the Screening process, which resulted in an increased

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			number of sites / features being screened in for further consideration and / assessment.
		Natural England highlighted that puffin is not a qualifying feature of the FFC SPA, but is a component of the seabird assemblage feature.	Noted. Puffin are screened in on the basis that they are a named feature of the seabird assemblage feature.
		Herring gull is a component of the seabird assemblage feature of the FFC SPA and is a species known to be sensitive to collision. On what basis is it being screened out of LSE? Please note that the maximum foraging range given for this species in Thaxter et al (2012) may be out of date.	A revised set of criteria were applied for the updated HRA Screening report, for which the Woodward et al. (2019) foraging range paper was considered, with herring gull from the FFC SPA being screened in as a result.
		Roseate tern does not currently breed at the Farne Islands, so a conclusion of no LSE could be made for this feature of the SPA.	Noted.
		Razorbill is a component of the seabird assemblage feature of Farne Islands SPA. However, whilst the other auk species triggers an LSE in the breeding season, it does not.	Noted. Razorbill is not included within this RIAA (as outside the mean max plus 1 Standard Deviation (SD) for the Farne Islands), whilst the other auk species are assessed in **Section 10.4.4.**
		The LSE test requires consideration of the project alone and/ or in-combination with other plans and projects. Therefore, it is not necessary at the LSE stage to consider sites/features for which an LSE 'alone' has already been identified, as in-combination effects would where relevant be considered during the AA. The focus at this stage should be to identify sites/features for which no LSE alone was concluded, but an LSE in-combination is plausible (e.g. due to wide foraging ranges resulting in a species interacting with a large number of projects). As the methodology of this section of the assessment is not fully set out, it is unclear whether the RIAA has considered any such sites/features. However, given that the resultant in-combination assessment only considers the FFC SPA, it is perhaps unlikely.	This is noted and the criteria is set out in **Appendix A**, which provides an account of the Screening process for sites / features for assessment alone and in-combination. This decision-making, providing transparency on the process of considering qualifying features alone and in-combination, is presented in **Section 8**.
		The approach to construction displacement seems to overlook that displacement may occur in response to constructed turbines as well as	These comments have been considered in the RIAA and Natural England's advice has been

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		construction activities themselves. Similarly, displacement effects cannot truly be short term and temporary if once constructed / operational the turbines lead to avoidance by birds – disturbance is ongoing from the point of construction until the completion of decommissioning.	incorporated into the assessments on potential displacement impacts on seabirds during the construction phase both for Hornsea Four alone in **Section 10.4.3** and in-combination in **Section 11.4.2**
		Natural England queried the displacement rates applied in the assessments for puffins and for other species that used Thanet in isolation from other studies.	A review of displacement rates and the extent of potential displacement buffers was undertaken for the RIAA, presented in **Section 10.3.4.10**, accounting for Natural England's comments. The revised assessments based on an evidence led approach and incorporating Natural England's advice are presented for the construction phase for Hornsea Four alone in **Section 10.4.3** and in-combination in **Section 11.4.2** as well as for the operational & maintenance phase for both Hornsea Four alone (**Section 10.4.4**) and in-combination (**Section 11.4.3**).
		Natural England suggest that many of the reasons claimed to make the assessment 'overly precautionary' seem unsupported by evidence.	A review of the precautionary nature of the assessments has been undertaken and additional evidence in support of any specific examples is provided throughout the RIAA.
		Natural England queried the use of SeaMast data to determine the densities of red-throated divers in the ECC for assessment of potential disturbance and displacement impacts during the export cable laying.	A revised agreed methodology was developed between APEM and Natural England that provides a robust account of the potential risk to divers from the export cable laying within the ECC, which is provided in **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis** and summerised in **Section 10.4.3**
		Natural England also suggested that focusing on red-throated diver and common scoter abundance ignores high level conservation objectives relating	Noted. These additional comments raised by Natural England have been considered and the

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		to distribution and habitat extent. They requested that this needs to be considered, particularly given the present lack of clarity regarding the extent to which the 2 km displacement buffer for cable installation overlaps with the Greater Wash SPA.	assessments within the RIAA provide an account with respect to the wider conservation objectives where appropriate within **Section 10.4.3**. Comment on the supporting benthic habitat with respect to screening is provided in **Section 8.1.2**.
		Natural England queried how the little gull assessment has been carried out and requested further detail.	These comments on little gull were noted and a review of data sources and potential risk for this species was undertaken. The details on little gull are presented in (**Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**).
		There is insufficient detail to fully understand the assessment for migratory waterbirds, including whether other migratory waterbird sites have been considered for LSE. Our understanding is that for the Humber Estuary SPA and Hornsea Mere SPA a qualitative review of other OWF ES has been carried out, rather than using a tool such as Migropath – although no details from these reviews. At this stage Natural England does not feel that a valid assessment has been carried out for any migratory waterbird SPAs, and recommends that an appropriate tool be used instead. This will also provide suitable values for use in an in-combination assessment.	As referenced above. A full review of migratory birds was completed following consultation responses from Natural England and the details of the species selection process and assessments for collision risk are presented in (**Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**) and those species / sites applicable that met the criteria in the HRA Screening are included in **Section 10.4.3.**
		As noted for the migratory waterbird impact assessments above, the assessment of impacts on migrating Arctic tern from Northumbria Coast SPA (and other migratory seabirds) lacks detail and does not use one of the standard tools available.	As above.
		Given the data available from the Hornsea zonal surveys and those for projects 1, 2 and 3, we are by no means persuaded by the assertion that 'very few auks forage in the waters east of the Hornsea 4 array area', or its use in the assessment of potential barrier effects.	A review of potential barrier effects from Hornsea Four for all species from the FFC SPA, including auks, was completed in response to Natural England. The results of this are presented in **Section 8** and subsequently auks

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			from the FFC SPA were screened in and assessed in Section 10.4.3.
		Natural England requested that additional consideration is provided for potential construction impacts in-combination.	The potential for construction impacts in-combination is considered according to the timetables of other OWF plans and where overlap may occur this is accounted for accordingly within Section 11.4.2
		Natural England requested that additional consideration is provided for potential displacement impacts in-combination for gannet.	The potential for displacement impacts in-combination for gannet is considered within Section 11.4.2
		Natural England requested the provision of more details and justification of the SPA apportioning approach. Natural England advises that unless a robust, repeatable alternative method can be brought forward, the relevant values from the Examinations of the OWF in question should be used in in-combination assessments, so this is likely to be the most appropriate approach to take.	The comments from Natural England are noted with respect to further detail on the approach and methods for apportionment of potential impacts between different SPAs of interest. Though previous values from historic examinations provide some value to the process it is not always the case and the approach in the assessments within this RIAA for the non-breeding apportionment takes a standard approach using Furness (2015) as agreed with Natural England and the RSPB that provides a level playing field to all sites and OWFs in order to undertake a robust evidence led approach to the apportionment. For apportionment of breeding season potential impacts the approach to apportionment for different species and SPAs are presented throughout Section 10.4 for Hornsea Four alone and Section 11.4 for in-combination accounts with the latest agreements and methods agreed in the most

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			recent examinations of other projects as well as additional more recent evidence. Further details of apportionemtn is provided in B2.2 Appendix H Offshore Ornithology FFC SPA Population Viability Analysis.
		Natural England highlighted a number of OWFs that they considered were missing from some of the in-combination tables.	A full review of all OWFs with available data are considered and presented in the in-combination tables in Section 8.2.4 of the RIAA.
		Natural England does not advocate use of SNH's apportionment tool in isolation from other approaches/considerations due to unrealistic assumptions inherent within it. Natural England would prefer a 'weight of evidence' approach looking at e.g. tracking and foraging distance data, likelihood of foraging segregation, evidence of fish carrying / direction from empirical data, relative colony size, etc.	The use of the SNH apportionment tool provides a method that allows for a level playing field approach to assessing the impacts of OWFs on species from individual or multiple SPAs. Following further consultation with Natural England additional consideration has been taken to incorporate further evidence as well as additional weighting mechansims from the SNH apportionment tool where appropriate in Section 10.4 for Hornsea Four alone and Section 11.4 in-combination of the RIAA. Further details of apportionment are provided in B2.2 Appendix H: Offshore Ornithology FFC SPA Population Viability Analysis.
		Natural England do not agree with the avoidance rates used in the collision risk assessments.	A full review of all CRM input parameters was undertaken in consultation with Natural England and the RSPB and a revised set of avoidance rates agreed on for use in the assessments, as described in (Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling).
		It is not possible to see which Band model options informs the collision estimates for gannet and kittiwake.	A range of Band Options were considered (Band Option 1, Band Option 2 and Band Option 3),

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			though for gannet and kittiwake Band Option 2 are presented in the assessments of collision risk in Section 10.4.4 and Section 11.4.3. For herring gull and great black-backed gull Band Option 3 was considered most appropriate for assessment in Section 10.4.4. Band Option 1 is used for migratory waterbirds and hen harrier in Section 10.4.4 of the RIAA, with all associated details on CRM methods described in (Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling).
		Natural England requested more information with respect to the source of some foraging ranges.	The revised assessments in the RIAA account for the latest evidence led approach to consider the most up-to-date foraging ranges, as presented in Woodward et al. (2019).
		Please note that Natural England did not agree with the assessment of impacts on herring and sandeel presented in the PEIR. As per our comments in the PEIR there were concerns with the baseline, with the WCS assessed and with the assessment methodology. When these issues are resolved and the impact assessment for these species is updated accordingly, the effect of Hornsea Four on prey availability for seabird species which are designated features of the relevant SPAs need to be reassessed.	A review of the updated assessments on herring and sandeel is included, where appropriate in the updated screening process on prey availability for seabirds in Section 8.
Comments on draft RIAA issued at PEIR, 23rd September 2019	Department of Agriculture, Environment and Rural Affairs (Northern Ireland)	No comment to make.	Noted.
Comments on PEIR and draft	RSPB	The RPSB highlighted the approach to disturbance and displacement and collision risk adopted in the RIAA where large quantities of text for each species in each SPA considered could have been reduced to a limited set of	Noted. The final RIAA takes on board this principle of providing a limited set of explanatory text setting out the approaches

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RIAA issued at PEIR, undated		explanatory text setting out the approaches adopted coupled with the presentation of the key numbers in a tabulated form. This would have made the information significantly more accessible as well as removing a significant amount of text and they encourage this to be addressed before the submission of the DCO application.	adopted and presenting the outcomes in a more succinct and tabulated manner. The condensed accounts for these sites are presented in Section 10.4.3 and Section 10.4.4.
		The RSPB welcome the decision to reduce the Developable Area of the OWF they note that whilst this removes the highest areas of bird usage from the scope of the scheme there are still significant levels of birds encountered across the scheme area and consequently they remain concerned about the extent of potential impacts to, in particular, the FFC SPA.	Noted.
		They noted the reservations expressed by Natural England in relation to likely cumulative impacts on guillemot, razorbill, gannet and kittiwake in the PEIR. Given the much closer proximity of Hornsea Four to the FFC SPA, and it is being considered after Hornsea Three and Norfolk Vanguard OWFs the RSPB doubt that it will be possible to avoid an AEoI on this SPA.	Noted, though the assessments for this RIAA provide an evidence led approach to cumulative impacts and the conclusions differ to the opinion of the RSPB in this matter.
		The RSPB welcomes commitment 86 (that the offshore export cable corridor route will avoid the Greater Wash SPA, FFC SPA and the Flamborough Head SAC).	Noted.
		The RSPB notes commitment 87 (reduction of the proposed developable area), that the intention is to “avoid areas with the highest concentrations of birds”. Whilst welcoming this reduction they are concerned that important areas for birds still remain within the revised developable area, particularly adjacent to the areas that have now been excluded.	Noted.
		The RSPB notes commitment 88 (construction and operational maintenance vessels will avoid high concentrations of rafting red-throated diver between their port of origin and the array area), although given the acknowledged distances of sensitivity of red-throated diver we consider that this commitment is likely to be difficult to operate in practice.	Noted. It must also be noted that this commitment is standard practice when considering red-throated diver and common scoter, though in this instance, should the port location be in the Humber then any vessels would follow the shipping lanes out of the Humber in an easertly direction. This shipping

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			lane has very low densities of both species, so it is highly unlikely that such measures would need to be implemented and once through the shipping lane vessels would travel in a northerly direction to the Hornsea Four array area avoiding any higher concentrations of such sensitive species, as described in Section 10.4.4.
		The RSPB notes commitment 138 (minimum lower air draft of wind turbines will be a minimum of 35m above Mean Sea Level). Whilst this is likely to reduce the potential collision risk arising from the scheme (as with similar measures set out in the deemed marine licences for Hornsea Two and Hornsea Three) we consider (as highlighted above) that despite this measure the impacts are likely to be too severe for it to be possible for the scheme to avoid an AEoI of the FFC SPA.	This is noted, though a revision to the project design for the DCO application is a new commitment to 40 m Mean Sea Level (MSL), which provides further reductions to potential risk to seabirds.
		The RSPB disagree with the statement in the draft RIAA that the assumptions in the assessment process "contribute to the predicted impacts and potential effects being considered overly precautionary".	Noted.
		The RSPB note with concern that in the assessments for each species for each SPA that an approach has been adopted that seeks to diminish the population that falls to be assessed	Noted. The Applicant undertook a review of the assessment approach for all species and the populations that they fall within for the final RIAA.
		The RSPB note that for gannet, although both displacement and collision impacts are assessed, that contrary to SNCB advice, these impacts are not combined for assessment of total impact.	Assessment of combined displacement and collision has been undertaken for gannet as detailed in Section 10.4.4 and Section 11.4.3, though it must be noted that in doing so it is recognised that an element of double counting occurs (as it is not possible to be subject to collision risk as well as being displaced at the same time) resulting in an over-inflated potential impact when combining multiple seasonal

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			impacts. A second element of over-inflation of potential impacts occurs as assessing annual impacts against a single seasonal population does not account for the mixing of birds between seasons, so assesses against a population that is underestimated.
Comments on draft RIAA issued at PEIR, 23rd September 2019	Dogger Bank Wind Farms	When considering the impacts of wind farms on the SPAs, a generic approach has been taken in the draft RIAA that assumes, for example, that the same percentage for attributing the birds to specific SPAs can be used for all sites, irrespective of distance from site. Based on the ongoing discussions on this topic and SNCB guidance on previous projects, we would expect the assessment to be updated to reflect the actual potential connectivity to the SPAs. Due to the interactions between the Creyke Beck projects and Hornsea Four ongoing interface meetings will be required to ensure necessary crossing agreements or other interactions are properly understood and managed.	The assessment in **Section 11.4** adheres to the industry guidance on apportionment of species within wider geographical zones with respect to estimating potential interactions between species from particular SPAs and OWFs. This approach allows for a level playing field to be used to identify potential interactions / impacts and as such is the basis for our assessments. Following the publication of the latest mean max foraging ranges for seabirds in Woodward et al (2019) the assessments in **Section 11.4.3** also considers these as and where appropriate for species of interest. The Applicant is consulting regularly with Dogger Bank A and B and understands that specific meetings will be needed in relation to crossing agreements and other interactions.
Offshore Ornithology Evidence Plan Technical Panel Meeting Four, 16/06/2019	Natural England and the RSPB	Natural England are in agreement that 24 months of survey data collection, the frequency of surveying and the overall methodology are sufficient for baseline characterisation. The only query is about the amount of data used (10% coverage using 2 cameras or 20% coverage using 4 cameras from aerial digital video survey data). The RSPB agreed.	As detailed in **Volume A5 Annex 5.1 Offshore and Intertidal Ornithology Baseline Characterisation Report**, 20% coverage using 4 cameras was collected with only 10% coverage using two cameras being used to characterise the baseline as is standard practice for analysing

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			aerial digital survey data. Further consultation on the use of 10% coverage versus 20% coverage with Natural England resulted in agreement that additional analysis of data did not significantly change the baseline results and Naural England therefore agreed with Hornsea Four using 10% coverage for determining the baseline and using for impact assessments going forward (OFF-ORN-1.19 **Volume B1 Annex 1.1 Evidence Plan**).
Offshore Ornithology Evidence Plan Technical Panel Meeting Five, 29/10/2019	Natural England	Natural England is content with the use of the calculated population estimate within the little gull note, highlighting that is provides the best available evidence and a clear audit trail but that is it important to acknowledge in the assessment the low data confidence and how poor the understanding of the population of little gulls is with quite broad estimates.	Noted.
		Natural England confirmed that for the purpose of assessing red-throated diver connected to the GW SPA any birds to the south of the ECC could be considered to be SPA birds and any to the north of the ECC could be considered to be non-SPA birds.	Noted. Following these comments from Natural England additional consultation was undertaken and a revised method to estimate red-throated diver densities and connectivity to the GW SPA were agreed (OFF-ORN-2.25 **B1.1.1 Evidence Plan**) and the methods are presented in **Section 10.4.4**, with further detail provided in **Volume A5 Annex 5.2 Offshore Ornithology Displacement Analysis**.
Offshore Ornithology Evidence Plan Technical Panel Meeting Nine, 21/04/2020	Natural England and the RSPB	Natural England and the RSPB are in agreement that the use of the sCRM (Donovan, 2018) when run deterministically is appropriate to estimate collision risk for all seabirds assessed for this project.	Noted

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Offshore Ornithology Evidence Plan Technical Panel Meeting Ten, 15/05/2020	Natural England	Natural England agreed that the revised methodology to estimate the density and abundance of red-throated diver within the ECC for the purpose of assessing potential impacts was fit for the purpose.	Noted
Feedback note from Natural England on 17/06/2020	Natural England	Agreed with the demographic rates, baseline mortality rates and colony counts presented by APEM at Offshore Ornitholgoy Evidence Plan Technical Panel Meeting Ten.	Noted
		Natural England recommended that additional migratory bird species be considered for Migropath modelling, including; avocet (non-breeding), ruff, pink-footed goose, white-fronted goose (European), teal, goldeneye, oystercatcher, whimbrel, turnstone and hen harrier.	These additional species were noted and have been included in an updated assessment of migratory birds presented in (**Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**), with the exception of pink-footed goose that was screened out due to a lack of connectivity between Hornsea Four and its dominant migratory pathways. The results of the additional analysis to determine whether any species were screened into this RIAA are provided in brief in **Section 10.4.4.**
		Natural England advised that additional OWFs should be included in any in-combination assessments where data were available, including for the following projects; Gunfleet Sands, Methil, Rampion, Scroby Sands, East Anglia One North and East Anglia Two.	These additional sites are noted and where appropriate have been included in the in-combination assessments in **Section 11.4.3.**
Offshore Ornithology Evidence Plan Technical Panel Meeting Eleven, 15/07/2020	Natural England and the RSPB	Following receipt of a report on the aerial digital video surveys data providing additional coverage of 20% for seven months Natural England and the RPSB agreed that as there was no significant difference in the abundance / density estimates associated with 10%, 15% or 20% coverage utilising 2, 3 or 4 cameras from the transect data they had no further queries on the use of these data to define the baseline.	Noted

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	Natural England and the RSPB	Neither Natural England or the RSPB agree with the use of the The Crown Estate's CRM headroom reports (including the latest by RHDHV, (2019)) to determine cumulative or in-combination collision risk. Natural England instead recommend that Hornsea Four account for the most recent in-combination assessments as agreed for Norfolk Boreas for such matters.	This advice is noted and consideration is given to this and other sources for the determination of all potential in-combination impacts in Section 11.4.
	Natural England and the RSPB	A detailed set of comments with respect to the HRA Screening were provided following the PEIR submissions.	The responses in relation to Natural England and the RSPB's key issues raised on the HRA Screening are present in the HRA Screening Report (Appendix A).
	Natural England and the RPSB	Natural England and the RSPB agreed that the use of Furness (2015) for determining the apportionment of non-breeding birds to specific SPAs is appropriate, though some additional consideration may be required for the migratory periods for the FFC SPA.	The apportionment process is presented for non-breeding birds in association with SPAs in Section 10.4 for Hornsea Four alone and Section 11.4 for in-combination.
	Natural England and the RPSB	Natural England and the RSPB agreed that the use of a multi-layered approach to apportionment of birds in the breeding season to determine SPA connectivity following the SNH (2018) guidance note is currently the best method available.	The apportionment process is presented for non-breeding birds in association with SPAs in Section 10.4 for Hornsea Four alone and Section 11.4 for in-combination.
Marine Mammals Evidence Plan Technical Panel Meeting Eight, 4th June 2020.	Natural England	Group for Dogger Bank A and B and Teesside A. There is some spatial overlap between the proposed wind farm areas. As regards the RIAA – the in-combination assumptions are very precautionary and would expect project timeframes to be refined going forward.	Project timeframes refined based on available information. The Outline SNS SAC SIP (F2.11: Outline Southern North Sea Special Area of Conservation Site Integrity Plan) allows for further timeframe refinement to be taken into consideration going forward.
		Comment and discussion on the Marine Mammal Technical Report, draft MMMP, use of modelling and requirement for mitigation and the UXO assessment.	Comments addressed within the relevant reports and chapters, with any updates or changes incopprorated into the RIAA.
		No comments on the draft Outline SNS SAC SIP which is high level as expected at this stage.	Noted.

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		Questionned why accidental pollution had been screened out in all cases (Sweetman compliance related question).	Confirmed that accidental pollution had been screened out in all cases within the draft RIAA issued for consultation at PEIR, with no comments received. Reference provided during the meeting[9] and clarification on the position requested. Accidental pollution screened in (alone and in-combination) for sites with physical overlap (SNS SAC) and sites with designated benthic features within 16 km (Flamborough Head SAC).
		Marine mammal screening.	Confirmed no further comments on marine mammal screening (other than the accidental pollution question).
		For the grey seal assessment – reference to the citation population is required, with a Conservation Objective of maintain the population. It was noted that the grey seal population has grown, and continues to grow, since designation. Natural England confirmed that a current population size could be used in the assessment.	In agreement with Natural England, the grey seal assessment in **Section 10.3** presents the citation population, the conservation objective and the current population, with the assessment based on the current population.
		The grey seal assessment needs to be made based on a worst case scenario. Discussion held on the use of the worst case scenario (based on worst case location) in the context of spatial variability in disturbance across the site. Noted approval of the approach taken in **Appendix G**, as provided for consultation.	The grey seal assessment presented in **Section 10.3** draws on the assessment made in **Appendix G**. The assessment is made on a worst case scenario basis for disturbance from piling, (which draws on the worst case location and worst case piling parameter scenario) while acknowledging the spatial variability in disturbance across the site.
	Cefas	No comments on the draft Outline SNS SAC SIP which is high level as expected at this stage.	Noted.

[9] https://www.gov.uk/guidance/appropriate-assessment

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		Marine mammal screening.	Confirmed no further comments on marine mammal screening (other than the accidental pollution question).
	MMO	No comments on the draft Outline SNS SAC SIP which is high level as expected at this stage.	Noted.
		Marine mammal screening.	Confirmed no further comments on marine mammal screening (other than the accidental pollution question).
	Natural England	Received in comments on the Technical Panel meeting minutes. Recommended that accidental pollution be screened in for potential LSE	Accidental pollution screened in (alone and in-combination) for sites with physical overlap (SNS SAC) and sites with designated benthic features within 16 km (Flamborough Head SAC).
Offshore Ornithology Evidence Plan Technical Panel Meeting Twelve, 19/10/2020	Natural England and the RPSB	Natural England requested that the following is incorporated into apportionment for the FFC SPA; wider extended breeding bio-season of March to August is considered and a range of apportionment values for post-breeding season up to 100% apportionment, excluding the use of a 10% sabbatical rate. Natural England also stated that they disagree with juveniles not being considered. As there is significant disagreement on the apportionment approach Natural England suggest that two apportionment methods are presented.	The Applicant disagrees with this approach suggested by Natural England for the assessment of the features of the FFC SPA. The reason for not taking forward this proposed apportionment is that it does not follow an evidence-led approach and the methodology does not align with other recent consented projects considering designated features from the same SPA.
Natural England advice note ref 326008, 06/11/2020	Natural England	Methodology and results were provided on how Natural England derived productivity rates for gannet and razorbill to be used in FFC SPA PVA assessments, stating that this methodology should be followed for other features of the FFC SPA.	The Applicant has followed the methodology provided for productivity rate calculation with results presented in **Volume A5, Annex 5.4: Offshore Ornithology Popualtion Viability Analysis**. All PVA results in **Sections 10.4** and **11.4** are derived from productivity rates calculated using the method advised.

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		In relation to interpretation of PVA results for razorbill (and other auk species), Natural England stated that the Applicant should refer to advice provided to Norfolk Boreas in their deadline 4 feedback.	The Applicant has referred to the specified advice note when interpreting the results of the PVA in **Section 11.4.3** for razorbill (and other applicable auk species).
Offshore Ornithology Evidence Plan Technical Panel Meeting Thirteen, 23/11/2020	Natural England and the RPSB	RSPB noted that they have a difference of opinion on the applicable avoidance rate for gannet to be used for CRM, so will disagree with the Applicant and Natural England on the collision mortality rates, although this does not necessarily mean they will disagree on the overall project alone outcome.	Noted. The agreed collision risk modelling tool for assessment (sCRM) does not currently include the ability to specifiy avoidance rates per season.
		Natural England have advocated the use of Hornsea Three's contribution of 73 kittiwakes for other projects' in-combination assessments.	Due to Hornsea Three now securing full compensation for impacts attributed to kittiwakes of the FFC SPA the kittiwake in-combination results in **Table 55** now has zero contribution from Hornsea Three as advised by Natural England (Natural England, 2021a).
Natural England Evidence Plan Technical Panel Meeting Thirteen questions response note, 16/12/2020.	Natural England	Natural England confirmed agreement on the collison risk numbers presented for projects since Norfolk Vanguard for both gannet and kittiwake, although the Applicant should monitor final numbers for EA1N and EA2 as they progress through the examination.	Noted.
		Natural England stated that based on the findings presented, they believe an AEoI can be ruled out for the gannet feature of the FFC SPA from Hornsea Four impacts alone.	Noted.
		In order for Natural England to be satisfied that an AEoI can be ruled out for the auk features of the FFC SPA, they request that connectivity between the Hornsea Four array area and the Flamborough / Frisian front is assessed.	Description of the Flamborough Front and relative location with respect to the Hornsea Four array area is provided in **Volume A5, Annex 1.1: Marine Processes Technical Report**, although it should be noted that the Flamborough Front is a constant shifting band of water. Connectivity between the front and

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
			Hornsea Four in relation to auk species and disturbance is addressed in Section 10.4.4.
		Natural England stated that their reasoning for an AEoI for kittiwake is set out in the feedback they provided to Norfolk Boreas in their deadline 4 feedback note.	The Applicant has referred to the specified advice note when interpreting the results of the PVA in Section 11.4.3 for kittiwake.
		Natural England confirmed agreement on the productivity rate of 0.722 + / - 0.210 for the kittiwake feature of the FFC SPA.	The Applicant has used the agreed productivity rate for the PVA assessments presented in Section 11.4.3.
Offshore Ornithology Evidence Plan Technical Panel Meeting Fourteen, 04/03/2021	Natural England	Natural England advised that PVA results should present the counterfactuals of reduction in growth rate and the final population size should be presented, recognising that the two counterfactuals have varying reliability in different contects.	The Applicant disagrees with the applicability of the use of final population size for assessment and have presented the results of PVA for reduction in population growth only. When considering which PVA to use density independent PVA analysis was advised as Natural England's preference. However, due to the absence of population regulation being included within PVA's using density independence, which cause populations to grow exponentially or decline with no means of recovery as would occur naturally, it is therefore not appropriate to use the final population size as a determining factor as it does not have sufficient consideration within the modelling. It is understood that the use of final population size should only be used when running density dependant PVA, where population regulation is included in the model. As Natural England currently disagree with the use of density dependant PVA modelling for use in impact

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
			assessments it is therefore not possible to provide a reliable final population size from PVA for impact assessments if only density independence PVAs are run.
		Natural England requested that the Hornsea Four array area is put into wider context in terms of the importance of array area for auk species in order to draw conclusions and consider displacement and mortality ranges. In particular, during the post breeding months as some of the population will be flightless during this period due to moulting. Natural England suggested looking at combining habitat modelling and density hotspots areas.	A process of analysing and interpreting data from the Hornsea Four array area and wider regions was undertaken as requested, with particular focus on the connectivity between the Flamborough Front during the post breeding dispersal period for auks and density hotspot areas as indentified from tracking studies for auks detailed in Section 10.4.4.
Hornsea Four Evidence Plan Marine Mammals Meeting #9 10/05/2021	The Wildlife Trusts Natural England MMO Cefas	Discussion with TWT around bottlenose dolphin data from Sea Watch and potential connectivity between east England and Scotland. Request to include in ES and HRA.	Screening for bottlenose dolphin revisited in Section 8.1.
		Request for any updates to UXO assessment in the ES that are relevant to the HRA be carried across.	RIAA updated in line with the ES.
Natural England advice note ref 357238, 21/06/2021	Natural England	Natural England provided detailed comments and recommendations based on drafts of the offshore ornithology ES, RIAA and associated annexes and appendices from early 2021. These documents were provided in order for Natural England to see how previous consultation and comments from 2020 had been incorporated and in order for their new advisors to review the project to this point in time.	These comments and recommendations were discussed at an Offshore Ornithology Evidence Plan Technical Panel meeting between the Applicant and Natural England, and have been incorporated into the final ES Chapter, RIAA and associated annexes and appendices where the Applicant considers appropriate.
		Within this advice note Natural England recommended that the Northumberland Marine SPA be included in the list of designated sites, as it has guillemot and puffin as qualifying features relevant to the displacement assessment. Natural England note that the relevant species are covered by the component SPAs within the wider site, however for clarity and	The Northumberland Marine SPA was removed from the original HRA Screening following previous advice from Natural England. This was due to all the qualifying features for the Northumberland Marine SPA being associated with four separate SPAs (Farne Islands SPA,

Date and consultation phase/ type	Consultee	Consultation and key issues raised	Section where comment addressed
		completeness the SPA should be listed as an SPA in the list of designated sites considered.	Coquet Island SPA, Lindisfarne SPA (screened out) and Northumbria Coast SPA) that it overlaps and therefore being covered by individual screening considerations and subsequent assessments of those SPAs. However, in order to ensure that all relevant SPAs are included within this RIAA the Applicant has provided a further set of updates in this final RIAA covering the Northumberland Marine SPA.
Natural England advice note ref 359042, 22/07/2021	Natural England	On review of the Applicant's latest position on gannet assessments in relation to collision risk and displacement Natural England confirmed that, pending receipt of the updated PVA, they are minded to advise that Hornsea Four alone will not result in an AEoI. Natural England's advice (pending receipt of the updated PVA), is that they are minded to advise that Hornsea Four in-combination with those projects already submitted into Examination will likely be at a similar level to that which they have previously concluded no AEoI for gannet at FFC SPA (they also note they do not agree with the current impact predictions for Dudgeon and Sheringham Shoal Extension Projects).	Noted.

6 Project Overview

6.1 Introduction

6.1.1.1 The RIAA draws on **Volume A1, Chapter 4: Project Description** which includes an 'envelope' designed to include necessary flexibility to accommodate further project refinement and optimisation during detailed design, post consent. The proposed wind farm array area is 468 km^2, located approximately 69 km from the Yorkshire coastline at its closest point. A maximum of 180 wind turbines is proposed, with the maximum rotor blade diameter of 305 m. The ultimate capacity of the project can only be determined post-consent based on technical and commercial factors, for example the capacity awarded at auction.

6.1.1.2 The power from the Hornsea Four array area to the UK National Grid will be transmitted using HVAC or HVDC with up to six cable circuits installed within the offshore ECC. Hornsea Four requires flexibility in the choice of transmission system to ensure that anticipated changes in available technology and project economics can be accommodated within the Hornsea Four design. It is important to note that such an approach was accepted by the SoS for Hornsea Three.

6.1.1.3 The offshore export cables will make landfall south of Bridlington. Electricity generated will be transported via a maximum of six circuits installed in six trenches and an onshore HVDC converter/HVAC substation to allow the power to be transferred to the National Grid via the existing Creyke Beck National Grid substation.

6.1.1.4 Full details on the project description are presented within the ES, specifically in **Volume A1, Chapter 4: Project Description**. It is noted that for a number of aspects of the project, a range of options are available, particularly during the construction phase. To manage the potential for impact, and in line with both the PEIR and PINS Advice Note 9: Rochdale Envelope, the project elements that represent the maximum design scenario (MDS) for each topic (the 'Rochdale Envelope') have been identified and taken forward.

6.1.1.5 The Screening report identified a number of receptor groups, with the topic-specific MDS for each group presented within the relevant chapter from the ES. The receptor groups identified are: benthic and intertidal ecology; marine mammals; offshore and intertidal ornithology; (onshore) ecology and nature conservation; and migratory fish. Migratory fish and onshore ecology are screened out from potential LSE (**Appendix A**) and therefore are not assessed here.

6.1.1.6 The relevant MDS applied here and drawing on the above ES chapters, are described below.

6.2 Project Description

6.2.1.1 The project description is described in detain is **Volume A1, Chapter 4: Project Description**. Impact-specific MDS relevant to the RIAA are described in **Appendix F**.

6.2.2 Hornsea Four array area

6.2.2.1 The Hornsea Four array area is approximately 69 km due east of Flamborough Head, at its closest point. Water depths generally vary from around 30 m below Chart Datum

(CD) in the south of the Hornsea Four array area to more than 60 m below CD in the north, although the greatest depths are on the north-eastern flank which shelves into Outer Silver Pit. Sandwaves are present within the Hornsea Four array area, particularly across the north western corner and also along the southern margin. Surficial sediments across the Hornsea Four array area are typically sandy material with small amounts of gravel and muds. The main exception is along the southern boundary where there is a slightly higher percentage of gravels and a coarser substrate described as slightly gravelly sand.

6.2.3 Hornsea Four offshore ECC

6.2.3.1 Depths across the Hornsea Four offshore ECC are relatively similar to the Hornsea Four array area until closer to the coastline. Sediments across the Hornsea Four offshore ECC show an increasing gravel content towards the coast, transiting from the sandy Hornsea Four array area into slightly gravelly sand, gravelly sand to sandy gravel. The beach at landfall, south of Bridlington, itself is a thin veneer of sand over rock.

6.2.4 Hornsea Four onshore ECC

6.2.4.1 Underground cables will connect the landfall first to the onshore substation and then on to the National Grid substation at Creyke Beck. Where possible and practical, less intrusive construction methods will be adopted (see Co1 in **Volume A4, Annex 5.2: Commitments Register** of the ES) All main rivers, Internal Drainage Board (IDB) maintained drains, main roads and railways will be crossed by Horizontal Directional Drilling (HDD) or other trenchless technology as set out in **Volume A4, Annex 4.2: Onshore Crossing Schedule**. Where HDD technologies are not practical, the crossing of ordinary watercourses may be undertaken by open cut methods. In such cases, temporary measures will be employed to maintain flow of water along the watercourse. Cables will be delivered in sections and buried in trenches, which will subsequently be reinstated to pre-existing condition as far as reasonably practical. Sections will be connected within jointing bays.

6.2.5 Hornsea Four onshore substation

6.2.5.1 The onshore substation (OnSS) will be located as close as practical to the National Grid Energy Transmission (NGET) substation at Creyke Beck and will include all necessary electrical plant to meet the requirements of the National Grid. The OnSS contains the electrical components for transforming the power supplied from the wind farm to 400 kV and to adjust the power quality and power factor, as required to meet the UK Grid Code for supply to the National Grid.

6.3 Consideration of Alternatives

6.3.1.1 The Applicant has undertaken an extensive process to determine final site selection and a consideration of alternatives. The process followed, together with the reasons behind the final project site selection and alternatives considered (in terms of location and methods) is presented in full in **Volume A1, Chapter 3: Site Selection and Consideration of Alternatives** of the ES. Additional information on alternatives, specifically in relation to the HRA process, is provided within **Without Prejudice Derogation Case B2.5**.

6.3.1.2 The approach taken to site selection and alternatives has involved early engagement with stakeholders, together with a range of electrical, engineering, ecological and socio-economic considerations.

6.3.1.3 The site selection process began early in the project lifetime and involved the following stages:

- Stage 1 – Identification of the Offshore Array and Infrastructure;
- Stage 2 – Identification of an Electrical Infrastructure Study Area;
- Stage 3 – Identification of the Landfall;
- Stage 4 – Identification of the Onshore Site Substation; and
- Stage 5 – Identification of the Onshore and Offshore Export Cable Routes.

6.3.1.4 These stages reflect the sequential nature of the site selection process between components, as follows:

- Round 3 Zone. Smart Wind lead the Zone Appraisal and Planning (ZAP) process. The ZAP process resulted in the identification and subsequent application and award of the Agreement for Lease (AfLs) for the Hornsea Projects One through to Four;
- Orsted acquired the Hornsea Zone and the associated AfLs from Smart Wind in 2015.
- Development of the Hornsea Four AfL began in early 2018;
- The location of the final wind farm array within the Hornsea Four AfL was determined via a further site refinement process involving internal and external stakeholders through a series of workshops between March 2019 and April 2021, known as the Developable Area Approach (DAA), which resulted in a major reduction to the AfL from an initial 846km^2 to a final 468km^2;
- The grid connection point is agreed in dialogue with National Grid as part of the Connection and Infrastructure Options Note (CION) process. The location of the OnSS has been the subject of a site selection process led by the Applicant;
- The location of the landfall is influenced by the location of the AfL and OnSS;
- The route of the offshore ECC is influenced by the location of the wind farm array and the landfall; and
- The route of the onshore ECC is influenced by the location of the landfall and OnSS.

6.3.1.5 Key principles applied during the site selection and alternatives process can be summarised as follows:

- Route preference for cable routing aimed to minimise environmental impact (such as shortest route where possible, minimising overlap with European sites, noting all sites avoided by the offshore ECC, with overlap with a single site as a consequence of the location of the AfL), disturbance, cost and transmission losses;
- Avoidance of key sensitive features (such as European site boundaries and features) where possible;
- Minimisation of disruption to populated areas; and
- The need to accommodate the range of technology sought within the design envelope.

6.3.2 Consultation on site selection

6.3.2.1 Consideration has been given to feasible alternatives at every stage of the process of developing Hornsea Four. This has formed a fundamental driver for every decision within the project, from the technical options within the engineering side to the micro-siting and route changes during the development of the cable routes.

6.3.2.2 Consultation is a key part of this process informing all stages and has helped to refine the project through wider spatial, design and process considerations discussed in broader forums, both formally through Evidence Plan meetings, DAA workshops or more informally through the feedback received through public events. Following receipt of the Scoping Opinion, the project consulted with a range of interested parties on the potential for array area refinement (see **Table 2**). This process was iterative, taking account of refinements to the offshore ECC search area and the latest site-specific data to ensure that options were aligned and site appropriate. Consideration was given to several technical, commercial and environmental consenting constraints (Section 7.1 of **Volume A4, Annex 3.2: Selection and Refinement of the Offshore Infrastructure**) informed by data analysis and constraints mapping prior to presentation and consultation with key stakeholders.

6.3.2.3 Full details of the project consultation process and mechanisms are presented within **Volume A1, Chapter 6: Consultation** and **B1.1: Consultation Report**. **Table 2** provides a summary of events undertaken and scheduled to inform the site selection process.

Table 2: Summary of Consultation Undertaken to Inform the Site Selection Process.

Dates	Events	Objective
Offshore ECC		
November 2018	Informal consultation events	To acquire public and stakeholder feedback to inform route planning within scoping boundary to enable cable route refinement and inform PEIR submission.
September 2019	Section 42 and 47 consultation	To inform route planning and site selection.
Offshore Array		
November 2018	Informal consultation events for public and stakeholders	To inform route planning and site selection process within the scoping boundary.
Q2 2019	DAA stakeholder engagement	Meeting relevant stakeholders to obtain information and opinions on the DAA.
June 2019	DAA#1	Inform on the Hornsea Four decision to adopt a major site reduction as a consequence of the DAA process.
September 2019	Section 42 and 47 Consultation	Public and stakeholder consultation to inform developable area.
September 2020	DAA#2	Stakeholder engagement (DFDS, and Chamber of Shipping) on shipping and navigation uses and confirmation of site reduction to minimise impacts.
May 2021	DAA#3	Stakeholder engagement (Natural England and RSPB) on ornithology issues and confirmation of site reduction to reduce impacts on ornithology.

Dates	Events	Objective
Landfall		
November 2018	Informal consultation events to acquire public and stakeholder feedback	To inform route planning within the scoping boundary.
Q2 2019 and Q3-4 2019	Landfall Working Group meetings	To obtain information and opinions on the landfall site selection.
September 2019	Section 42 and 47 consultation	To inform final site selection and mitigation.
Onshore ECC		
October 2018	Local Information Events	Series of events to obtain feedback to inform route planning within the scoping boundary.
Q3 2018 – Q1 2019	Landowner Feedback	Liaison with landowners on indicative 80 m export cable corridor
Q3 2018 – Q1 2019 and Q3-Q4 2019	Cable Corridor Working Group	Meetings with local parish councils top obtain information and opinions on route planning.
September 2019	Section 42 and 47 consultation	To Inform route refinement and mitigation.
Onshore substation		
November 2018	Informal Consultation events	To inform site selection within scoping boundary.
Q1-Q2 2019	Onshore Substation Working Group	Meetings with local parish councils to obtain information and opinions on site selection.
September 2019	Section 42 and 47 consultation	To obtain feedback to inform detailed site layout design and mitigation.
Q3-Q4 2019	Onshore Substation Working Group	Engagement on design amendments and mitigation.

6.4 Maximum Design Scenario

6.4.1.1 The MDS is referred to throughout the ES and here in the RIAA. This approach ensures that the scenario that would have the greatest impact (e.g. largest footprint, longest exposure, or tallest dimensions, depending on the topic) is assessed; we can be confident that any other (lesser) scenarios will have an impact that is no greater than that assessed.

6.4.1.2 The Screening Report identified a number of receptor groups, with the topic specific maximum adverse scenario for each group presented within the relevant chapter from the ES. Where a receptor group remains screened in for potential LSE (noting that migratory fish and onshore ecology are screened out from potential LSE), these chapters are drawn on here. The receptor groups are outlined below, together with the relevant ES chapter:

- Table 2.12 from **Volume A2, Chapter 2: Benthic and Intertidal Ecology**;
- Table 4.10 from **Volume A2, Chapter 4: Marine Mammals**;
- Table 5.17 from **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**;
- Table 3.15 from **Volume A3, Chapter 3: Ecology and Nature Conservation**; and
- Table 3.10 from **Volume A2, Chapter 3: Fish and Shellfish Ecology**.

6.4.1.3 The maximum design scenario, as it applies to each receptor group, is defined in **Appendix F** and draws on the information presented in the tables listed above in the individual ES chapters. For clarity regarding the differences between receptor groups, the information is presented according to individual project parameters, including a note regarding why the scenario is relevant to that receptor. Where relevant, the information includes any designed-in features which, whilst also providing mitigation, are integral to the design or physical characteristics of the project.

6.5 Construction Programme

6.5.1.1 An indicative programme of relevant construction works is presented in **Figure 3** below, illustrating the main project infrastructure elements and the window within which construction is expected to occur. The earliest possible construction start date is January 2024, with works at landfall expected broadly ~Q2 2025 – end 2027. The piling window is expected to fall within the window of ~Q4 2026 - ~Q4 2027, with any UXO clearance (if required) and associated geophysical survey work to occur within the pre-construction phase (specifically Q1 2026 – Q3 2026). The maximum total construction duration (onshore and offshore) is five years and one month (61 months).

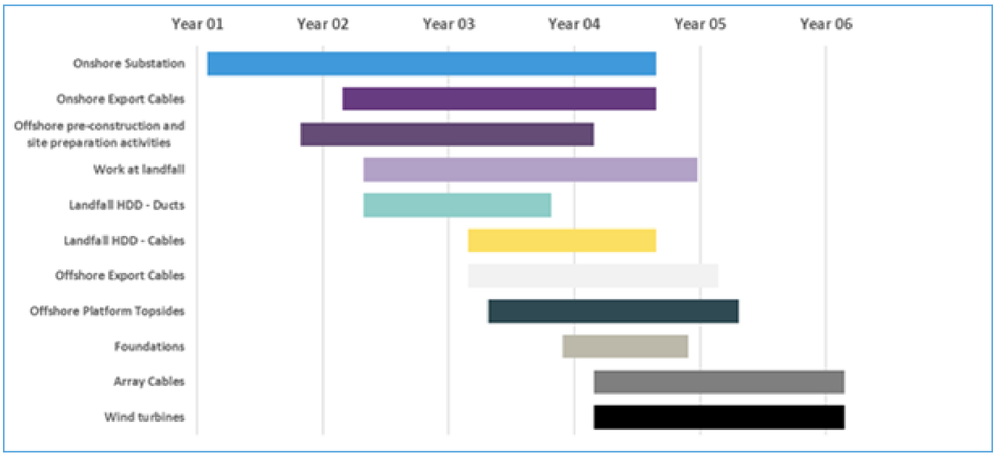


Figure 3: Indicative construction programme for Hornsea Four.

6.6 Operation, Maintenance and Decommissioning Programme

6.6.1.1 A full project description is provided in **Volume A1, Chapter 4: Project Description**, with Operation and Maintenance addressed in Section 4.11 of that chapter. **Appendix F** presents a summary of the MDS per receptor, including that during all phases of the project. A summary is provided here.

6.6.1.2 The overall operation and maintenance strategy will be finalised once the operation and maintenance base location and technical specification of Hornsea Four are known, including wind turbine generator type, electrical export option and final project layout. Maintenance operations will be undertaken throughout the operational life of Hornsea Four (anticipated 35 years) and will be both preventive (scheduled) and corrective (unexpected repairs).

6.6.1.3 The onshore operation and maintenance requirements for the onshore export cables will be largely corrective (because there is limited requirement for preventative maintenance on the onshore cables), accompanied by infrequent on-site inspections of the onshore export cables. Whereas, operation and maintenance requirements for the onshore substation and electrical balancing infrastructure will be both preventative and corrective.

6.6.1.4 At the end of the operational lifetime of Hornsea Four, it is anticipated that all structures above the seabed or ground level will be completely removed, with detail on removal for aspects such as scour protection, cables and cable protection as follows:

- Any scour protection left *in situ*;
- Expected that most cables will be left *in situ*, exposed cables to be removed;
- Rock protection to be left *in situ* as it is deemed more harmful to remove it. If removed, would be done by a dredger or grab but only if it is determined at the time that it is not more harmful than leaving *in situ*.

6.6.1.5 The decommissioning sequence will generally be the reverse of the construction sequence and involve similar types and numbers of vessels and equipment. The decommissioning plan and programme will be updated during Hornsea Four's lifespan to take account of changing best practice and new technologies. The approach and methodologies employed at decommissioning will be compliant with the legislation and policy requirements at the time of decommissioning.

7 Commitments

7.1.1.1 The information on Commitments per receptor draws on individual topic chapters. All Commitments relevant to the RIAA are summarised below in **Table 3** including the route for securing each Commitment. Further detail on these Commitments is presented in **Volume A4, Annex 5.2: Commitments Register**. Commitments are not taken into account during the consideration of potential LSE, however Commitments are a consideration during the determination of potential for adverse effect within the design scenario assessed. The approach ensures the RIAA is compliant with the People over Wind ruling referenced in **Section 3.1**.

Table 3: Hornsea Four Commitments.

Commitment ID	Commitment	Mechanism for Securing Commitment
Subtidal and intertidal benthic ecology		
Co2	A range of sensitive historical, cultural and ecological conservation areas (including statutory and non-statutory designations) have been directly avoided by the permanent Hornsea Four footprint, at the point of Development Consent Order Submission (DCO). These include, but are not restricted to: Listed Buildings (564 sites); Scheduled Monuments (30 sites); Registered Parks and Gardens (Thwaite Hall and Risby Hall); Onshore Conservation Areas (18 sites); Onshore National Site Network (one site); Offshore National Site Network (three sites); Offshore Marine Conservation Zones (two sites); Sites of Special Scientific Interest (two sites); Local Nature Reserves (none have been identified); Local Wildlife sites (33 sites); Yorkshire Wildlife Trust Reserves (none have been identified); Royal Society for the Protection of Birds (RSPB) Reserves (none have been identified); Heritage Coast; National Trust land; Ancient Woodland (10 sites and known Tree Preservation Orders (TPOs)); non-designated built heritage assets (334 sites); and historic landfill (none have been identified). Where possible, unprotected areas of woodland, mature and protected trees (i.e. veteran trees) have and will also be avoided.	DCO Works Plan -Onshore (**Volume D1, Annex 4.2: Works Plan – Onshore**); and DCO Works Plan - Offshore (**Volume D1, Annex 4.1: Works Plan – Offshore**)
Co48	Habitats of principal importance (Section 41 of the 2006 Natural Environment and Rural Communities (NERC) Act) will be avoided where possible, informed through the undertaking of survey works pre-construction.	DCO Schedule 11, Part 2 - Condition 13(1)(a)(v) and; DCO Schedule 12, Part 2 - Condition 13(1)(a)(v) (Pre-construction plans and documentation)
Co82	A Scour Protection Management Plan will be developed. It will include details of the need, type, quantity and installation methods for scour protection.	DCO Schedule 11, Part 2 - Condition 13(1)(e) and; DCO Schedule 12, Part 2 - Condition 13(1)(e) (Scour Protection Management Plan)
Co83	Where possible, cable burial will be the preferred option for cable protection.	DDCO Schedule 11, Part 2 - Condition 13(1)(h) and; DCO Schedule 12, Part 2 - Condition 13(1)(h) (Cable specification and installation plan)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co84	Presence of habitats of principal importance (Section 41 of the 2006 Natural Environment and Rural Communities (NERC) Act) will be identified through a review of the latest available benthic datasets and pre-construction surveys. Foundations and cables will be micro-sited around habitats of principal importance wherever reasonably practicable (subject to agreement with the MMO) to an extent not resulting in a hazard for marine traffic and Search & Rescue capability.	DCO Schedule 11, Part 2 - Condition 13(1)(a)(v) and; DCO Schedule 12, Part 2 - Condition 13(1)(a)(v) (Pre-construction plans and documentation)
Co86	The offshore export cable corridor and cable landfall (below MHWS) will not cross the Greater Wash SPA, Flamborough & Filey Coast SPA and the Flamborough Head SAC.	DCO Works Plan - Offshore (**Volume D1, Annex 4.1: Works Plan – Offshore**)
Co111	A Construction Project Environmental Management and Monitoring Plan (CPEMMP) will be developed and will include details of: - a marine pollution contingency plan to address the risks, methods and procedures to deal with any spills and collision incidents of the authorised project in relation to all activities carried out below MHWS; - a chemical risk review to include information regarding how and when chemicals are to be used, stored and transported in accordance with recognised best practice guidance; - a marine biosecurity plan detailing how the risk of introduction and spread of invasive non-native species will be minimised; - waste management and disposal arrangements; - a vessel management plan, to determine vessel routing to and from construction sites and ports, to include a code of conduct for vessel operators; and - the appointment and responsibilities of a company fisheries liaison officer.	DCO Schedule 11, Part 2 - Condition 13(1)(d) and; DCO Schedule 12, Part 2 - Condition 13(1)(d) (Construction Project Environmental Management and Monitoring Plan)
C0181	An Offshore Decommissioning Plan will be developed prior to decommissioning.	DCO Schedule 11, Part 1(6) and; DCO Schedule 12, Part 1 (6) (General Provisions)
Co187	The installation of the offshore export cables at landfall will be undertaken by Horizontal Directional Drilling or other trenchless methods.	DCO Requirement 17 (Code of construction practice); and DCO Schedule 12, Part 2 - Condition 13(1)(h) (Cable specification and installation plan)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co188	No cable protection will be employed within 350 m seaward of MLWS.	DCO Schedule 11, Part 2 - Condition 13(1)(h) and; DCO Schedule 12, Part 2 - Condition 13(1)(h) (Cable specification and installation plan)
Co189	The Dogger Bank cable crossing will be positioned east of Smithic Bank (as identified at https://data.gov.uk/dataset/d19f631c-27c0-4c74-804f-d76a4632b702/annex-i-sandbanks-in-the-uk-v2-public) and seaward of 20 m depth contour.	DCO Schedule 11, Part 2 - Condition 13(1)(h) and; DCO Schedule 12, Part 2 - Condition 13(1)(h) (Cable specification and installation plan)
Co201	Gravity Base Structure (GBS) foundations (WTG type) will be utilised at a maximum of 110 of the 180 WTG foundation locations. The location of GBS foundations, if used for WTG, will be confirmed through a construction method statement which will include details of foundation installation methodology.	DCO Schedule 11, Part 2 - Condition 13(1(c) (Construction Method Statement)
Marine Mammals		
Co85	No more than a maximum of two foundations are to be installed simultaneously.	DCO Schedule 11, Part 2 - Condition 13(1)(g) and; DCO Schedule 12, Part 2 - Condition 13(1)(g) (Marine mammal mitigation protocol) DCO Schedule 11, Part 2 - Condition 13(1)(c) and; DCO Schedule 12, Part 2 - Condition 13(1)(c) (Construction method statement)
Co108	A Vessel Management Plan (VMP) will be developed pre-construction which will determine vessel routing to and from construction areas and ports to minimise, as far as reasonably practicable, encounters with marine mammals.	DDCO Schedule 11, Part 2 - Condition 13(1)(d)(v) and; DCO Schedule 12, Part 2 - Condition 13(1)(d)(v) (Vessel management plan)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co110	A piling Marine Mammal Mitigation Protocol (MMMP) will be developed in accordance with the Outline MMMP and will be implemented during construction. The piling MMMP will include measures to ensure the risk of instantaneous permanent threshold shift (PTS) to marine mammals is negligible and will be in line with the latest relevant available guidance. The piling MMMP will include details of soft starts to be used during piling operations with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels.	DCO Schedule 11, Part 2 - Condition 13(1)(g) and; DCO Schedule 12, Part 2 - Condition 13(1)(g) (Marine mammal mitigation protocol)
Co111	A Construction Project Environmental Management and Monitoring Plan (CPEMMP) will be developed and will include details of: - a marine pollution contingency plan to address the risks, methods and procedures to deal with any spills and collision incidents of the authorised project in relation to all activities carried out below MHWS; - a chemical risk review to include information regarding how and when chemicals are to be used, stored and transported in accordance with recognised best practice guidance; - a marine biosecurity plan detailing how the risk of introduction and spread of invasive non-native species will be minimised; - waste management and disposal arrangements; - a vessel management plan, to determine vessel routing to and from construction sites and ports, to include a code of conduct for vessel operators; and - the appointment and responsibilities of a company fisheries liaison officer.	DDCO Schedule 11, Part 2 - Condition 13(1)(d) and; DCO Schedule 12, Part 2 - Condition 13(1)(d) (Construction Project Environmental Management and Monitoring Plan)
Co113	A Decommissioning Marine Mammal Mitigation Protocol (MMMP) will be implemented during decommissioning. The Decommissioning MMMP will be approved by the Marine Management Organisation (MMO) in consultation with Natural England. The Decommissioning MMMP will include measures to ensure the risk of instantaneous permanent threshold shift (PTS) to marine mammals is negligible and will be in line with the latest relevant available guidance.	A separate Marine Licence will be applied for at the point of decommissioning which will include Conditions relevant to minimising impacts on marine mammals where appropriate.
C0181	An Offshore Decommissioning Plan will be developed prior to decommissioning.	DCO Schedule 11, Part 1(6) and; DCO Schedule 12, Part 1 (6) (General Provisions)
Offshore Ornithology		
Co86	The offshore export cable corridor and cable landfall (below MHWS) will not cross the Greater Wash SPA, Flamborough & Filey Coast SPA and the Flamborough Head SAC.	DCO Works Plan - Offshore (**Volume D1, Annex 4.1: Works Plan – Offshore**)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co87	Proposed developable area has been selected and refined from the larger Hornsea Four Agreement for Lease (AfL) area to avoid areas with the highest concentrations of birds (kittiwake, gannet and guillemot) that are more likely to be displaced by the construction activities, and birds that are more likely to fly at heights that brings them within the rotor swept zone and hence at risk of collision.	DCO Works Plan - Offshore (**Volume D1, Annex 4.1: Works Plan – Offshore**)
Co88	Construction and operational maintenance vessels (e.g. CTVs) will avoid high concentrations of rafting red-throated diver.	DCO Schedule 11, Part 2 - Condition 13(1)(d)(v) and; DCO Schedule 12, Part 2 - Condition 13(1)(d)(v) (Vessel Management Plan)
Co138	Lower air draught of wind turbines will be a minimum of 40 m above Mean Sea Level (MSL) 42.43 m above Lowest Astronomical Tide (LAT)).	DCO Requirement 2(2)(c) (Detailed offshore design parameters) DCO Schedule 11, Part 2 - Condition 1(2)(c) (Design parameters)
C0181	An Offshore Decommissioning Plan will be developed prior to decommissioning.	DCO Schedule 11, Part 1(6) and; DCO Schedule 12, Part 1 (6)
Onshore Ecology		
Details regarding Commitments that Hornsea Four have embedded within the project design that are related to onshore ecology are presented in Table 3.12 of **Volume A3, Chapter 3 Ecology and Nature Conservation**.		
Co1	All Environment Agency (EA) main rivers, Internal Drainage Board (IDB) maintained drains, main roads and railways will be crossed by HDD or other trenchless technology as set out in the Onshore Crossing Schedule. Where HDD technologies are not practical, the crossing of Ordinary watercourses may be undertaken by open cut methods. In such cases, temporary measures will be employed to maintain flow of water along the watercourse. Main rivers will not be temporarily dammed and/or rerouted.	DCO Requirement 17 (Code of construction practice)
Co2	A range of sensitive historical, cultural and ecological conservation areas (including statutory and non-statutory designations) have been directly avoided by the permanent Hornsea Four footprint, at the point of Development Consent Order Submission (DCO). These include, but are not restricted to: Listed Buildings (564 sites); Scheduled Monuments (30 sites); Registered Parks and Gardens (Thwaite Hall and Risby Hall); Onshore Conservation Areas (18 sites); Onshore National Site Network (one site); Offshore National Site Network (three sites); Offshore Marine	DCO Works Plan -Onshore (**Volume D1, Annex 4.2: Works Plan – Onshore**); and DCO Works Plan - Offshore

Commitment ID	Commitment	Mechanism for Securing Commitment
	Conservation Zones (two sites); Sites of Special Scientific Interest (two sites); Local Nature Reserves (none have been identified); Local Wildlife sites (33 sites); Yorkshire Wildlife Trust Reserves (none have been identified); Royal Society for the Protection of Birds (RSPB) Reserves (none have been identified); Heritage Coast; National Trust land; Ancient Woodland (10 sites and known Tree Preservation Orders (TPOs)); non-designated built heritage assets (334 sites); and historic landfill (none have been identified). Where possible, unprotected areas of woodland, mature and protected trees (i.e. veteran trees) have and will also be avoided.	(**Volume D1, Annex 4.1: Works Plan – Offshore**)
Co4	A Pollution Prevention Plan (PPP) will be developed in accordance with the outline PPP and will include details of emergency spill procedures. Good practice guidance detailed in the Environment Agency's Pollution Prevention Guidance (PPG) notes (including PPG01, PPG05, PPG08 and PPG21) will be followed where appropriate, or the latest relevant available guidance.	DCO Requirement 17 (Code of construction practice)
Co7	The construction work area associated with onshore export cable corridor will be 80 m working width to minimise the construction footprint, except at the Network Rail Crossing near Beswick, the approach to landfall and the approach to the onshore substation. At the Network Rail Crossing the working width is extended up to 120 m to facilitate HDD of the railway line. The permanent onshore export cable corridor width will be 60m except where obstacles are encountered such as the Network Rail Crossing near Beswick (where the permanent footprint may be extended up to 120 m to facilitate HDD of the railway line), and on the approach to the landfall and onshore substation.	DCO Works Plan -Onshore (**Volume D1, Annex 4.2: Works Plan – Onshore**);
Co18	HDD entry and exit points will be located at least 9 m away from IDB and Ordinary surface watercourses and 20m from EA surface water courses or the landward toe of the EA surface watercourse's flood defences. Where a surface watercourse is to be crossed by HDD, the onshore export cables will be installed at least 1.2 m beneath the hard bed of any watercourses and the optimal clearance depth beneath watercourses will be agreed with the relevant authorities prior to construction. Where EA flood defences are present a minimum 1.2 m vertical clearance will be maintained between the hard bed of the watercourse and the landward toe of those flood defences. Where Hornsea Four crosses sites of particular sensitivity (e.g. embanked EA watercourses, SSSIs or groundwater Inner Source Protection Zones (SPZs)) a hydrogeological risk assessment will be undertaken to inform a site specific crossing method statement which will also be agreed with the relevant authorities prior to construction.	DCO Requirement 17 (Code of construction practice)
Co26	Where hedgerows and/or trees require removal, this will be undertaken prior to topsoil removal. Sections of hedgerows and trees which are removed will be replaced using like for like hedgerow species.	DCO Requirement 17 (Code of construction practice); and DCO Requirement 10 (Ecological Management Plan)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co27	Trees identified to be retained within the Onshore Crossing Schedule will be fenced off and worked around. Where works are required close to trees that will remain in situ, techniques will be used to safeguard the root protection zone.	DCO Requirement 17 (Code of construction practice); and DCO Requirement 10 (Ecological Management Plan)
Co30	A Landscape Management Plan will be developed in accordance with the Outline Landscape Management Plan. The Landscape Management Plan will include details of mitigation planting at the onshore substation site, including the number, location, species and details of management and maintenance of planting. Where practical, landscape mitigation planting will be established as early as reasonably practicable in the construction phase.	DCO Requirement 8 (Provision of landscaping)
Co33	All vegetation requiring removal will be undertaken outside of the bird breeding season. If this is not reasonably practicable, the vegetation requiring removal will be subject to a nesting bird check by a suitably qualified ECoW. If nesting birds are present, the vegetation will not be removed until the young have fledged or the nest failed.	DCO Requirement 10 (Ecological Management Plan); and DCO Requirement 17 (Code of construction practice).
Co35	Where required, provision will be made for badger access in relevant construction areas, when work is not taking place in order to ensure normal movements as far as reasonably possible. Provision will be made to ensure avoiding the entrapment of any animals within relevant construction areas. Checks will be made prior to the start of any works to ensure no animals are trapped. Appropriate checks will be made as required by the ECoW.	DCO Requirement 10 (Ecological Management Plan DCO Requirement 17 (Code of construction practice).
Co36	Core working hours for the construction of the onshore components of Hornsea Four will be as follows: • Monday to Friday: 07:00 - 18:00 hours; • Saturday: 07:00 - 13:00 hours; • Up to one hour before and after core working hours for mobilisation ("mobilisation period"), i.e. 06:00 to 19:00 weekdays and 06:00 to 14:00 Saturdays; and • Maintenance period 13:00 to 17:00 Saturdays. Activities carried out during mobilisation and maintenance will not generate significant noise levels (such as piling, or other such noisy activities). In circumstances outside of core working practices, specific works may have to be undertaken outside the core working hours. ERYC will be informed in writing.	DCO Requirement 17 (Code of construction practice)
Co41	All HDD crossings will be undertaken by non-impact methods in order to minimise construction vibration beyond the immediate location of works.	DCO Requirement 17 (Code of construction practice)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co65	A Site Waste Management Plan (SWMP) will be developed in accordance with the Outline Site Waste Management Plan, with consideration of the latest relevant available guidance.	DCO Requirement 17 (Code of construction practice)
Co68	All logistics compounds will be removed and sites will be reinstated when construction has been completed.	DCO Requirement 17 (Code of construction practice) DCO Requirement 20 (Restoration of land used temporarily for construction)
Co69	Construction site lighting will only operate when required and will be positioned and directed to avoid unnecessary illumination to residential properties, sensitive ecological receptors, footpath users, and minimise glare to users of adjoining public highways. Construction site lighting will be designed in accordance with latest relevant available guidance and legislation and the details of the location, height, design and luminance of lighting to be used will be detailed within the final Code of Construction Practice. The design of construction site lighting will accord with the details provided in the Outline Code of Construction Practice (Co124) and Outline Ecological Management Plan (Co168).	DCO Requirement 17 (Code of construction practice) DCO Requirement 10 (Ecological Management Plan)
Co78	All ponds identified during the route planning and site selection process have been avoided where possible. During construction and newly identified ponds will be avoided through micro-siting of the onshore export cable where reasonably practicable.	DCO Requirement 10 (Ecological Management Plan)
Co114	Good practice air quality management measures will be applied where human receptors reside within 350 m of works or ecological receptors are present within 200 m, as described in Institute of Air Quality Management (IAQM) Guidance on the Assessment of Dust from Demolition and Construction 2014, version 1.1, or latest relevant available guidance.	DCO Requirement 17 (Code of construction practice)
Co119	In areas of confirmed presence, or potential for great crested newt (i.e. within 250 m of an identified great crested newt pond) appropriate exclusion fencing will be erected and working areas 'trapped out' prior to the commencement of relevant onshore construction works, in line with Great crested newt mitigation guidelines, English Nature, 2001 or the latest available relevant guidance.	DCO Requirement 10 (Ecological Management Plan) DCO Requirement 17 (Code of construction practice)
Co120	Habitat manipulation will be undertaken in order to discourage reptiles from the working area(s). A qualified ecologist will undertake a search of all working areas identified as being suitable for reptiles. Any reptiles found within the working area will be relocated into suitable adjacent habitat.	DCO Requirement 10 (Ecological Management Plan) DCO Requirement 17 (Code of construction practice)

Commitment ID	Commitment	Mechanism for Securing Commitment
Co122	Prior to the commencement of construction activities, pre-construction surveys will be undertaken by the Ecological Clerk of Works (ECoW) where necessary, in accordance with the Outline Ecological Management Plan and latest available species specific guidance.	DCO Requirement 10 (Ecological Management Plan) DCO Requirement 17 (Code of construction practice)
Co123	Based on noise modelling results, where noise has the potential to cause significant adverse effects, mufflers and acoustic barriers will be used where HDD is being undertaken.	DCO Requirement 17 (Code of construction practice)
Co124	A Code of Construction Practice (CoCP) will be developed in accordance with the outline CoCP. The outline CoCP will include measures to reduce temporary disturbance to residential properties, recreational users and existing land users.	DCO Requirement 17 (Code of construction practice)
Co127	An Onshore Decommissioning Plan will be developed prior to decommissioning in a timely manner. The Onshore Decommissioning Plan will include provisions for the removal of all onshore above ground infrastructure and the decommissioning of below ground infrastructure and details relevant to flood risk, pollution prevention and avoidance of ground disturbance. The Onshore Decommissioning Plan will be in line with the latest relevant available guidance.	DCO Requirement 24 (Onshore decommissioning)
Co157	Fences, walls, ditches and drainage outfalls will be retained along the onshore export cable corridor and landfall, where possible. Where it is not reasonably practicable to retain them, any damage will be repaired and reinstated as soon as reasonably practical. The Environment Agency must be notified if damage occurs to any EA Main river or related flood infrastructure.	DCO Requirement 17 (Code of construction practice)
Co159	Operational noise from the onshore substation will be at a noise level no greater than 5dB above the representative background ($L_{A90,T}$) during the day time and night at the identified noise Sensitive Receptors, as stated within the onshore noise assessment (document reference A3.8).	DCO Requirement 21 (Control of noise during operational phase)
Co168	An Ecological Management Plan (EMP) will be developed in accordance with the Outline Ecological Management Plan (OEMP). The OEMP includes, but is not limited to pre-construction (Section 3), construction (Section 4) and post-mitigation measures (Section 5) relating to: habitats, hedgerows, birds, bats, badgers, otters, water voles, reptiles, great crested newts, terrestrial invertebrates, and other protected or notable species where relevant. The EMP will include details of any long-term mitigation and management measures relevant to onshore ecology and nature conservation The EMP will be developed in consultation with the relevant responsible authorities.	DCO Requirement 10 (Ecological Management Plan)
Co170	Joint bays and link boxes will be located a minimum of 20 m away from Environment Agency (EA) Main rivers.	DCO Requirement 17 (Code of construction practice)
Co172	The bed and banks of watercourses will be reinstated to their pre-construction condition following the removal of any temporary structures. Culverts will not be used for temporary access track crossings across EA Main Rivers. Where a	DCO Requirement 17 (Code of construction practice)

Commitment ID	Commitment	Mechanism for Securing Commitment
	temporary access track crossing across an EA Main River may be required, clear span/ bailey bridges will be used. There will be no loss of cross-sectional area to Environment Agency (EA) Main rivers.	
Co175	A pre and post construction condition survey will also be undertaken at each Environment Agency (EA) Main river crossings, including any flood defences to be crossed. The scope and methodology of the survey will be agreed in advance with the EA. On completion of the project, details of the surveys under each Main River and flood defence will be submitted to the EA.	DCO Requirement 17 (Code of construction practice)
Co193	Operational site lighting at the onshore substation will be designed in accordance with latest relevant available guidance and legislation and the details of the location, height, design and luminance of lighting to be used will be provided as part of detailed design for the onshore substation. The design of operation site lighting will accord with the details provided in the Outline Design Plan (Co195) and Outline Ecological Management Plan (Co168).	DCO Requirement 7 (Detailed design approval onshore)
Co195	Detailed design will be developed for the Onshore Substation in accordance with the Outline Design Plan which will include details regarding design and access. Examples of such detailed design information includes (but are not limited to): building heights and form; site layout; external appearance and colours; vehicular and pedestrian access.	DCO Requirement 7 (Detailed design approval onshore)
Co196	The design of the attenuation feature will incorporate an appropriate landscaping to create an area of biodiverse habitat, as outlined in the Outline Enhancement Strategy.	DCO Requirement 22 (Enhancement Strategy)
Migratory Fish		
Co83	Where possible, cable burial will be the preferred option for cable protection.	DCO Schedule 11, Part 2 - Condition 13(1)(h) and; DCO Schedule 12, Part 2 - Condition 13(1)(h) (Cable specification and installation plan)
Co85	No more than a maximum of two foundations are to be installed simultaneously.	DCO Schedule 11, Part 2 - Condition 13(1)(g) and; DCO Schedule 12, Part 2 - Condition 13(1)(g) (Marine mammal mitigation protocol) DCO Schedule 11, Part 2 - Condition 13(1)(c) and;

Commitment ID	Commitment	Mechanism for Securing Commitment
		DCO Schedule 12, Part 2 - Condition 13(1)(c) (Construction method statement)
Co110	A piling Marine Mammal Mitigation Protocol (MMMP) will be developed in accordance with the Outline MMMP and will be implemented during construction. The piling MMMP will include measures to ensure the risk of instantaneous permanent threshold shift (PTS) to marine mammals is negligible and will be in line with the latest relevant available guidance. The piling MMMP will include details of soft starts to be used during piling operations with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels.	DCO Schedule 11, Part 2 - Condition 13(1)(g) and; DCO Schedule 12, Part 2 - Condition 13(1)(g) (Marine mammal mitigation protocol)
Co111	A Construction Project Environmental Management and Monitoring Plan (CPEMMP) will be developed and will include details of: - a marine pollution contingency plan to address the risks, methods and procedures to deal with any spills and collision incidents of the authorised project in relation to all activities carried out below MHWS; - a chemical risk review to include information regarding how and when chemicals are to be used, stored and transported in accordance with recognised best practice guidance; - a marine biosecurity plan detailing how the risk of introduction and spread of invasive non-native species will be minimised; - waste management and disposal arrangements; - a vessel management plan, to determine vessel routing to and from construction sites and ports, to include a code of conduct for vessel operators; and - the appointment and responsibilities of a company fisheries liaison officer.	DCO Schedule 11, Part 2 - Condition 13(1)(d) and; DCO Schedule 12, Part 2 - Condition 13(1)(d) (Construction Project Environmental Management and Monitoring Plan)
Co113	A Decommissioning Marine Mammal Mitigation Protocol (MMMP) will be implemented during decommissioning. The Decommissioning MMMP will be approved by the Marine Management Organisation (MMO) in consultation with Natural England. The Decommissioning MMMP will include measures to ensure the risk of instantaneous permanent threshold shift (PTS) to marine mammals is negligible and will be in line with the latest relevant available guidance.	A separate Marine Licence will be applied for at the point of decommissioning which will include Conditions relevant to minimising impacts on marine mammals where appropriate.
Co181	An Offshore Decommissioning Plan will be developed prior to decommissioning.	DCO Schedule 11, Part 1(6) and; DCO Schedule 12, Part 1 (6)
Co190	No impact piling within the HVAC search area (DCO Works No. 3) will be undertaken between 1st September and 16th October unless otherwise agreed with the relevant stakeholders.	DCO Schedule 12, Part 2 - Condition 23 (Piling restriction)

8 HRA Screening

8.1 Screening Undertaken for Hornsea Four Alone

8.1.1.1 As noted in **Section 1.4** above, the first stage to the HRA process is Screening, the process followed to identify the potential for LSE from the project, alone and or in-combination, on European sites of nature conservation importance. Screening for Hornsea Four alone was initially undertaken during Scoping, with the draft Screening Report issued in October 2018 for consultation, along with the Scoping Report. A subsequent update to screening was issued to Natural England in May 2019, following receipt of Natural England's comments on Screening in May 2019. A further key change to screening came in December 2019, in response to a new paper that explores seabird foraging ranges (Woodward et al. 2019, which updated the previously applied foraging ranges from Thaxter et al. 2012).

8.1.1.2 As a result of these various iterations and updates, a revised and updated Screening Report was drafted in May 2020 for clarity – the report incorporates the majority of the changes since the original Screening Report was issued (including responses to Natural England's comments). That report is appended here as **Appendix A**, which includes detail on all consultation carried out during Screening within Section 3 of **Appendix A**. The exception to that is accidental pollution, which had been screened out for no LSE on the basis of recent government advice[10], with control of accidental pollution deemed to be integral to the project. However, following the Eighth Marine Mammals Evidence Panel Meeting held on 4th June 2020, Natural England recommended screening accidental pollution in. The Screening Matrix incorporates all final decisions on HRA Screening and is appended as **Appendix B**, following the structure provided in PINS Advice Note 10[11]. The screening conclusions presented in **Table 4** therefore draw on **Appendix B** and includes potential for LSE as a result of accidental pollution for sites with which Hornsea Four has a physical overlap and where designated benthic habitats occur within the screening range applied for suspended sediment screening (16 km).

8.1.1.3 A further key change subsequent to the update to the Screening Report relates to the Hornsea Four AfL, which was 846 km^2 at the Scoping phase of project development. In the spirit of keeping with Hornsea Four's approach to Proportionate Environmental Impact Assessment (EIA), the project has due consideration to the size and location (within the existing AfL area) of the final project that is being taken forward to Development Consent Order (DCO) application. This consideration is captured internally as the "Developable Area Process", which includes Physical, Biological and Human constraints in refining the developable area, balancing consenting and commercial considerations with technical feasibility for construction.

8.1.1.4 The combination of Hornsea Four's Proportionality in EIA and Developable Area process has resulted in a marked reduction in the AfL taken forward at the point of DCO application. Hornsea Four adopted a major site reduction from the AfL presented at Scoping (846 km^2) to the Preliminary Environmental Information Report (PEIR) boundary (600 km^2), with a further reduction adopted for the Environmental Statement (ES), RIAA and DCO application (468 km^2) due to the results of the PEIR, technical considerations and stakeholder feedback. The evolution of the Hornsea Four Order Limits is detailed in

[10] https://www.gov.uk/guidance/appropriate-assessment
[11] https://infrastructure.planninginspectorate.gov.uk/wp-content/uploads/2015/06/Advice-note-10v4.pdf

Volume A1, Chapter 3: Site Selection and Consideration of Alternatives and **Volume A4, Annex 3.2: Selection and Refinement of the Offshore Infrastructure** and summarised here in **Section 6.3**.

8.1.1.5 For the RIAA, the change in the order limits means a reduction in the array boundary towards the south east and the north west. The screening approach (as presented in **Appendix A**), in terms of distances to relevant sites, has been confirmed here through the use of GIS, as that process is primarily driven by the spatial separation between Hornsea Four (and its zone of influence) and designated sites. The change in such distances is minimal in the context of the distances involved, is limited to designated sites located towards the easterly end of Hornsea Four, and has not result in in any change to the list of sites and features previously screened in for potential LSE. The updated ranges are included here in **Table 4**. The change in the Order Limits is, however, taken into account within the assessment presented in **Section 10** and **Section 11** where relevant.

8.1.1.6 For offshore ornithology, and in agreement with Natural England (OFF ORN-2.41 in **B1.1.1 Evidence Plan**), post-PEIR a number of additional migratory species of bird have been screened in. These additional designated features or components of bird assemblages have been included within **Appendix B** and **Table 4** and include Hornsea Mere SPA, Teesmouth and Cleveland SPA (as extended), Northumbria Coast SPA, Coquet Island SPA, the Farne Islands SPA and additional features for the Humber Estuary SPA and Ramsar. Screening of sites in Scotland along the east coast and Northern Isles are also detailed in **Table 4**.

8.1.1.7 A final update to the Screening presented in **Appendix A** has been prompted by consultation (**Table 1**), specifically the Marine Mammal Evidence Plan meeting on 10 May 2021. During that meeting, additional recent data was highlighted with respect to bottlenose dolphin sightings and potential connectivity between these dolphins and the Moray Firth SAC. In response, additional work is presented in **Volume A5, Annex 4.1: Marine Mammals Technical Report** and **Volume A2, Chapter 4: Marine Mammals,** and the site has been screened in for bottlenose dolphin only (with effects in line with those screened in for the Southern North Sea SAC with the exception of underwater noise in operation, for which physical overlap between the designated site and the array boundary would be required or accidental pollution, based on the criteria applied above).

8.1.1.8 Other than the information above and the note provided below, screening is not repeated or expanded on here further, with screening information for the project alone summarised in **Table 4,** as adapted from the Screening Matrix (**Appendix B**). **Table 4** summarises, on a site by site basis, the features screened in for potential LSE from the project alone. For information on sites/features/effects screened out from potential LSE, that is contained within the Screening Report and Screening Matrix (**Appendix B**) but is not reproduced in full here in the interests of brevity.The Screening Report (**Appendix A**) also included screening for potential LSE for onshore ecology and migratory fish, which confirmed that no potential for LSE alone had been identified.

8.1.1.9 Following a consultation exercise between the Applicant and Natural England the offshore ornithology assessments within the draft RIAA from early 2021 were provided in order for Natural England to see how previous consultation and comments from 2020 had been incorporated and in order for their new advisory team to review the project to this point in time (**Table 2**). Natural England provided comments and recommendations following this consultation, which were subject to further discussion between the Applicant and Natural England, as many of the assessments had been superceded inline with the comments made by Natural England in the final offshore ornithology RIAA and associated annexes and appendices. In their advice notes Natural England recommended that the Northumberland Marine SPA be included in the list of designated sites, as it has qualifying features relevant to the displacement assessment. Natural England note that the relevant species are covered by the component SPAs within the wider site, however for clarity and completeness the SPA should be listed as an SPA in the list of designated sites considered.

8.1.1.10 The Northumberland Marine SPA had previously been removed from the original HRA Screening following previous advice from Natural England. This was due to all the qualifying features for the Northumberland Marine SPA being associated with four separate SPAs (Farne Islands SPA, Coquet Island SPA, Lindisfarne SPA (screened out) and Northumbria Coast SPA) that it overlaps and therefore being covered by individual screening considerations and subsequent assessments of those SPAs. Following Natural England's most recent advice on this SPA and in order to ensure that all relevant SPAs are included within this RIAA the Applicant has provided a further set of updates in this final RIAA, including the HRA Screening Matrices (see **Appendix B**) covering the Northumberland Marine SPA in **Section 10.4** and **Section 11.4**.

8.1.2 Clarity on Screening for Supporting Habitats within the Greater Wash SPA

8.1.2.1 The Greater Wash SPA is designated for a number of bird species (red-throated diver, common scoter, non-breeding little gull and breeding sandwich tern, common tern and little tern[12]), and has been included in the Screening process here as summarised in **Table 4** but in more detail in **Appendix A** and **Appendix B**. It is acknowledged that designated species are dependant on a number of supporting habitats, however none of the Greater Wash SPA habitats have been identified through the Screening process (a combination of lack of connectivity, distance between works and the SPA and the scale and extent of works along the cable corridor). With respect to the comment by Natural England (see **Table 1**) on the draft RIAA issued at PEIR regarding habitat distribution and extent within the Greater Wash SPA, the following comments are added here for clarity.

- The cable corridor makes landfall at least 1.5 km distant from the boundary of the Greater Wash SPA. **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** and **Volume A5, Annex 1.1 Marine Processes Technical Report** are clear, in that the potential for any change to physical processes (and therefore the potential for any change to benthic habitats) at landfall are highly localised and therefore not sufficient to reach the Greater Wash SPA. Therefore, the intertidal works do not trigger inclusion of supporting habitats within the Greater Wash SPA in the Screening process;
- The offshore ECC no longer has any overlap with the Greater Wash SPA boundary (Co86). The ECC is formed of a roughly central section within which the cables will be installed, with a buffer to either side termed the 'temporary works area'. The inclusion of this temporary works area means that cables will on average be at least 500 m distant from the SPA boundary. There is therefore no potential for direct

[12] https://jncc.gov.uk/our-work/greater-wash-spa/

impact to supporting habitats within the SPA (**Table 3**) and so no trigger for inclusion within the Screening process. The minimal potential for secondary effects to supporting benthic habitats is addressed in the following points (bearing in mind the size of the Greater Wash SPA, which extends across some 3,536 km^2);
- Supporting habitat use in terms of where birds may be found is addressed in Screening through the consideration of the potential for displacement or disturbance, with potential for indirect consequences for prey (which may or may not be benthic species, depending on the designated feature) addressed through consideration of prey resource; and
- In terms of direct usage of subtidal benthic habitat by the designated species, such use would be limited to benthic feeding species that are found in proximity to the offshore ECC. Terns are not found in proximity to the offshore ECC, red throated diver are not benthic feeders, with the distribution of both common scoter and little gull focused round the Wash[13.] Therefore, the minimal potential for indirect impacts on the undesignated benthic habitats within the Greater Wash SPA is not considered relevant to the designated festures and therefore did not trigger inclusion of the the supporting benthic habitats in the Screening process.

8.1.2.2 The habitat related conservation objectives for the Greater Wash SPA are provided in **Appendix D** but are repeated here for ease as follows:

- Maintain the structure, function and supporting processes associated with the feature and its supporting habitat;
- Maintain the extent, distribution and availability of suitable habitat;
- Maintain the depth of inshore waters currently used as feeding or moulting sites; and
- Maintain various water quality parameters, including natural levels of turbidity.

8.1.2.3 It is clear that the existing Screening process takes account of these measures through the parameters applied previously, in the context of the proximity of the works to the supporting features and the scale and nature of the changes predicted. Therefore, the conclusions of the Screening process with respect to the Greater Wash SPA are considered to remain valid.

[13] http://data.jncc.gov.uk/data/c35b649e-f3bd-42d0-b6c4-96ed66cc2fc2/JNCC-Report-574-FINAL-WEB.pdf

Table 4: Summary of Potential for LSE for Hornsea Four Alone.

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
Southern North Sea SAC	0	0	Harbour porpoise	Increase in underwater noise Vessel disturbance Vessel collision risk Accidental pollution	Increase in underwater noise Vessel disturbance Vessel collision risk Accidental pollution	Similar to and potentially less than those outlined in the construction phase.
Moray Firth SAC	522.5	522.1	Bottlenose Dolphin	Increase in underwater noise Vessel disturbance Vessel collision risk	Vessel disturbance Vessel collision risk	Similar to and potentially less than those outlined in the construction phase.
Flamborough Head SAC	60.2	1.4	Reef	-	Changes to physical processes	Similar to and potentially less than those outlined in the construction phase.
			Reef Submerged and partially submerged caves (cable corridor only)	Temporary increase in suspended sediment/ smothering Accidental pollution	Temporary increase in suspended sediment/ smothering Accidental pollution	
			Reef Submerged and partially submerged caves	Invasive non-native species	Invasive non-native species (previously referenced as introduction of hard substrate for O&M phase, amended to INNS to ensure all contributing factors included)	
The Wash and North Norfolk Coast SAC	105.4	100.1	Harbour seal	Increase in underwater noise Vessel disturbance	Vessel disturbance	Similar to and potentially less than those outlined in the construction phase.

[14] Noting that all ranges are measured in a straight line

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
Humber Estuary SAC	79.7	32.2	Grey seal	Increase in underwater noise Vessel disturbance Vessel collision risk	Vessel disturbance Vessel collision risk	Similar to and potentially less than those outlined in the construction phase.
			Atlantic saltmeadows *Salicornia* and other annuals colonising mud and sand	Nitrogen deposition	-	Similar to and potentially less than those outlined in the construction phase.
Humber Estuary Ramsar	77.9	32.2	Grey seal	Increase in underwater noise Vessel disturbance Vessel collision risk	Vessel disturbance Vessel collision risk	Similar to and potentially less than those outlined in the construction phase.
			Saltmarshes	Nitrogen deposition	-	Similar to and potentially less than those outlined in the construction phase.
Berwickshire and North Northumberland Coast SAC	201.4	171	Grey seal	Increase in underwater noise Vessel disturbance Vessel collision risk	Vessel disturbance Vessel collision risk	Similar to and potentially less than those outlined in the construction phase.
Transboundary harbour seal sites[15]	Ranges up to 89.4	Ranges up to 106.1	Harbour seal	Increase in underwater noise Vessel disturbance	Vessel disturbance	Similar to and potentially less than those outlined in the construction phase.
Transboundary grey seal sites[16]	Ranges up to 320 km	Ranges up to 320 km	Grey seal	Increase in underwater noise Vessel disturbance	Vessel disturbance	Similar to and potentially less than those outlined in the construction phase.
	63.4	0.4	Little gull	-	Risk of Collision	-

[15] Doggersbank (Netherlands) SAC; Klaverbank SC

[16] Doggersbank (Netherlands) SAC; Klaverbank SC; Bancs des Flandres; Vlaamse Banken; SBZ 1; SBZ 2; SBZ 3; Vlakte van de Raan; Westerschelde & Saeftinghe; Voordelta; Noordzeekustzone; Waddenzee

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
Greater Wash SPA			Red-throated diver, Common scoter	Disturbance and displacement	Disturbance and displacement	Similar to and potentially less than those outlined in the construction phase.
Flamborough and Filey Coast SPA	63.0	2.5	Gannet, Kittiwake and Herring gull	-	Risk of Collision	-
			Gannet, Guillemot, Razorbill, and Puffin	Displacement and disturbance	Displacement and disturbance	Similar to and potentially less than those outlined in the construction phase.
			Guillemot, Razorbill, and Puffin	-	Barrier effect	-
Humber Estuary SPA	77.9	32.2	Hen harrier, Avocet, Golden plover, Black-tailed godwit, Bar-tailed godwit, Ruff, Shelduck, Dunlin, Redshank, Knot and the following named Waterbird assemblage species (Teal, Wigeon, Goldeneye, Ringed plover, Grey plover, Lapwing, Sanderling, Oystercatcher, Curlew, Whimbrel, Turnstone and Dark-bellied brent goose) as well as a non-	-	Risk of collision	-

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
			named species (White-fronted goose).			
			Supporting habitats - saltmarsh	Increased nitrogen deposition	-	Similar to and potentially less than those outlined in the construction phase.
Humber Estuary Ramsar	77.9	32.2	Shelduck, Golden plover, Black-tailed godwit, Bar-tailed godwit, Dunlin, Redshank, Knot and named features of the assemblage (Hen harrier, Dark-bellied brent goose, Teal, Wigeon, Goldeneye, Avocet, Ringed plover, Grey plover, Lapwing, Sanderling, Oystercatcher, Curlew, Whimbrel, Turnstone).	-	Risk of Collision	-
			Saltmarsh	Increased nitrogen deposition	-	Similar to and potentially less than those outlined in the construction phase.
Hornsea Mere SPA	78.6	12.9	Gadwall	-	Risk of Collision	-

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
Northumbria Coast SPA	151.7	102.6	Arctic tern	-	Risk of Collision	-
Teesmouth and Cleveland Coast SPA[17]	132.4	81.6	Sandwich tern, Common tern		Risk of Collision	
Coquet Island SPA	200.9	167.7	Kittiwake, Common tern, Arctic tern, Roseate tern, Sandwich tern	-	Risk of Collision	-
			Puffin	Disturbance and displacement	Disturbance and displacement	Similar to and potentially less than those outlined in the construction phase.
Farne Islands SPA	225.2	198.3	Kittiwake, Common tern, Arctic tern, Sandwich tern	-	Risk of Collision	-
			Guillemot, Puffin	Disturbance and displacement	Disturbance and displacement	Similar to and potentially less than those outlined in the construction phase.
Northumberland Marine SPA	187.0	144.0	Common tern, Arctic tern, Roseate tern, Sandwich tern, Kittiwake	-	Risk of Collision	-
			Guillemot, Puffin	Disturbance and displacement	Disturbance and displacement	Similar to and potentially less than those outlined in the construction phase.
St Abb's SPA	269.6	240.4	Kittiwake	-	Risk of Collision	-

[17] As extended in January 2020

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
			Guillemot, Razorbill	-	Disturbance and displacement	-
Forth Islands (UK) SPA	304.2	272.2	Gannet, Kittiwake, Common tern, Arctic tern, Sandwich tern	-	Risk of Collision	-
			Guillemot, Razorbill, Puffin	-	Disturbance and displacement	-
Outer Firth of Forth and St Andrew's Complex pSPA	270.5	242.0	Gannet, Kittiwake	-	Risk of Collision	-
			Guillemot, Puffin	-	Disturbance and displacement	-
Fowlsheugh SPA	356.0	341.2	Kittiwake	-	Risk of Collision	-
			Guillemot, Razorbill	-	Disturbance and displacement	-
Buchan Ness to Collieston Coast SPA	389.4	381.1	Kittiwake	-	Risk of Collision	-
			Guillemot	-	Disturbance and displacement	-
Troup, Pennan and Lion's Heads SPA	431.1	423.1	Kittiwake	-	Risk of Collision	-
			Guillemot, Razorbill	-	Disturbance and displacement	-
East Caithness Cliffs SPA	516.8	500.6	Kittiwake	-	Risk of Collision	-
			Guillemot, Razorbill	-	Disturbance and displacement	-
North Caithness Cliffs SPA	543.0	534.5	Kittiwake	-	Risk of Collision	-
			Guillemot, Razorbill, Puffin	-	Disturbance and displacement	-
Copinsay SPA	562.9	558.3	Kittiwake	-	Risk of Collision	-

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
			Guillemot	-	Disturbance and displacement	-
Hoy SPA	567.6	558.5	Arctic skua, Great skua, Kittiwake	-	Risk of Collision	-
			Guillemot, Puffin	-	Disturbance and displacement	-
Marwick Head SPA	602.9	595.0	Kittiwake	-	Risk of Collision	-
			Guillemot	-	Disturbance and displacement	-
Rousay SPA	600.1	594.7	Arctic skua, Kittiwake, Arctic tern	-	Risk of Collision	-
			Guillemot	-	Disturbance and displacement	-
Calf of Eday SPA	599.0	595.5	Kittiwake, Great black-backed gull	-	Risk of Collision	-
			Guillemot	-	Disturbance and displacement	-
West Westray SPA	605.5	610.6	Arctic skua, Kittiwake, Arctic tern	-	Risk of Collision	-
			Guillemot, Razorbill	-	Disturbance and displacement	-
Fair Isle SPA	606.7	610.9	Gannet, Arctic skua, Great skua, Kittiwake, Arctic tern	-	Risk of Collision	-
			Guillemot, Razorbill, Puffin	-	Disturbance and displacement	-
Sumburgh Head SPA	639.4	646.3	Kittiwake, Arctic tern	-	Risk of Collision	-
			Guillemot	-	Disturbance and displacement	-

Designated Site[14]	Distance to Hornsea Four Order Limits (km)		Feature(s) screened in*	Potential for Likely Significant Effect		
	Array Area	Offshore ECC		Construction	O&M	Decommissioning
Noss SPA	666.9	675.7	Gannet, Great skua, Kittiwake	-	Risk of Collision	-
			Guillemot, Puffin	-	Disturbance and displacement	-
Foula SPA	678.4	681.4	Arctic skua, Great skua, Kittiwake, Arctic tern	-	Risk of Collision	-
			Guillemot, Razorbill, Puffin	-	Disturbance and displacement	-
Fetlar SPA	712.0	722.6	Arctic skua, Great skua, Arctic tern	-	Risk of Collision	-
Hermaness, Saxa Vord and Valla Field SPA	742.8	733.0	Gannet, Great skua, Kittiwake	-	Risk of Collision	-
			Guillemot, Puffin	-	Disturbance and displacement	-

* Note that additional feature(s) may be included within the designation; however, those detailed here are limited to the habitat and/ or species screened in for potential LSE. All feature(s) are included within the Screening Matrix, appended at **Appendix B**.

8.2 Screening Undertaken for Hornsea Four In-combination

8.2.1.1 The Habitats Regulations and the Offshore Habitats Regulations include a requirement for the Competent Authority to carry out an AA in respect of the likely significant effects of a plan or project alone and or in-combination with other plans or projects, where these are not directly connected with or necessary to the management of the site. Screening for the project alone is summarised above in **Section 8.1**, with screening for the project in-combination undertaken within the Screening Report and the conclusions confirmed here.

8.2.1.2 The following list has been applied to Hornsea Four when identifying plans and projects for consideration in- combination (taking account of relevant advice, such as the PINS Advice Note 10, which addresses which plans and projects to include, with the addition of relevant projects in operation):

- Projects in operation (that do not form part of the baseline);
- Projects that are under construction;
- Permitted application(s) not yet implemented;
- Submitted application(s) not yet determined;
- All refusals subject to appeal procedures not yet determined;
- Projects on the National Infrastructure's programme or projects; and
- Projects identified in the relevant development plan (and emerging development plans - with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited and the degree of uncertainty which may be present.

8.2.1.3 A full review of such plans and projects has been conducted for Hornsea Four, with each individual topic chapter for the ES having undertaken screening of the full list of projects, plans and activities, to identify those relevant to individual receptor groups. The relevant plan/ project screening tables to the receptor groups within the RIAA are presented within the ES chapters as follows:

- Table 2.20 within **Volume A2, Chapter 2: Benthic and Intertidal Ecology**;
- Table 4.57 within **Volume A2, Chapter 4: Marine Mammals**;
- Table 5.38 within **Volume A2, Chapter 5: Offshore and Intertidal Ornithology**;
- Table 3.21 within **Volume A3, Chapter 3: Ecology and Nature Conservation**; and
- Table 3.19 within **Volume A2, Chapter 3: Fish and Shellfish Ecology**.

8.2.1.4 With respect to in-combination effects within the HRA process, the Screening Report (**Appendix A**) identified the broad categories of plans and projects to be considered within this RIAA. The specific plans and projects relevant to individual receptors draw on those identified within the individual ES chapters, as highlighted above, together with any additional plans or projects relevant to the designated site(s) under consideration. The intention of in-combination screening is to determine, for the plans and projects relevant to each receptor group, which of the designated sites screened in for determination of potential LSE alone may be affected by a spatial and/ or temporal overlap of effect from a relevant plan or project.

8.2.1.5 Further, it is acknowledged that the potential contribution to an in-combination AEoI by Hornsea Four could stem not only from those effects where potential LSE exists in relation to the project alone (as highlighted in **Table 4** above), but also potentially from an aspect of the project that is not significant when considered alone, but that may become more relevant in-combination. As such, where the potential exists for Hornsea Four to contribute to potential LSE in-combination this has been considered, immaterial of whether a potential LSE alone applies or not.

8.2.1.6 The determination of potential LSE in-combination takes into account the following:

- Level of detail available for project/ plans;
- Potential for an effect-pathway-receptor link;
- Potential for a physical interaction; and
- Potential for temporal interaction.

8.2.1.7 The approach applied to screening in-combination is outlined below.

8.2.1.8 A tiered approach has been applied to the in-combination assessment to reflect the different levels of uncertainty associated with the project design and timeframes for the projects screened into assessment. The allocated 'Tiers' reflect the current stage of the relevant projects within the planning and development process. This allows the in-combination impact assessment to consider several future development scenarios, each with a differing potential for being ultimately built out. Appropriate weight may therefore be given to each scenario (Tier) in the decision making process when considering the potential in-combination impact associated with Hornsea Four.

8.2.1.9 The tiering structure applied is in common with that within relevant ES chapters, with the benthic ecology approach provided below in **Table 5**. For both offshore ornithology and marine mammals, a more detailed tiering structure has been applied to allow for the specific concerns for those receptors to be fully addressed. These tiers are defined in **Table 8** (offshore ornithology) and (marine mammals) and is intended to ensure that there is a clear understanding of the level of confidence in the in-combination assessment within the RIAA. In particular, it is noted that within Tier 1 there is significant variability in project certainty between a project in planning but not yet submitted to PINS, a project under construction and a project in operation, specifically as regards the 'final' scheme design and construction programme (noting that the assessment made here draws on the 'consented' and not 'as built' design envelope). Experience from other offshore wind projects over many years indicates that the project as assessed on application (in terms of maximum design scenario and the overall construction window) is almost always much greater in terms of impact/timeframe than a project at the point of construction – e.g. fewer turbines, more clearly defined (and often shorter) construction window etc.

Table 5: Description of Tiers of Other Developments Considered for In-Combination Assessment (adopted from PINS Advice Note 10, with the addition of projects in operation).

Tier 1	Projects in operation (that do not form part of the baseline)
	Project that are under construction.
	Permitted applications, whether under the Planning Act 2008 or other regimes, but not yet implemented.
	Submitted applications, whether under the Planning Act 2008 or other regimes, but not yet determined.
	All refusals subject to appeal procedures not yet determined
Tier 2	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted.
Tier 3	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has not been submitted.
	Identified in the relevant Development Plan (and emerging Development Plans with appropriate weight being given as they move closer to adoption) recognising that much information on any relevant proposals will be limited.
	Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward.

8.2.2 Subtidal and Intertidal Benthic Ecology

8.2.2.1 The Screening Report (**Appendix A**) identified the designated sites and relevant plans and projects to include for in-combination assessment. For subtidal benthic ecology, the Flamborough Head SAC is the only relevant designated site.

8.2.2.2 For intertidal benthic ecology, the interest is limited to saltmarsh habitat within the Humber Estuary, specifically the Humber Estuary SAC, Humber Estuary Ramsar and Humber Estuary SPA (the latter as a supporting habitat only).

8.2.2.3 In terms of plans and projects to be considered, the conclusions of the screening for other plans and projects considered relevant for subtidal benthic ecology are provided in **Table 6**.

Table 6: Summary Plans and Projects to be Considered In-Combination in Relation to Subtidal Benthic Ecology.

Project/ Plan				Range to Flamborough Head SAC (km)
Development Type	Project	Status	Tier	
Dredge spoil site	Bridlington A	Open	Tier 1	0
Offshore windfarm ECC	Dogger Bank A	Consented	Tier 1	1.04 (closest point of approach for the export cable route)
Offshore windfarm ECC	Dogger Bank B	Consented	Tier 1	1.04 (closest point of approach for the export cable route)
Offshore cable	Scotland England Green Link 2 (SEGL2) Cable – Peterhead to Drax	In planning	Tier 3	Outside screening range to the array boundary (at 54 km) but within screening range to the cable corridor (at 0.15 km)

8.2.2.4 In addition to the plans and projects identified in **Table 6**, a number of additional projects are identified in the ES for benthic ecology; however, these are not considered relevant to the subtidal benthic habitats under consideration here given the distance between these additional projects and the designated site (i.e. all fall outside the relevant and precautionary screening range of 16 km[18] as defined through the Technical Panel meetings for the project alone and applied in **Appendix A**):

- Hornsea Project Two OWF and ECC – (array located more than 94 km and ECC located more than 47 km from the Flamborough Head SAC at its nearest point;
- Hornsea Project One OWF and ECC –array located more than 111 km and ECC located more than 47 km from the Flamborough Head SAC at its nearest point;
- Viking Link Interconnector – route located approximately70 km from the Flamborough Head SAC at its nearest point;
- Dana Petroleum Platypus pipeline – located approximately 69 km from the Flamborough Head SAC at its nearest point;
- Johnston WHP – located 79 km from the Flamborough Head SAC at its nearest point;
- Johnston template/manifold - located 79 km from the Flamborough Head SAC at its nearest point;
- Tolmont Platform - located 85 km from the Flamborough Head SAC at its nearest point; and
- Endurance Carbon Capture and Storage – a Tier 3 project located approximately 44km distant from the Flamborough Head SAC at its nearest point.

8.2.2.5 For the in-combination assessment of the potential impacts on the intertidal saltmarsh of the Humber Estuary SAC, Ramsar and SPA, a traffic component is included in the air quality modelling, which includes the effect of traffic growth, together with potential additional contributions from agricultural and industrial projects in the Hull area (with just one such project found within the relevant area, being an "Erection of a free-range egg laying unit with associated feed bins and hard-standings"). More detail is provided in **Section 11.2.1**.

8.2.2.6 For the plans and projects highlighted in **Table 6**, it is considered that there is potential for LSE in-combination with Hornsea Four with respect to the relevant site/feature(s). The potential for such an effect will vary, depending on parameters such as the timing of works and the nature of those works, with these to be considered in full in the determination of AEoI.

8.2.2.7 The effects considered in-combination for subtidal and intertidal benthic ecology are the same as those screened in for potential LSE for the project alone in **Table 4**. No potential for any meaningful contribution to an in-combination effect resulting from Hornsea Four has been identified in relation to those effects screened out from potential LSE alone, with no comments received during consultation suggesting anything contrary to this conclusion.

[18] As noted in Table 1 of Appendix A, 16km was agreed by Natural England in September 2018 as an appropriate screening range for benthic habitats, with a request at PEIR for the range to be revisited. As summarised in Table 1 of Appendix A, project reporting post PEIR has confirmed that the range should actually be reduced to 14km, however for consistency and as a precaution the original 16km range for benthic screening has been retained in the RIAA. It should be noted that no change to benthic screening would result regardless of the range applied – 14km or 16km. The subsequent assessment draws on the final technical reporting that accompanies the application.

8.2.3 Marine Mammals

8.2.3.1 For marine mammals, the in-combination screening has considered those designated sites where the potential for LSE was identified for the project alone. For all other designated sites, the distance is such that there is considered to be no pathway for effect from Hornsea Four to reach the designated site boundary and therefore no potential for an in-combination effect (effectively screening out all transboundary harbour porpoise sites). The screening ranges applied for marine mammals in-combination are the same as those applied for the project alone, being 26 km for harbour porpoise (JNCC 2016), 120 km for harbour seal (SMRU 2011) and 145 km for grey seal (Thompson et al. 1996), together with consideration of site connectivity in the same manner as screening for the project alone. The screening in-combination presented in the Screening Report (**Appendix A**) therefore considers the following sites:

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- The Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland SAC (grey seal);
- Transboundary sites for harbour seal (Doggersbank (Netherlands) SAC and Klaverbank SCI); and
- Transboundary sites for grey seal (Doggersbank (Netherlands) SAC, and Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI, Waddenzee SCI).

8.2.3.2 As noted above in **Section 8.1**, the revised Hornsea Four Order Limits has reduced slightly the range between Hornsea Four and some designated sites (notably the transboundary marine mammal sites). However, that reduction in range is not sufficient to change the conclusions of screening – with the same sites and features remaining screened in for potential LSE. The key change is the inclusion of the Moray Firth SAC for bottlenose dolphin.

8.2.3.3 The effects considered in-combination for marine mammals are the same as those screened in for potential LSE for the project alone in **Table 4**, with the inclusion of habitat loss during operation and maintenance for the SNS SAC only (harbour porpoise) in response to comments received during consultation (**Table 1**). The contribution made by Hornsea Four to all other potential effects is considered to be insufficient to make any other meaningful contribution in-combination; with no further comments received during consultation contrary to this conclusion.

8.2.3.4 Construction and decommissioning related effects are highly temporally limited and therefore for an in-combination effect to occur, a measure of temporal overlap is required (with respect to the SNS SAC, that relates also to seasonal overlap). It is widely acknowledged that uncertainty exists around the timeframe of works for projects going forward. Certainty of construction in a defined timescale is highly dependent on the stage a project has reached. Some projects, predominantly those 'proposed' or identified in development plans etc. may or may not actually be taken forward or may change considerably (for example, in the case of offshore wind projects, construction window changes, Order Limits changes, WTG number changes etc).

8.2.3.5 There is thus a need to build in some consideration of certainty (or uncertainty) with respect to the potential impacts which might arise from such proposals when the assessment is made for the construction and decommissioning period. For example, relevant projects / plans with consent and (if required) a CfD (or similar) are more likely to contribute to in-combination impacts with Hornsea Four (providing an effect or temporal pathway exists), whereas projects/ plans not yet approved or not yet submitted to planning are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors.

8.2.3.6 That uncertainty in the context of the Hornsea Four tiering structure is noted above in **Section 8.2.** A key part of the response to that uncertainty is the provision of the Outline Site Integrity Plan (SIP) which accompanied the application (**F2.11:: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**). The requirement for a final SIP to be prepared and approved is secured within the draft DCO in Condition 13(1)(j) of Schedules 11 and 12. The purpose of the SIP is to provide the required level of certainty that such risk will be managed and addressed going forward (following Application, through Examination and up to and including construction), thus ensuring that the conclusions of the RIAA remain valid in any given scenario. Such a SIP has been used on a number of other offshore wind projects to date and is designed to provide the required level of certainty. Although the SIP is specific to the SNS SAC, management and/or mitigation of underwater noise for one species (harbour porpoise) has wider benefits for other noise sensitive species.

8.2.3.7 The Outline SNS SAC SIP has been drafted in consultation with the Evidence Plan Process, and addresses the following key points:

- Introduction –provides an overview of the project, the purpose of and requirement for the Outline SNS SAC SIP. Notes consultation relevant to the Outline SNS SAC SIP. Includes a timeframe for review, updates and re-issue of the SIP as construction draws closer;
- Final Design Plan –summarises the relevant points of the final scheme design for Hornsea Four and the relevant Commitments made;
- The Southern North Sea SAC – provides an overview of the site and its conservation objectives
- Potential Mitigation and Management Measures – notes the measures included within the RIAA and that should the need for further measures be identified through the SIP process, these would be to address risk of disturbance only. Includes note on potential mitigtion measures available and the relative efficacy (where known, while leaving the option for novel technologies to be developed in the interim and applied);
- Additional Licensing Requirements – to be clear on additional licences e.g. Marine Licence and/ or EPS licence; and
- References.

8.2.3.8 Drawing on the long list of projects identified by the application of the screening ranges applied for each marine mammal species screened in, the potential for in-combination

LSE as a result of underwater noise during the construction and decommissioning phase has been determined based on the following:

- For a plan or project where there is potential for the construction period to have temporal overlap with the construction window of Hornsea Four (i.e. the plan/ or project is identified by 'yes' in terms of construction window overlap) AND the plan/ or project is within the relevant species specific screening range of the designated site (or drawn in via potential site connectivity); and
- For a plan/ or project where there is no potential for temporal overlap with the construction period (i.e. the plan/ or project is identified by 'no'), only those designated sites with physical overlap with the plan/ or project are screened in for potential LSE.

8.2.3.9 For all other potential effects, consideration has also been given to plans and projects in construction, operation and decommissioning, as identified through the same screening ranges.

8.2.3.10 For bottlenose dolphin (screened in following consultation highlighted data indicating potential connectivity between the adjacent coast and the Moray Firth SAC), the following criteria have been applied for screening plans and projects in-combination:

- For a plan or project in operation – physical overlap with the SAC would be required;
- For a plan or project in construction – potential for temporal overlap of the construction period AND a plan or project location along the east coast of Scotland and south to the Humber (but no further offshore than Hornsea Four, given the coastal nature of the SAC dolphins) would be required; and
- All other plans and projects are screened out.

8.2.3.11 The differentiation between construction period and O&M period impacts is made here for marine mammals, in light of the typical scale of effects that may occur during construction compared to those during O&M (as evidenced by **Volume A2, Chapter 4: Marine Mammals**).

8.2.3.12 It is acknowledged that other activities have the potential to contribute to an in-combination effect, specifically with regard to underwater noise. Previous assessments within the SNS SAC (e.g. the recently consented Hornsea Three) have included consideration of seismic survey associated with oil and gas activity, together with UXO detonations. Where planned seismic survey is known in association with the plans and projects identified in **Table 7**, these will be screened in for assessment. Given the timeframes involved (with offshore piling works at Hornsea Four expected to start in Q4 2026 at the earliest, albeit potentially preceeded from Q1 2026 by geophysical survey and/or UXO clearance), the available information regarding planned oil and gas works[19] currently extends to June 2022 only (website accessed July 2021) and therefore does not cover the required period, with no certainty regarding what or where (if anything) further applications would come forward in the relevant timeframe. It is therefore not possible to include such oil and gas works here.

[19] Sourced from https://itportal.beis.gov.uk/eng/fox/live/PETS_EXTERNAL_PUBLICATION/main

8.2.3.13 Similarly, as regards UXO clearance, where any planned works associated with projects screened in are known, these will be included within the assessment. As regards UXO clearance more widely, previous projects have considered ongoing UXO clearance, with OSPAR data providing a comprehensive source of historic information[20].

8.2.3.14 The RIAA only takes account (and should only take account) of planned/consented works within the licensing process. It is not considered appropriate to undertake a speculative in-combination assessment in HRA terms based on historic activity for either oil and gas works or UXO clearance. It is therefore considered appropriate within the RIAA for Hornsea Four to limit the in-combination assessment to works known to be occurring and not based on an assumption of past activity continuing. In any case, any activity that would be included within an in-combination assessment (but for which no information is as yet in the public domain) would be expected to undertake the HRA process in its own right and would therefore be the subject of assessment at that point, including consideration in combination with Hornsea Four. Finally, the delivery of the SIP (as secured within the draft DCO in Condition 13(1)(j)) with the application for Hornsea Four with respect to the SNS SAC provides certainty that the in-combination assessment will be revisited on a defined timeframe, with additional plans/projects (or if necessary, the relevant project parameters) to be amended/included at that point as relevant. The process provides certainty in the in-combination Screening process for harbour porpoise and, given the potential for effect of underwater noise on bottlenose dolphin, harbour seal and grey seal is contained within that for harbour porpoise, by default for these species too.

8.2.3.15 **Table 7** below draws on the outputs of the Screening Report (**Appendix A**), which in turn identified plans and projects to be considered for screening in-combination for marine mammals (as identified through the use of GIS) and included comment on potential for temporal overlap with offshore construction for Hornsea Four. Further, in-combination screening identified a potential for LSE that did not apply for the project alone, namely habitat loss with respect to the SNS SAC during the operation and maintenance phase only. Therefore, the following table also includes plans and projects for which the operation and maintenance phase only could overlap with the operation and maintenance phase of Hornsea Four, to enable the potential for habitat loss in-combination to be taken into account. Such projects are those with physical overlap with the SNS SAC only (i.e. those with a zero range to the SNS SAC).

[20] Information contained https://www.ospar.org/work-areas/eiha/munitions and data held http://odims.ospar.org/odims_data_files/

Table 7: Summary of Plans and Projects Screened in per designated site for the Marine Mammal Assessment In-Combination.

Project/ Plan				Range to Designated Site (screening range in km)																	
Type	Project	Overlap with construction and/or Operation and Maintenance	Tier	Southern North Sea SAC	Moray Firth SAC	The Wash and North Norfolk Coast SAC	Humber Estuary SAC	Humber Estuary Ramsar	Berwickshire and North Northumberland SAC	Doggersbank (Netherlands) SAC	Klaverbank SCI	Bancs des Flandres SAC	Vlaamse Banken SAC	SBZ 1 SAC	SBZ 2 SAC	SBZ 3 SAC	Vlakte van de Raan SAC	Westerschelde & Saeftinghe SAC	Voordelta SAC	Noordzeekustzone SAC	Waddenzee SAC
OWF	Hornsea Project One	**Yes** – operation and maintenance only.	1	0		94	102	102		64	44										
OWF	Hornsea Project Two	**Yes** – operation and maintenance only.	1	0		91	89	89		63	50										
OWF	East Anglia One	**Yes** – operation and maintenance only.	1	0		116						93	69	103	91	95	82	93	81	138	
OWF	Triton Knoll	**Yes** – operation and maintenance only.	1	23		40	32	32			135										
UXO clearance	Viking Link	**Yes** – operation and maintenance only.	1	0		19	9	9		17	0										
OWF	Neart na Gaoithe	**Yes** – operation and maintenance only.	1						29												
OWF	Inch Cape	**Yes** – operation and maintenance only.	1						52												
OWF	SeaGreen Alpha Bravo	**Yes** – operation and maintenance only.	2						65												
OWF	Marr Bank and Berwick Bank	**Yes –** construction window unknown.	2		232				30												
OWF	Kincardine	**Yes –** operation and maintenance only.	1						116												
OWF	Moray West	**Yes –** operation and maintenance only.	1		17																
OWF	Moray East	**Yes –** operation and maintenance only.	1		36																
OWF	Thanet Extension	**No** – Consent refused.																			
OWF	East Anglia Three	**Yes** - operation and maintenance phase only – piling scheduled 2021-2023.	1	0		113					120	136	112	143	128	126	109	117	95	101	115
OWF	Dogger Bank A	**Yes** - construction window unclear but potential for all phases.[21]	1	0						47	66										
OWF	Dogger Bank B	**Yes –** construction window unclear but potential for all phases.[22].	1	0						71	87										
OWF	Dogger Bank C	**Yes –** construction window unclear but potential for all phases.[23].	1	24						0	74										

[21] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023 https://doggerbank.com/construction/offshore/
[22] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023 https://doggerbank.com/construction/offshore/
[23] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023 https://doggerbank.com/construction/offshore/

Project/ Plan				Range to Designated Site (screening range in km)																	
Type	Project	Overlap with construction and/or Operation and Maintenance	Tier	Southern North Sea SAC	Moray Firth SAC	The Wash and North Norfolk Coast SAC	Humber Estuary SAC	Humber Estuary Ramsar	Berwickshire and North Northumberland SAC	Doggersbank (Netherlands) SAC	Klaverbank SCI	Bancs des Flandres SAC	Vlaamse Banken SAC	SBZ 1 SAC	SBZ 2 SAC	SBZ 3 SAC	Vlakte van de Raan SAC	Westerschelde & Saeftinghe SAC	Voordelta SAC	Noordzeekustzone SAC	Waddenzee SAC
OWF	Sofia	**Yes –** construction window unclear but potential for all phases[24].	1	0						34	69										
OWF	Norfolk Vanguard	**Yes –** piling scheduled Q2 2024-Q1 2025 OR Q2 2024-Q1 2025 and Q2 2027-Q1 2028.	1	0		80					93		14				135	141	106	98	110
OWF	Hornsea Project Three	**Yes –** piling scheduled Q1 2022- Q2 2023 and/or Q1 2027-Q2 2028.	1	1.4		120	141	141		42	11									138	
OWF	Norfolk Boreas	**Yes**. Survey Q4 2024-Q2 2025, UXO Q3 2025-Q1 2026 and piling Q2 2026-Q3 2027 OR Q2 2026-Q4 2026 and Q2 2027-Q4 2027.	1	0		110				128	68								118	96	106
OWF	EnBW He Dreiht	**Yes** Operation & Maintenance only– scheduled for commissioning 2025.	1																	84	87
OWF	East Anglia One North	**Yes –**piling expected 2026-2028.	1	0		99						110	87	122	111	113	98	109	93	135	
OWF	East Anglia Two	**Yes –**piling expected 2025-2027.	1	0		99						82	59	94	84	92	82	96	84		
OWF	Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	**Yes –** earliest construction expected to start 2024, offshore construction to follow in 2 years (2026)[25]	2	26		8	60	60			134										
			2	14		24	63	63		144	114										
OWF	Race Bank Extension	**No – removed from the Plan Level HRA**																			
OWF	North Falls	**Not known.**	3	0		117						37	34	64	69	82	81	99	86		
OWF	Five Estuaries	**Not known.**	3	0								49	35	68	66	78	74	90	78		
OWF	Round 4 – Leasing Area 1 (Bidding Area 1)	**Not known.**	3	0			129	127		72	76										
OWF	Round 4 – Leasing Area 2 (Bidding Area 1)	**Not known.**	3	0			142	140		41	44										
OWF	Round 4 – Leasing Area 3 (Bidding Area 2)	**Not known**	3	0		48	53	53		116	96										
O&G	Dana Petroleum Platypus (oil and gas pipeline)	**Yes –**operation life of pipeline only. In planning, with construction expected 2020-22.	2	0		96	66	65													
O&G	Tolmount Wellhead	**Yes –**operation life of asset only. Consented with construction extected 2020.	1	1		102	50	49													
O&G	Johnston Template Manifold	**Yes-** with decommissioning of the asset only. Currently operational, decommissioning expected from 2022.	1	0		111	85	84													

[24] Noting that current project information states offshore construction to start 2023, piling in 2024, turbines installed 2025 and complete by 2026 https://sofiawindfarm.com/offshore-construction/

[25] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

Project/ Plan				Range to Designated Site (screening range in km)																	
Type	Project	Overlap with construction and/or Operation and Maintenance	Tier	Southern North Sea SAC	Moray Firth SAC	The Wash and North Norfolk Coast SAC	Humber Estuary SAC	Humber Estuary Ramsar	Berwickshire and North Northumberland SAC	Doggersbank (Netherlands) SAC	Klaverbank SCI	Bancs des Flandres SAC	Vlaamse Banken SAC	SBZ 1 SAC	SBZ 2 SAC	SBZ 3 SAC	Vlakte van de Raan SAC	Westerschelde & Saeftinghe SAC	Voordelta SAC	Noordzeekustzone SAC	Waddenzee SAC
O&G	Johnston WHSP	**Yes-** with decommissioning of the asset only. Currently operational, decommissioning expected from 2022.	1	0		108	88	87													
Marine aggregates	Humber Overfalls Area 493	**Yes** – existing activity.	1			28	10	9													
	Off Saltfleet Area 197	**Yes** – existing activity.	1			29	11	11													
	Humber Estuary Area 400	**Yes** – existing activity.	1			28	14	11													
	Humber 1 Area 514/1	**Yes** – existing activity.	1	10		50	9	9													
	Humber 2 Area 514/2	**Yes** – existing activity.	1	8		54	12	12													
	Humber Estuary Area 514/3	**Yes** – existing activity.	1	9		56	15	15													
Carbon Capture Storage	Endurance	**Unknown – pre-scoping**	3	0		111	69	67		91	92										
Dredge spoil disposal	Bridlington A disposal site	**Yes** – existing activity.	1			111	39	39													
	Humber 4	**Yes** – existing activity.	1			80	0	0													
	Humber 3a	**Yes** – existing activity.	1			68	0	0													
	Humber 2	**Yes** – existing activity.	1			60	0	0													
	Goole Reach	**Yes** – existing activity.	1			100	0	0													
	Whitgift Bight (River Ouse)	**Yes** – existing activity.	1			97	0	0													
	Hedon Haven	**Yes** – existing activity.	1			78	0	0													
	Bull Sand Fort Extension	**Yes** – existing activity.	1			52	0	0													
	Sunk Dredge Channel Window C	**Yes** – existing activity.	1			62	0	0													
	Humber 1a	**Yes** – existing activity.	1	25		59	0	0													
	Holme Channel Deep	**Yes** – existing activity.	1			67	0	0													
	Humber 4B/Hook Extension	**Yes** – existing activity.	1			79	0	0													
	Humber 4B Hook	**Yes** – existing activity.	1			79	0	0													

8.2.4 Offshore Ornithology

8.2.4.1 The following definitions have been applied for offshore ornithology for the various 'tiers' and 'sub-tiers', included in Table 8 below. These also reflect the consultation responses received from Natural England.

Table 8: Description of tiers and sub-tiers considered in the offshore ornithology in-combination assessment.

Tier	Sub-Tier	Description of stage of development of project
Tier 1	Tier 1a	Project under operation
	Tier 1b	Project under construction
	Tier 1c	Consented project, whether under the Planning Act 2008 or other regimes, but not yet implemented
	Tier 1d	Submitted project, whether under the Planning Act 2008 or other regimes, but not yet determined
Tier 2	Tier 2	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has been submitted and/or the developer has released details in, for instance, a PEIR
Tier 3	Tier 3a	Projects on the Planning Inspectorate's Programme of Projects where a Scoping Report has not been submitted
	Tier 3b	Project identified in the Development Plan or emerging Development Plans noting that any information on the project will be limited
	Tier 3c	Identified in other plans and programmes (as appropriate) which set the framework for future development consents/approvals, where such development is reasonably likely to come forward

8.2.4.2 The plans and projects identified as relevant to the in-combination assessment for offshore ornithology receptors are based on an initial screening exercise undertaken on a long list of plans and projects and published in the ES (see **Volume A4, Annex 5.3: Offshore Cumulative Effects**). A consideration of effect-receptor pathways, data confidence and temporal and spatial scales has been made in order to select the projects that have been included in the in-combination assessment.

8.2.4.3 Where planned and operational projects were screened out of further consideration for potential in-combination effects this was because the potential for impact-receptor-pathway that occured during construction, operation and maintenance or decommissioning had been excluded, for one or more of the following reasons:

- There was no potential impact-receptor-pathway due to the project being outside of the UK North Sea and English Channel;
- There was no temporal overlap between projects / activities;
- The project / activity is ongoing and was considered to be part of the current baseline;
- There was no data available or there was a low level of confidence in the available data (see below).

8.2.4.4 The projects screened out included UK offshore wind farms evaluated as having low data confidence on the basis that no construction or operational period is known and /

or because they were a UK offshore wind farm located outside of the North Sea. Other projects from non-offshore energy projects screened out included commercial fisheries as well as shipping and navigation, which were evaluated as being part of the offshore baseline.

8.2.4.5 The specific projects screened into the in-combination assessment for offshore ornithology receptors, which included only offshore wind farm projects, as well as the tiers (and sub-tiers) into which they have been allocated are presented in **Table 9** below.

Table 9: Projects screened into the offshore ornithology in-combination assessment.

Tier	Long List Offshore Project Name	Offshore Project Details/ Relevant dates (cf Hornsea Four Construction Period Of 2026-2028)	Distance to Hornsea Four Array (km)	Distance to Hornsea Four ECC (km)	Distance to Hornsea Four HVAC Booster Station Search Area (km)	Reason for Project Inclusion in Hornsea Four In-combination Assessment
1a	Beatrice	Operational	>500.00	489.40	497.77	Potential temporal overlap of operation with Hornsea Four
1a	Blyth Demonstration Site	Operational	174.71	139.88	155.81	Potential temporal overlap of operation with Hornsea Four
1a	Dudgeon	Operational	70.83	72.72	101.65	Potential temporal overlap of operation with Hornsea Four
1a	East Anglia One	Operational	194.09	198.56	236.63	Potential temporal overlap of operation with Hornsea Four
1a	EOWDC	Operational	379.67	369.14	376.52	Potential temporal overlap of operation with Hornsea Four
1a	Galloper	Operational	219.97	223.34	251.02	Potential temporal overlap of operation with Hornsea Four
1a	Greater Gabbard	Operational	221.71	224.96	251.61	Potential temporal overlap of operation with Hornsea Four
1a	Humber Gateway	Operational	66.37	40.96	42.02	Potential temporal overlap of operation with Hornsea Four
1a	Hywind 2 Demonstration	Operational	381.06	379.01	383.20	Potential temporal overlap of operation with Hornsea Four
1a	Lincs, Lynn & Inner Dowsing	Operational	96.62	83.65	89.25	Potential temporal overlap of operation with Hornsea Four

Tier	Long List Offshore Project Name	Offshore Project Details/ Relevant dates (cf Hornsea Four Construction Period Of 2026-2028)	Distance to Hornsea Four Array (km)	Distance to Hornsea Four ECC (km)	Distance to Hornsea Four HVAC Booster Station Search Area (km)	Reason for Project Inclusion in Hornsea Four In-combination Assessment
1a	Kentish Flats I	Operational	276.33	277.51	290.21	Potential temporal overlap of operation with Hornsea Four
1a	Kentish Flats II	Operational	277.24	278.22	290.25	Potential temporal overlap of operation with Hornsea Four
1a	Kincardine	Operational	353.00	343.00	350.00	Potential temporal overlap of operation with Hornsea Four
1a	London Array	Operational	249.99	252.41	270.96	Potential temporal overlap of operation with Hornsea Four
1a	Race Bank	Operational	78.83	72.40	82.66	Potential temporal overlap of operation with Hornsea Four
1a	Sheringham Shoal	Operational	89.51	88.65	106.44	Potential temporal overlap of operation with Hornsea Four
1a	Teesside	Operational	136.72	86.37	108.47	Potential temporal overlap of operation with Hornsea Four
1a	Thanet	Operational	277.04	279.59	298.70	Potential temporal overlap of operation with Hornsea Four
1a	Westermost Rough	Operational	62.75	21.63	25.40	Potential temporal overlap of operation with Hornsea Four
1a	Hornsea Project One	Operational	5.08	21.32	82.50	Potential temporal overlap of operation with Hornsea Four
1b	Hornsea Project Two	Under Construction	0.00	5.84	66.43	Potential temporal overlap of construction with Hornsea Four

Tier	Long List Offshore Project Name	Offshore Project Details/ Relevant dates (cf Hornsea Four Construction Period Of 2026-2028)	Distance to Hornsea Four Array (km)	Distance to Hornsea Four ECC (km)	Distance to Hornsea Four HVAC Booster Station Search Area (km)	Reason for Project Inclusion in Hornsea Four In-combination Assessment
1b	Moray East	Under Construction	494.29	484.40	491.93	Potential temporal overlap of operation with Hornsea Four
1b	Triton Knoll	Under Construction	56.99	49.70	60.93	Potential temporal overlap of operation with Hornsea Four
1b	Neart na Gaoithe	Under Construction	296.16	271.32	284.45	Potential temporal overlap of operation with Hornsea Four
1b	Seagreen Alpha	Under Construction	312.11	295.09	304.91	Potential temporal overlap of operation with Hornsea Four
1b	Seagreen Bravo	Under Construction	312.11	295.09	304.91	Potential temporal overlap of operation with Hornsea Four
1c	Dogger Bank A	Consented– construction expected 2021-2024	65.86	83.65	107.52	Potential temporal overlap of operation with Hornsea Four
1c	Dogger Bank B	Consented– construction expected 2021-2024	76.14	94.18	111.26	Potential temporal overlap of operation with Hornsea Four
1c	Dogger Bank C	Consented - construction expected 2023-2026	120.86	135.62	170.16	Potential temporal overlap of construction with Hornsea Four
1c	East Anglia Three	Consented - construction expected 2021-2024	157.84	164.73	211.81	Potential temporal overlap of operation with Hornsea Four
1c	Hornsea Three	Consented – construction expected 2024-2030	36.34	55.47	116.10	Potential temporal overlap of construction with Hornsea Four
1c	Inch Cape	Consented	311.89	291.43	303.06	Potential temporal overlap of operation with Hornsea Four

Tier	Long List Offshore Project Name	Offshore Project Details/ Relevant dates (cf Hornsea Four Construction Period Of 2026-2028)	Distance to Hornsea Four Array (km)	Distance to Hornsea Four ECC (km)	Distance to Hornsea Four HVAC Booster Station Search Area (km)	Reason for Project Inclusion in Hornsea Four In-combination Assessment
1c	Moray West	Consented	490.62	478.40	486.94	Potential temporal overlap of operation with Hornsea Four
1c	Sofia	Consented - construction expected 2023-2026	97.75	113.14	143.26	Potential temporal overlap of construction with Hornsea Four
1d	East Anglia One North	In examination construction expected 2025-2028	178.58	182.88	219.69	Potential temporal overlap of construction with Hornsea Four
1d	East Anglia Two	In examination construction expected 2026-2029	187.28	191.13	224.09	Potential temporal overlap of construction with Hornsea Four
1d	Norfolk Boreas	Awaiting determination construction expected 2023-2025	123.34	133.68	187.40	Potential temporal overlap of construction with Hornsea Four
1d	Norfolk Vanguard	Awaiting determination– construction expected 2024-2028	123.39	130.86	175.94	Potential temporal overlap of construction with Hornsea Four
2	Rampion 2	In planning	>400.00	>400.00	>400.00	Potential temporal overlap of construction with Hornsea Four
2	Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	In planning	65.00	68.00	93.00	Potential temporal overlap of construction with Hornsea Four
3b	Endurance CCS	Pre-planning	-	-	-	Potential temporal overlap of construction with Hornsea Four

Tier	Long List Offshore Project Name	Offshore Project Details/ Relevant dates (cf Hornsea Four Construction Period Of 2026-2028)	Distance to Hornsea Four Array (km)	Distance to Hornsea Four ECC (km)	Distance to Hornsea Four HVAC Booster Station Search Area (km)	Reason for Project Inclusion in Hornsea Four In-combination Assessment
3b	Five Estuaries (Galloper Extension)	In planning	223.00	227.00	256.00	Potential temporal overlap of construction with Hornsea Four
3b	North Falls (Greater Gabbard Extension)	In planning	218.00	222.00	249.00	Potential temporal overlap of construction with Hornsea Four
3c	Round 4 – Leasing Area 1 - Bidding Area 1	Pre-planning	41.40	57.78	95.38	Potential temporal overlap of construction with Hornsea Four
3c	Round 4 – Leasing Area 2 - Bidding Area 1	Pre-planning	41.62	59.87	77.71	Potential temporal overlap of construction with Hornsea Four
3c	Round 4 – Leasing Area 3 - Bidding Area 2	Pre-planning	36.53	36.75	67.36	Potential temporal overlap of construction with Hornsea Four

8.2.4.6 The key risks in terms of potential in-combination effects on offshore ornithology receptors relate to the combined impacts on breeding and non-breeding seabirds (on passage or over-wintering), of displacement during the construction, operational & maintenance and decommissioning phases and mortality resultant from collison in the operational phase. In relation to those breeding and non-breeding seabirds, for there to be an in-combination effect to be assessed, it is considered that an effect arising from Hornsea Four assessed alone has to be of sufficient magnitude to make a material contribution to an in-combination assessment at the wider, usually North Sea, scale. Therefore, where an effect from Hornsea Four alone was determined to be trivial and inconsequential that would be well within the error margins of the assessment, there is no potential for any contribution for an in-combination effect to occur on such features and designated sites. It is also worth noting that the screening process followed a precautionary approach and where potential for an LSE has been identified alone it has been assumed that potential for LSE should also be considered in-combination in **Section 11.4**. Therefore, with respect to offshore ornithology, screening alone has been undertaken in an extremely precautionary manner in response to discussion during the Evidence Plan Process (OFF-ORN-5.1 to 5.9 **B1.1.1 Evidence Plan**), with that level of precaution being taken into account within the subsequent in-combination assessment. In order to understand this process a summary of features and designated sites considered for each potential impact pathway that are assessed or not assessed in detail in-combination are provided in **Section 11.4**.

8.2.4.7 Therefore, for clarity and in response to the precautionary screening undertaken for offshore ornithology alone, the subsequent assessment in-combination in **Section 11.4** is focused on those designated sites and species for which there is potential for a material contribution from Hornsea Four alone (as confirmed in the assessment alone in **Section 10.4**). Where an effect from Hornsea Four alone was determined to be a trivial and inconsequential that would be well within the error margins of the assessment (as confirmed in the assessment alone in **Section 10.4**), such features and designated sites are not assessed further as there is no potential for any contribution for an in-combination effect to occur.

8.2.4.8 Additional consideration has been given to the potential for in-combination effects on non-breeding waterbird species from European and Ramsar sites. Non-breeding waterbirds from these sites may pass through or visit the Hornsea Four array area during the non-breeding season and were considered for assessment, but due to a thinning of the potential risk when considering birds from multiple designated sites, the relative impact on a specific SPA or Ramsar population is considered to be inconsequential if any potential mortalities were apportioned between those sites. Therefore, no migratory non-breeding waterbird species, or the sites for which they are designated features, were screened into the in-combination assessment for Hornsea Four.

8.2.5 Onshore Ecology

8.2.5.1 The study areas that have been identified for in-combination effects for onshore ecology are in line with the study areas as described in the Screening Report (**Appendix A**), namely a maximum 5 km buffer of the onshore elements of Hornsea Four, taking into consideration the Natural England IRZs. This is in order to account for highly mobile bat and bird species. For other protected species and habitats, a maximum extent of impact is considered to be 2 km, taking into consideration potential pathways (i.e. connecting habitats between projects) as well as temporal overlap on shared habitat resources.

8.2.5.2 A total of nine projects have been identified for inclusion on the shortlist of projects to be assessed cumulatively for effects on onshore ecology and nature conservation receptors. Projects that have not been considered as resulting in likely cumulative significant effects for onshore ecology are not considered to be functionally connected to designated sites, or do not have an overlap in project timescales. The full approach to the CEA for onshore ecology is presented in **Volume A3, Chapter 3: Ecology and Nature Conservation**.

8.2.5.3 Screening in-combination has been based on information available on each potential project (e.g. as set out on the ERYC planning portal or in an attendant, available ES) and it is noted that the project details available may change in the period up to construction or may not be available in detail at all. The assessment presented within **Volume A3, Chapter 3: Ecology and Nature Conservation** is therefore considered to be conservative, with the level of impacts ultimately arising expected to be reduced compared to those presented here.

8.2.5.4 Screening in-combination has not identified any potential impacts that are considered to be of any greater significance than those identified for the project alone and therefore no in-combination effects are forecast, including no in-combination effects where an effect alone is insufficient to result in potential LSE (ie. it therefore follows that the conclusion of no LSE for the project alone with respect to onshore ecology also applies in-combination, with no LSE in-combination for onshore ecology).

8.2.6 Migratory Fish

8.2.6.1 As noted above in paragraph 6.4.1.2, all potential effects for migratory fish have been screened out from potential LSE for migratory fish alone (as confirmed within the Screening Report (**Appendix A**) and the Screening Matrix (**Appendix B**)) given the lack of any viable pathway. Therefore, no further consideration is given here to migratory fish, with a conclusion that there will be no in-combination LSE.

9 Summary of Designated Sites

9.1.1.1 Summary information on each designated site screened in for potential LSE alone and/ or in combination is provided in **Appendix D**, including the designated feature(s), key literature sources describing the site and the features/ effects screened in under potential LSE. The conservation objectives for each site are also provided.

10 Assessment of Adverse Effect Alone

10.1.1.1 Where potential for LSE on a European site has been identified, there is a requirement to consider whether those effects will adversely affect the integrity of the site in view of its conservation objectives. The conclusion on potential LSE for Hornsea Four alone and/ or in-combination is presented in **Table 4**, with the conservation objectives for all relevant sites provided in **Appendix D**. The information is presented below according to the following receptor groupings:

- Subtidal and Intertidal Benthic Ecology;
- Marine Mammals;
- Offshore Ornithology;
- Onshore Ecology; and
- Migratory Fish.

10.1.1.2 The assessment approach applied here is to first summarise each designated site screened in for potential LSE in turn, highlighting the feature(s) screened in together with the site's conservation objectives and the effects identified as potentially resulting in LSE. To minimise the potential for repetition, the determination of AEoI that follows is made on a receptor by receptor basis – however the relevant sites (and their features) are identified for each receptor, together with the relevant effects.

10.1.1.3 The nature of each relevant effect is then described (e.g. in terms of scale, duration, frequency, etc), drawing on the relevant project literature, and summarising the relevant conclusion from the ES. A conclusion on AEoI is then drawn for each site feature screened in, with these conclusions summarised on a site by site basis in **Table 62**.

10.2 Subtidal and intertidal benthic ecology

10.2.1 Assessment Criteria

10.2.1.1 RIAA has been prepared in accordance with Advice Note 10: Habitats Regulations Assessment Relevant to Nationally Significant Infrastructure Projects (PINS 2017), with the method for determining potential impact with respect to subtidal and intertidal benthic ecology being compliant with the Chartered Institute of Ecology and Environmental Management (CIEEM) guidelines (CIEEM 2016).

10.2.1.2 The assessment criteria and conclusions presented within Volume A2, Chapter 2: Benthic and Intertidal Ecology have been drawn on to inform this report when considering the potential for adverse effects on site integrity with respect to intertidal and benthic ecology features, with the ES conclusions on significance being considered here specifically in the context of the conservation objectives of the designated sites being assessed. The final assessment for each effect is based upon expert judgement. Where possible, parameters are quantified and predicted changes presented.

10.2.1.3 Full detail of the assessment criteria and assignment of significance applied within the ES are provided within Section 2.10 of **Volume A2, Chapter 2: Benthic and Intertidal Ecology**, and take account of the following:

- Sensitivity/ importance of the environment (drawing on MarLIN and MARESA sensitivity categories;

- Magnitude of impact (the degree of change from baseline, in terms of spatial extent, duration, timing, seasonality and/ or frequency); and
- Significance of potential effect in terms of large/ moderate/ slight and negative/ beneficial (defined in a matrix combining sensitivity and magnitude).

10.2.2 Description of Significance

10.2.2.1 A description of the significance of project level effects upon the receptors grouped under 'subtidal and intertidal benthic ecology', as relevant to the designated sites and their associated features screened in for potential LSE is provided below.

10.2.2.2 As described in **Table 4**, there are four European sites which have the potential to be affected through impacts on subtidal and intertidal benthic ecology. These are described in turn below.

10.2.2.3 The Flambrough Head SAC is situated 1.4 km from the ECC at its nearest point. The HRA Screening Report (**Appendix A**), concluded that the following impacts should be screened in for consideration in the RIAA because a potential LSE could not be discounted for these impacts:

- Temporary increases in suspended sediments / smothering (reef and seacave features only for cable corridor only, all project stages);
- Accidental pollution (reef and seacave features only for cable corridor only, all project stages);
- Invasive non-native species (reef and seacave features only, all project stages); and
- Changes to physical processes (reef feature during O&M phase only).

10.2.2.4 The remaining three sites screened in for benthic ecology (Humber Estuary SAC, SPA and Ramsar) are all screened in for intertidal habitat for the same reason – saltmarsh habitats (see **Table 4** for specific site features/supporting habitats) within the Humber Estuary with potential LSE for effects on saltmarsh from increased nitrogen deposition during construction only. The sites are some 32.2 km distant from the EEC at their nearest point.

10.2.3 Construction and Decommissioning

Temporary increases in suspended sediment concentrations (SSC) / smothering

10.2.3.1 The potential for an AEoI as a result of an increase in SSC and subsequent deposition on benthic subtidal and intertidal habitats during construction and decommissioning relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

10.2.3.2 There is the potential for a temporary increase in SSCs and subsequent deposition to result from construction and decommissioning operations within the ECC. **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect.

10.2.3.3 Temporary, intermittent and localised increase in SSCs could potentially affect the benthos e.g. through lower light levels, with deposition potentially leading to smothering. Temporary increases in SSC and associated sediment deposition are expected from activities including seabed preparation, sediment disposal and the cable installation works. **Volume A5, Annex 1.1: Marine Processes Technical Report** provides a full description of the physical assessment, **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Process** assessed the increase in suspended sediments, with the subsequent effect on benthic habitats and species assessed in **Volume A2, Chapter 2: Benthic and Intertidal Ecology**. A summary of the existing baseline and the maximum design scenarios associated with the impact summarised below.

10.2.3.4 SSC in the southern North Sea varies widely both spatially and temporally, with a general pattern of an inshore to offshore gradient in SSC. SSCs vary seasonally and are generally in the range 2 to 14 mg/l closer inshore on the ECC. SSCs reduce further offshore reaching levels of around 2 to 3 mg/l. The larger variations and higher concentrations in the inshore region are mainly due to fine sediments eroded from the cliffs during winter periods, shallower water and locally stronger flows maintaining the material in suspension, preventing local deposition. Specifically, **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Process** found that suspended sediment concentrations are highest for around the first 10 km from the coastline and for the area around Flamborough Head. This is mainly in response to fine sediments from the beach being washed into the sea and wave stirring influences.

10.2.3.5 During seabed preparation (sandwave clearance), a sediment plume will form from the marginal amount of fine sediments present in the overspill. The pathway for any sediment plume will be governed by tidal advection (flood to the south-east and ebb to the north-west) with reduced concentrations around this axis due to dispersion and diffusion mixing processes spreading the plume. Plume concentrations will reduce over distance due to increased mixing and material falling out of suspension. Modelling undertaken on the spoil disposal site indicates a scale of tidal advection around 10 km with concentrations generally < 10 mg/l away from the point of release (noted in **Volume A5, Annex 1.1: Marine Processes Technical Report** as being within 2 km and therefore in the same order as the minimum distance between the ECC and the SAC – i.e. any sediment released by works in the ECC will result in a SSC generally < 10 mg/l at most within the SAC boundary and will therefore be within background levels (as noted in Section 4.3 of **Volume A5, Annex 1.1: Marine Processes Technical Report**).

10.2.3.6 For cable trenching, the ES found that the majority of the excavated material is expected to drop back to the seabed relatively quickly and close to the point of disturbance. The content of fine sediments (silts and muds) is generally expected to be low (< 1 % to < 7% depending on location, based on the site-specific PSA data) limiting the potential for sediment plumes to be formed with high concentrations. Although the ES found potential for plumes to potentially reach the Flamborough Head SAC (particularly on a spring tide), the conditions at the SAC are highly dispersive for muds and silts, so there is no expectation for material to settle in this location.

10.2.3.7 It is therefore likely that effects of deposition from the construction works for Hornsea Four would be limited primarily to the immediate vicinity of the works or sediment disposal, with fine material distributed much more widely and becoming so dispersed that it is unlikely to settle in measurable thickness locally, with no expectation for sediment settling within the SAC boundary.

10.2.3.8 The communities associated with subtidal chalk reef habitat, which is a protected feature of the Flamborough Head SAC, are expected to have some tolerance to increases in SSC (De-Bastos and Hill 2016; Tillin and Hill 2016), particularly as these habitats are near the coast, where SSC are naturally highest. Designated site 'Advice on Activities' (see **Appendix D**) identifies a pressure benchmark of >5cm deposition in a single event, with physical conditions in the site meaning that there is no expectation of that benchmark being met. As noted above and drawing on the physical processes modelling (as presented in **Volume A5, Annex 1.1: Marine Processes Technical Report**), the majority of the disturbed or released material would be deposited in close proximity to works, with limited fines potentially reaching the SAC and no expectation of sediment settling within the SAC boundary given the physical conditions in the SAC (fast current speeds). As such, the relevant benchmark will not be exceeded. Sensitivity of many animals associated with soft rock habitats to light sediment deposition in any case would be expected to be limited due to the resilience of some characterising species (De-Bastos and Hill 2016) and the natural sediment mobility in these areas.

10.2.3.9 The ES concluded a not-sensitive to low MarESA sensitivity for 'submerged or partially submerged sea caves', which is a protected feature of the Flamborough Head SAC (Tyler-Walters 2018). The designated site 'Advice on Activities' identifies a pressure benchmark of >5cm deposition in a single event. As noted above, physical conditions in the site mean that there is no expectation for material to settle in this location and therefore no expectation of that benchmark being met. The upper, vertical walls of caves are unlikely to be subject to any smothering, but the inner reaches of caves with shallow slopes or horizontal ledges may be. In the wave exposed conditions experienced by biotopes typical of this habitat, any light smothering of sediment may be removed quickly, depending on the shape of the cave. It is unlikely that the magnitude of this impact would result in any localised effect on the biota within the cave and would certainly remain below the relevant benchmark.

10.2.3.10 It is concluded that given the short-term and temporary nature of the change in SSC, the existing levels of SSC in the area, the predicted lack of any accumulation of sediment within the SAC (and therefore any impact being less than the pressure benchmark) due to the distance from the release point and the high mobility of sediment within the SAC ensuring that the benchmarks for impact to the features are not reached; that the sites conservation objectives (as detailed in **Appendix D**) will be maintained in the long-term. There is, therefore, no potential for an AEoI, having regard to the conservation objectives of the reef and sea cave features of the Flamborough Coast SAC, in relation to temporary and short-term increased SSC and associated deposition from Hornsea Four alone and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term.

Invasive non-native species

10.2.3.11 The potential for an AEoI as a result of spread of invasive non-native species (INNS) during construction and decommissioning relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

10.2.3.12 There is a risk that the project could increase the spread of INNS through the movement of vessels in and out of the benthic subtidal study area, should work vessels arrive from outside the UK. **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect.

10.2.3.13 There will be up to 6,126 round trips to port during the construction phase (a combination of all maximum construction vessel return trips), which will contribute to the risk of introduction or spread of INNS in ballast water should any of these contain ballast water and arrive from a non UK port). It should be noted that it is by no means certain thay any vessel will arrive from a non UK port and/ or contain ballast water, especially given the type of vessels involved and the proximity of the project to UK ports. A series of mitigation measures are proposed including a Construction Project Environmental Management and Monitoring Plan (CPEMMP) with a marine biosecurity plan (see Co111 of **Volume A4, Annex 5.2: Commitment Register**, and **Table 3**) will, however, ensure that the risk of potential introduction and spread of INNS will be minimised.

10.2.3.14 There is a lack of evidence to date from other offshore wind farm developments within the North Sea having had any adverse effects on key species and habitats through increasing the spread of marine INNS, with the majority of the vessel movements associated with the array some 60 km distant from the SAC (and therefore offering further limited potential for a linkage between any INNS and the SAC). Further, the ES concluded that the magnitude would be negligible and that regardless of sensitivity of a feature the overall significance is negligible, which is not significant in EIA terms.

10.2.3.15 It is concluded that due to the lack of evidence of any adverse effect from INNS and offshore wind farms, the project level commitments to mitigate the risk and the ES conclusion of negligible significance, there is a low risk of promoting the spread of INNS. The conclusion is supported by the distance between the array and the SAC boundary (approximately 60 km), where the majority of vessel movements will occur (within the array boundary and therefore offering further limited potential for a linkage between any INNS and the SAC); all supporting the conclusion that the sites conservation objectives will be maintained in the long-term. There is, therefore, no potential for an AEoI to the conservation objectives (**Appendix D**) of the reef and sea cave features of the Flamborough Coast SAC in relation to spread of INNS from Hornsea Four alone and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term.

Nitrogen Oxides (NOx), Nutrient Nitrogen (NN) and Ammonia (NH_3) deposition

10.2.3.16 The potential for an AEoI to result from increased airborne nitrogen oxides (NOx) and ammonia (NH3) and the deposition of nutrient nitrogen (NN) relates to the following designated sites and relevant features (i.e. those features for which potential LSE could not be discounted):

Humber Estuary SAC

- Atlantic saltmeadows; and
- Salicornia and other annuals colonising mud and sand.

Humber Estuary Ramsar

- Saltmarshes.

Humber Estuary SPA

- Saltmarshes (as a supporting habitat of designated species).

10.2.3.17 **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect. The term 'saltmarsh' is used throughout this section to refer to all the designated features and supporting habitats above (noting that Salicornia is a pioneer saltmarsh species).

10.2.3.18 The potential risk for the saltmarsh is associated with vehicles using the A63 during construction (for an intermittent and variable level during a maximum period of 61 months (see **Section 6.5** for information on the construction programme and how onshore and offshore construction fits into the overall 61 month period) with comparable effects assumed during decommissioning. The subject area of saltmarsh (the small area potentially affected) is localised in the vicinity of the A63 at Hull (see Figure 4) and represents a small proportion of the overall saltmarsh feature across the Humber Estuary SAC, Ramsar and SPA.

10.2.3.19 The assessment is conducted on a precautionary basis for a number of reasons:

- The air quality results have been derived from HGV demand across a three year window within the overall 61 month period, which represents a worst case (**Volume A3, Chapter 9: Air Quality**). If the project were constructed over a longer timescale, the impacts would be lower than those predicted as the number of movements would be distributed over a longer timeframe;
- The movements are based on the average HGV demand over the first year of construction, when HGV movements are more intensive (325 two-way HGV movements). As such, impacts for subsequent years would be lower in magnitude than those presented (117 two-way movements for year 2 and 143 two-way movements for year 3, 190 two-way movements across all years);
- It is assumed that all HGV traffic may originate from ports in Hull and travel along the A63, when in reality some or all materials could be sourced from elsewhere via the M62;

- The approach does not account for the reallocation of traffic associated with existing permissions. For example, the HGVs associated with an aggregate supplier in Hull would already be travelling via the A63 to serve existing construction projects; as these projects naturally come to an end, the supplier would switch to serving new emerging construction projects such as Hornsea Four; and
- The air quality assessment at PEIR (with respect to the saltmarsh) considered NOx and NN only. It is of note that the DMRB methodology (Highways Agency 2013) only requires the assessment of NOx emissions and nitrogen deposition. It does not consider NH_3 or its contribution to nitrogen deposition. The inclusion of NH_3 in the assessment for application is therefore precautionary.

10.2.3.20 Nitrogen Oxides (NOx) are produced in combustion processes including road transport, with ammonia (NH3) coming primarily from agriculture, but also some traffic, biomass burning and industry. NOx and NH3 emissions contribute to total nitrogen deposition, the direct effects of NOx and NH3 can also be toxic to vegetation[26]. An exceedance of critical values for air pollutants could modify the chemical status of substrate supporting the saltmarsh, accelerating or damaging plant growth, altering its vegetation structure and composition and causing the loss of sensitive species (Natural England 2019a). This could further affect the quality and availability of nesting, feeding or roosting habitats for SPA and Ramsar bird species, should any use the saltmarsh fringing the A63.

10.2.3.21 The high-level Conservation Objectives for the SAC are provided in **Appendix D**. Of particular relevance in this regard, is the air quality target attribute that requires that project activities do not compromise the objective to "maintain concentrations and deposition of air pollutants to below the site-relevant Critical loads (for deposition of NN) or Critical levels (for airbourne NOx and NH3) given for this feature on APIS[27]" (Natural England 2019a).

10.2.3.22 For the SPA, the high-level Conservation Objectives of relevance to the assessment are to maintain or restore the extent, distribution, structure and function of the habitats of the qualifying features (Natural England 2014). In this regard, the relevant target attribute relating to "Supporting habitat: air quality" requires for each individual feature, that the concentrations and deposition of air pollutants should be maintained below the APIS Critical Load or Level values given for the habitats of the site (Natural England 2019b). The supplementary advice for the site notes that NN levels vary across the site and the current overall levels are not known to have a significant effect on birds within the SPA (Natural England 2019b).

10.2.3.23 There is significant overlap between the SAC, SPA and Ramsar designations in terms of geographical overlap and management objectives. For this assessment, the Conservation Objectives for the SAC and SPA are considered to provide a practical and robust basis to ensure that the Ramsar criteria (as per the JNCC 2007) are met and the SPA and Ramsar assessments are undertaken in parallel.

10.2.3.24 A condition assessment of the Humber saltmarshes has not been identified. It is noted that SSSI unit 070 - A63 Roundabout to Docks (lowland marsh and swamp), was reported as 'unfavourable, recovering' when last assessed in 2010 (Natural England 2019a). 'Coastal squeeze' is the only reason cited for the adverse condition in this unit (Natural

[26] https://cieem.net/wp-content/uploads/2020/12/Air-Quality-advice-note.pdf
[27] www.apis.ac.uk

England 2010). Human harvesting is reported as a current and notable threat to Salicornia more generally (Natural England 2019a). There are no data available on APIS for the Humber Estuary regarding trends in nitrogen deposition over time.

10.2.3.25 The assessment has been undertaken with reference to the approach described in IAQM guidance for designated sites (IAQM 2020, which updates the previous Holman et al 2019), Natural England's guidance to competent authorities on the assessment of road traffic emissions under the Habitats Regulations (Natural England 2018b), as recommended during consultation (**Volume A3, Chapter 9: Air Quality**), together with the January 2021 CIEEM 'Advisory Note: Ecological Assessment of Air Quality Impacts', the latter issued as a companion piece to IAQM (2020). IAQM (2020) recommends the assessment of ecological receptors when:

- Any sensitive qualifying features are located within 200 m of a road link projected to experience developmental-generated vehicle movements; and
- Onshore construction activities are likely to generate either >1,000 (and/ or >200 HDV) AADT movements on a road link within 200 m of the ecological receptor, or result in >1% of a Critical Level and/or Critical Load.

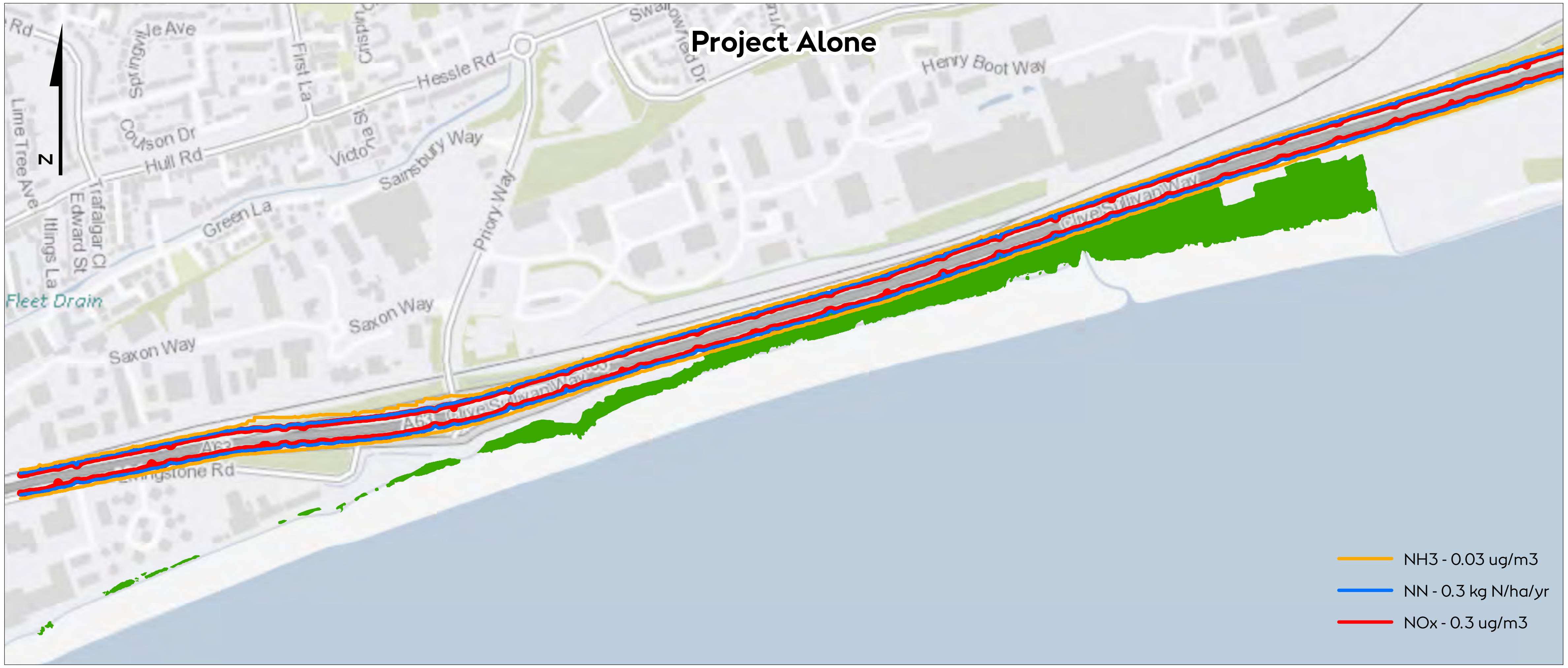
10.2.3.26 IAQM (2020) provides the annual critical level for NOx as being 30 μg m^{-3} and for NH3 being 3 μg m^{-3}. CIEEM (2021) identifies the critical load for NN as being 20 - 30 (kg N ha-1 $year^{-1}$). CIEEM (2021) notes that critical loads for saltmarsh are not as reliable as others, and that the higher end of the range, i.e. 30 kg/ha/yr N, should be applied except for densely vegetated upper saltmarsh. As noted above, the stretch of saltmarsh fringing the A63 is known to be subject to coastal squeeze, which is itself known to be a factor behind the loss of some upper marsh communities on the Humber[28]. The upper end of the NN critical load range is therefore deemed most appropriate to the assessment here.

10.2.3.27 With respect to the potential for impact and HRA Screening, IAQM (2020) comments that an 'increment of 1% (or less) of the relevant long term critical level or critical load alone is considered inconsequential. A change of such magnitude, i.e. two orders below the criterion for harm to occur, is challenging to measure (even by the most precise air quality instrument) and difficult to distinguish from natural fluctuations in measured data (due to other variables such as variations in emissions and weather)'. Further, IAQM (2020) clarifies that 'crucially, the 1% screening criterion is not a threshold of harm and exceeding this threshold does not, of itself, imply damage to a habitat'. That position is supported by Natural England 2018b, notably in relation to determination of adverse effect (i.e. an exceedance of the 1% threshold does not in itself constitute an AEoI). IAQM (2020) also noted that 'there is clear evidence that UK NOx emissions, including those from road traffic, are declining and will continue to do so in the future', while noting for NH3 that such declines are less certain, although the UK government is committed to doing so.

10.2.3.28 To quantify potential impacts, air quality modelling has been undertaken and reported in **Volume A3, Chapter 9: Air Quality** to determine potential rates of NOx, NH3 and NN associated with Hornsea Four traffic along the A63, both alone and in-combination with other sources and relative to existing background levels. Air quality effects (NOx, NH3 and NN) are predicted and compared to air quality limit values (critical loads / levels)

[28] https://www.humbernature.co.uk/estuary/habitats-and-species

provided by APIS, below which significant harmful effects (and adverse effects on site integrity) are not thought to occur. The highly precautionary nature of the assessment is noted above. **Figure 4** depicts modelled predictions for Hornsea Four alone (in terms of where the 1% of the critical load of NN and critical level of NH3 and NOx will be met, clearly showing that the contribution from Hornsea Four alone only meets the 1% screening crition for a very small proportion of the local saltmarsh, itself a small proportion of the total Humber saltmarsh) and for Hornsea Four with background (in terms of where the critical load of NN and critical level of NH3 and NOx will be met, in relation to the local saltmarsh in immediate proximity to the road, being a very small proportion of the total saltmarsh feature of the Humber).



Date: 16/08/2021 Author: BenBlakeman Name: HOW04GB0221_Modelled_Contours_NOx_NN_NH3_Alone

Hornsea Four

Figure 4

Modelled contours for project contributions (alone) for NOx, NH3 and NN

Saltmarsh Extent (Environment Agency, 2011)

Coordinate system: British National Grid
Scale@A3: 1:8,000

0 200 400 Metres
0 500 1,000 Feet

REV	REMARK	DATE
...	First Issue	16/08/2021

NOx, NH3 and NN Contours
Project Alone and In-combination
Document no: HOW04GB0222
Created by: BPHB
Checked by: SK
Approved by: LK

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10.2.3.29 Levels of NOx, NH3 and NN have been modelled at transect points at intervals from the road edge (in accordance with DMRB guidance (Highways Agency 2007)) from 0 m out to 25 m. Values were also modelled at 50 m and 100 m from the road edge. With respect to the modelled values at 0 m, it should be noted that IAQM (2020) notes that predictions closer than 2 m should not be made because 'such predictions can be unreliable and may not represent areas of relevance to the assessment'. The values for 0 m are therefore not included in the assessment. However, for clarity, the modelled values for both NOx and NN for the project alone at the road edge did not exceed the 1% screening criteria of the Critical Level or Load (as relevant) and for NH3 were only borderline at 1.1% of the Critical Level at 1 m (within the 0-2 m where predictions are deemed unreliable). As noted above, such a contribution would be both difficult to measure and difficult to differentiate from natural variation. Further, the DMRB methodology (Highways Agency 2013) only requires the assessment of NOx and NN and does not require the consideration of NH3 or its contribution to nitrogen, with NH3 included on a precautionary basis.

10.2.3.30 The reported values for the assessment alone comprise background levels and the contribution from the project alone. The assessment year applied is 2024, with 2019 being the base year (the most recent data available), noting that for NN deposition APIS provides a 3 year average (the most recent therefore covering 2017-2019).

10.2.3.31 The modelling predicts that the project acting alone would make only a small contribution to background NOx levels (at 16.71 ug/m3)[29]. Project contributions alone are not predicted to exceed 0.10 ug/m^3 at 10 m from the road (Transect T2-10 m); this contribution represents a 0.33% contribution to the Critical Level. This contribution would further diminish with distance from the road edge; at 100 m from the road, the project contribution alone is just 0.03 ug/m^3 (a 0.1% contribution).

10.2.3.32 Background NOx concentrations are below the Critical Level, and the short term and temporary contributions from the project alone (being at worst at these precautionary levels for a single year) would not make a significant difference to the existing situation nor result in an exceedance of that Critical Level. Further, and given that the project alone contribution is below 1% in all cases, and drawing on IAQM (2020), the project alone contribution would both be unlikely to be measurable while being within natural variation. The change will affect a very small proportion of the saltmarsh habitat across the SAC, SPA and Ramsar site on a short term and termporary basis. Therefore, the risk of AEoI resulting via this pathway for the project acting alone is discounted.

10.2.3.33 The modelling predicts that the project acting alone would make only a small contribution to background NH3 levels (being 2.03 ug/m^3). Project contributions alone are predicted to be at most 0.02 ug/m^3 at 10 m, a 0.7% contribution to the Critical Level, and falling further at 100 m from the road to just 0.01 ug/m^3 (a 0.2% contribution).

10.2.3.34 Background NH_3 concentrations are below the Critical Level, and the short term and temporary contributions from the project alone (being at worst at these precautionary levels for a single year) would not make a significant difference to the existing situation nor result in an exceedance of that Critical Level. Further, and given that the project alone contribution beyond the immediate vicinity of the road is below 1%, and drawing

[29] http://www.apis.ac.uk/srcl/select-a-feature?site=UK0030170&SiteType=SAC&submit=Next

on IAQM (2020), the project alone contribution would both be unlikely to be measurable while being within natural variation. The change will affect a very small proportion of the saltmarsh habitat across the SAC, SPA and Ramsar site on a short term and termporary basis. Therefore, the risk of AEoI resulting via this pathway for the project acting alone is discounted.

10.2.3.35 The modelling predicts that the project acting alone would make only a small contribution to background NN levels (being 20.4 kg N ha-1 year). Project contributions alone are predicted to be just 0.118 kg N ha-1 year-1 at 10 m, a 0.6% contribution to the lowest Critical Load or 0.4% of the more appropriate highest Critical Load.

10.2.3.36 Background NN concentrations are just above the lower end of the Critical Load but well within the more appropriate highest Critical Load, and the short term and temporary contributions from the project alone (being at worst at these precautionary levels for a single year) would not make a significant difference to the existing situation nor result in an exceedance of the highest Critical Load. Further, and given that the project alone contribution is below 1% in all cases, and drawing on IAQM (2020), the project alone contribution would both be unlikely to be measurable while being within natural variation. The change will affect a very small proportion of the saltmarsh habitat across the SAC, SPA and Ramsar site on a short term and termpoary basis. Therefore, the risk of AEoI resulting via this pathway for the project acting alone is discounted.

10.2.3.37 There is, therefore, no potential for an AEoI to the conservation objectives of the saltmarsh features of the Humber Estuary SAC, Humber Estuary Ramsar or saltmarsh as a supporting habitat within the Humber Estuary SPA in relation to nitrogen deposition from Hornsea Four alone and therefore, subject to natural change, the saltmarsh features (or supporting habitat) will be maintained in the long term.

Accidental pollution

10.2.3.38 The potential for an AEoI as a result of accidental pollution during construction and decommissioning relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

10.2.3.39 **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect.

10.2.3.40 The potential for accidental pollution to affect benthic habitats was not considered in the ES (Volume A2, Chapter 2: Benthic and Intertidal Ecology), given the project specific committments (contained within Table 2.11 of that chapter and **Table 3** here), beyond consideration of the potential for contaminants to be released from sediments. Accidental pollution had been previously scoped out from assessment within the Scoping Report on a conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the PEIR and ES, with the relevant commitments ensuring that conclusion. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**) and in line with the approach required following the People Over Wind decision.

10.2.3.41 However, mitigation is relevant at Stage 2 assessment, with the specific commitment being Co111 (**Table 3**), which references the following commitment to mitigation:

'A Construction Project Environmental Management and Monitoring Plan (CPEMMP) will be developed and will include details of:
- a marine pollution contingency plan to address the risks, methods and procedures to deal with any spills and collision incidents of the authorised project in relation to all activities carried out below MHWS;
- a chemical risk review to include information regarding how and when chemicals are to be used, stored and transported in accordance with recognised best practice guidance;
- a marine biosecurity plan detailing how the risk of introduction and spread of invasive non-native species will be minimised;
- waste management and disposal arrangements;
- a vessel management plan, to determine vessel routing to and from construction sites and ports, to include a code of conduct for vessel operators; and
- the appointment and responsibilities of a company fisheries liaison officer'

10.2.3.42 It is noted that Co111 is secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d).

10.2.3.43 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, enables the conclusion that there is, therefore, no AEoI to the conservation objectives (**Appendix D**) of the reef and sea cave features in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term with respect to the potential for accidental pollution.

10.2.4 Operation and Maintenance

Temporary increases in suspended sediments / smothering

10.2.4.1 The HRA screening report (**Appendix A**) identified the potential for LSE through sediment disturbance during operation and maintenance. It identified that there was the potential for suspended sediment released during maintenance works within the ECC to reach the SAC within which the reef and sea cave features are located.

10.2.4.2 **Volume A5, Annex 1.1: Marine Processes Technical Report** identifies that during the operation phase, there may be various maintenance activities with the potential to create short term periods of sediment. However, these are considered to be slight compared to those occurring during either the construction or decommissioning phases.

10.2.4.3 The potential for an AEoI as a result of an increase in SSC and subsequent deposition on subtidal and benthic intertidal habitats during operation and maintenance relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

10.2.4.4 **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect. The distance between the Hornsea Four array area and the SAC (at least 60 km) is such that effects resulting from the array have been screened out (**Appendix A**).

10.2.4.5 SSC in the southern North Sea varies widely both spatially and temporally, with a general pattern of an inshore to offshore gradient in SSC. SSCs vary seasonally and are generally in the range 2 to 14 mg/l closer inshore on the ECC. SSCs reduce further offshore reaching levels of around 2 to 3 mg/l. The larger variations and higher concentrations in the inshore region are mainly due to fine sediments eroded from the cliffs during winter periods, shallower water and locally stronger flows maintaining the material in suspension, preventing local deposition. Specifically, **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Process** found that suspended sediment concentrations are highest for around the first 10 km from the coastline and for the area around Flamborough Head. This is mainly in response to fine sediments from the beach being washed into the sea and wave stirring influences.

10.2.4.6 **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** assessed the increase in suspended sediments from the project as a whole and the subsequent effect on benthic habitats and species was assessed in **Volume A2, Chapter 2: Benthic and Intertidal Ecology** of the ES.

10.2.4.7 The ES and Technical report concluded that the potential for sediment release during operation and maintenance is considered less than during construction. The assessment above for the construction phase concluded no AEoI following sediment release and subsequent deposition. That conclusion is supported by the relevant 'Advice on Activities' which identifies a pressure benchmark of >5 cm sediment deposition in a single, discrete event – a level greater than predicted by **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes.**

10.2.4.8 Given the small scale and magnitude of possible impact during operation and maintenance compared to the construction phase, together with the potential for effect being well within the relevant pressure benchmark, it is concluded there is no potential for an AEoI to the conservation objectives (as detailed in **Appendix D**) of the reef and sea cave features of the Flamborough Coast SAC in relation to temporary and short-term increased SSC and associated deposition from Hornsea Four alone and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term.

Introduction of INNS

10.2.4.9 The potential for an AEoI as a result of the spread of INNS during operation and maintenance relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

10.2.4.10 **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect. There is a risk that the project could increase the spread of INNS through the introduction of hard substrate into a sedimentary habitat and also the movement of vessels in and out of the benthic subtidal study area (should those vessels arrive from a non UK port).

10.2.4.11 As presented in **Volume A2, Chapter 2: Benthic and Intertidal Ecology** a maximum habitat change of up to 3,730,671 m^2 will be introduced into the Hornsea Four benthic subtidal ecology study area, which will provide new habitat for potential colonisation by marine INNS. The majority of this will be within the Hornsea Four array area and therefore at least 60 km distant from the SAC (and therefore provides limited potential for linkage to the SAC). In addition to this, there will be up to 1,693 round trips to port by operational and maintenance vessels per year, which will contribute to the risk of introduction or spread of INNS (noting that these vessels will be stationed at a UK O&M base and therefore not coming in from a non UK port, limiting the potential to introduce INNS).

10.2.4.12 A series of mitigation measures are proposed including CPEMMP with a marine biosecurity plan (see Co111 of **Volume A4, Annex 5.2: Commitment Register**, and **Table 3**) will, however, ensure that the risk of potential introduction and spread of INNS will be minimised. Further, there is a lack of evidence to date from other offshore wind farm development within the North Sea having had any adverse effects on key species and habitats through increasing the spread of marine INNS.

10.2.4.13 It is concluded that due to the lack of evidence of any adverse effect from INNS and offshore wind farms, the location of Hornsea Four relative to the features (including the distance between array, where the majority of hard substrate will be introduced, and the features), the UK base for O&M vessels (limiting INNS opportunities) and the project level commitments to mitigate the risk, there is a low risk of the introduction of and or promotion of the spread of INNS. The conclusion is supported by the distance between the array and the SAC boundary (approximately 60 km), where the majority of hard substrates and vessel movements will occur; all supporting the conclusion that the sites conservation objectives (as detailed in **Appendix D**) will be maintained in the long-term. There is, therefore, no potential for an AEoI to the conservation objectives of the reef and sea cave features of the Flamborough Coast SAC in relation to spread of INNS from Hornsea Four alone and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term.

Changes to physical processes

10.2.4.14 The potential for an AEoI as a result of changes to physical processes during operation and maintenance relates to the following designated site and the relevant feature (i.e. that feature screened in for potential LSE):

Flamborough Head SAC

- Reefs.

10.2.4.15 **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect. **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** assessed the potential for changes to physical processes and the subsequent effect on benthic habitats and species was assessed in **Volume A2, Chapter 2: Benthic and Intertidal Ecology** of the ES.

10.2.4.16 The presence of foundations, scour protection and cable crossings may introduce changes to the local hydrodynamic and wave regime, potentially resulting in changes to the sediment transport pathways and associated effects on benthic ecology. Scour and increases in flow rates can change the characteristics of the sediment potentially making the habitat less suitable for some species.

10.2.4.17 The potential for such consequences is considered in full within the ES (**Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** and **Volume A5 Annex 1.1 Marine Processes Technical Report**), specifically through the following considerations:

- Scour around structures including the array/HVAC foundations, cable crossings and at landfall; and
- Cable crossings.

10.2.4.18 Any scouring around cable crossings along the offshore ECC is considered in **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** to have a negligible magnitude of impact on the seabed and would not have far reaching effects. With respect to potential scour around the HVAC Booster Station, the ES found that any scour would be localised and mainly limited to the mobile sand content, with the gravel fraction remaining in situ and helping to armour the seabed. Given the small scale and localised nature of such scour, and the lack of any receptors within range, no impact assessment was required for marine processes.

10.2.4.19 Coastal processes were of particular interest during consultation on the draft RIAA (**Table 1**), including issues around Smithic Bank. Smithic Bank is depicted on Figure 1.9 of **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**, including its proximity to the ECC and the Flamborough Head SAC with the comment on the Humber Estuary addressed in **Table 3**). Cable crossings are required seaward of Smithic Bank. The assessment considered potential for change to sediment transport, wave climate and tidal flow from the project, including from the cable crossings seawards of Smithic Bank, concluding any changes to be localised, with no alteration to nearshore sediment transport. Further, the assessment found the seabed substrate around the headland at Flamborough to be mainly rock, indicating an area scoured of mobile sediments by the locally faster flows. No change in physical processes within the SAC were predicted.

10.2.4.20 It is therefore concluded that there is no potential for an AEoI to the conservation objectives (as detailed in **Appendix D**) of the reef of the Flamborough Coast SAC in relation to changes to physical processes from Hornsea Four alone and therefore, subject to natural change, the reef features will be maintained in the long term with respect to this effect.

Accidental pollution

10.2.4.21 The potential for an AEoI as a result of accidental pollution during operation and maintenance relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

10.2.4.22 **Appendix D** provides the conservation objectives for the site, with these taken into account when concluding the potential for effect. The potential for accidental pollution to affect benthic habitats was not considered in the ES (**Volume A2, Chapter 2: Benthic and Intertidal Ecology**), given the project specific committments (contained within Table 2.11 of that chapter and **Table 3** here), beyond consideration of the potential for contaminants to be released from sediments. Accidental pollution had been previously scoped out from assessment within the Scoping Report on a conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the PEIR and ES, with the relevant commitments ensuring that conclusion. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**).

10.2.4.23 Specifically, Co111 (**Table 3**) references the following commitment to mitigation:

'A Construction Project Environmental Management and Monitoring Plan (CPEMMP) will be developed and will include details of:
- a marine pollution contingency plan to address the risks, methods and procedures to deal with any spills and collision incidents of the authorised project in relation to all activities carried out below MHWS;
- a chemical risk review to include information regarding how and when chemicals are to be used, stored and transported in accordance with recognised best practice guidance;
- a marine biosecurity plan detailing how the risk of introduction and spread of invasive non-native species will be minimised;
- waste management and disposal arrangements;
- a vessel management plan, to determine vessel routing to and from construction sites and ports, to include a code of conduct for vessel operators; and
- the appointment and responsibilities of a company fisheries liaison officer.

10.2.4.24 It is noted that Co111 (**Table 3**) is secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d).

10.2.4.25 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, enables the conclusion that there is, therefore, no AEoI to the reef and sea cave features in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore the sites conservation objectives (as detailed in **Appendix D**) will be maintained in the long term, subject to natural change with respect to the potential for accidental pollution.

10.3 Marine Mammals

10.3.1 Assessment Criteria

10.3.1.1 The assessment of the risk of injury in marine mammals follows the draft 2010 advice issued by JNCC, CCW and Natural England, titled 'The protection of marine European Protected Species from injury and disturbance'. In the UK, EPS include all species of cetacean, turtles and Atlantic sturgeon –the same definition for injury is applied here for seals. The risk of injury is seen as deriving from physical (e.g. collision) and underwater noise (defined as the onset of a permanent threshold shift, or PTS).

10.3.1.2 The assessment of disturbance for harbour porpoise draws on SNCB guidance, issued as final in May 2020 (JNCC et al. 2020). As regards piling, JNCC et al. (2020) draw on a body of literature, which in turn are drawn on within JNCC (2016), namely Dahne et al. (2013) and Tougaard et al. (2014), the latter being a report produced by an expert group convened under the Habitats and Wild Birds Directives – Marine Evidence Group. The Tougaard et al. (2014) report drew on a number of empirical sources, including Dahne et al. (2013), but also Brandt et al. (2011), Brandt et al. (2012) (contained within Popper & Hawkins (2012)), Braasch et al. (2013) and Thompson et al. (2010). These studies reported direct observations during wind farm construction at projects across Europe, thus enabling an Effective Deterrent Radius (EDR) of 26 km to be established for percussive piling (monopiles). The EDR is defined by Tougaard et al. as reflecting the overall loss of habitat that would occur if all animals vacated an area with a radius of the EDR around the pile driver, being equivalent to the mean loss of habitat per animal. More noise-tolerant animals will lose less than this mean area, while less noise-tolerant animals would lose more. It is acknowledged in the JNCC advice that there is, however, the potential for a reduced EDR should project specific details allow. For example, the final advice (JNCC et al. 2020) provided an EDR for pin piles of 15 km and an EDR for monopiles with noise abatement of 15 km.

10.3.1.3 For seismic survey (air guns), the 2020 advice identified an EDR of 12 km, reducing to 5 km for high resolution geophysical survey. It is understood that should further evidence be provided, then the relevant EDR could be refined further. The RIAA has assumed an EDR of 5 km applies (unless the survey specifically identifies the use of air guns).

10.3.1.4 The advice from JNCC et al (2020) also notes a precautionary 26 km EDR for high order detonation of UXOs. Although there is no empirical evidence of harbour porpoise avoidance, UXOs are one of the loudest sources of underwater noise. It further notes that although a one-off explosion would probably be of a too short duration to cause widespread displacement, these detonations are usually part of campaigns with potentially several detonations in the same general area over several days.

10.3.1.5 In summary, the EDRs applied here are as follows:

- An EDR of 26 km from the location of piling (monopiles);
- An EDR of 15 km from the locaton of piling (pin piles);

- An EDR of 5 km for survey (unless air guns are specifically mentioned) from the location of activity; and
- An EDR of 26 km from UXO clearance.

10.3.1.6 The spatial aspect of disturbance in harbour porpoise, as defined through the relevant EDRs, has a defined limit above which disturbance would be considered significant[30]. That limit (confirmed in JNCC et al. 2020) is 20% of the relevant area (defined as that part of the SAC that was designated on the basis of higher persistent densities for that season (summer defined as April to September inclusive, winter as October to March inclusive)) on any given day (determined here as a 24 hour period).

10.3.1.7 That spatial aspect is accompanied by a temporal element, as defined through the use of the temporal threshold, effectively 10% of the relevant area when averaged across a season (summer being April to September inclusive, winter being October to March inclusive).

10.3.1.8 For bottlenose dolphin and seals, the approach to assessing disturbance follows that used within the ES (as defined in Section 4.10 of **Volume A2, Chapter 4: Marine Mammals**), as considered in the context of potential for site connectivity and the conservation objectives of the relevant sites. That approach effectively requires a density value for each species together with noise modelling results and a dose response curve. For bottlenose dolphin, no density estimates are available, with no sightings recorded during site specific surveys or within SCANS III survey block O. In the absence of any such density, an estimate has been made drawing on the following assumptions (for further detail, please see **Appendix I**):

- The reference population is the combined Greater North Sea management unit population (2,002) and the Central East Scotland management unit (189), totalling 2,211 individuals;
- It is assumed that the reference population is formed from both phenotypes (the coastal and oceanic) although the Moray Firth SAC population is coastal;
- That the population is evenly distributed across the management unit; and
- An average density of 0.003 ind km-2.

10.3.1.9 In terms of the number of grey seals that may be affected and how these animals may relate to individual designated sites, additional work has been undertaken and presented in full within **Appendix G**. The assessment for grey seals draws on the following:

- Consideration of site connectivity – grey seal are wide ranging animals and are not necessarily defined as 'Humber grey seals' for example. The work utilised data on grey seal tagging at sea; and
- Consideration of the grey seal population– how it has increased since site designation and the contribution made by the proportion of seals at sea when haul out counts are made.

[30] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

10.3.2 Description of Significance

10.3.2.1 A description of the significance of project level effects upon the receptors grouped under 'marine mammals', as relevant to the designated sites and their associated features screened in for potential LSE, is provided below.

10.3.3 Construction and Decommissioning

Underwater Noise

10.3.3.1 The following assessment is in relation to the potential for effect during construction only. The Screening Report (**Appendix A**) determined that the potential for LSE in relation to underwater noise during decommissioning would be similar to and potentially less than those outlined in the construction phase. Effectively that potential for effect during decommissioning would fall within, and be no worse than, the degree of effect during construction, with any such decommissioning being subject to the relevant licensing requirements at that time.

10.3.3.2 The potential for an AEoI as a result of an increase in underwater noise on marine mammals during construction relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE).

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary sites (for harbour seal, specifically Doggersbank (Netherlands) SAC and Klaverbank SCI); and
- Transboundary sites (twelve sites for grey seal, specifically Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres, Vlaamse Banken, SBZ 1, SBZ 2, SBZ 3, Vlakte van de Raan, Westerschelde & Saeftinghe, Voordelta, Noordzeekustzone and Waddenzee).

10.3.3.3 There are a number of sources of underwater noise associated with the project alone during construction, with these identified within **Volume A2, Chapter 4: Marine Mammals**, with those screened in for potential LSE here (in line with **Section 8** of the current report) being:

- Underwater noise from percussive piling;
- Underwater noise during UXO clearance;
- Underwater noise from geophysical and seismic survey; and
- Seabed preparation and cable installation activities (including dredging, drilling, cable laying, rock placement and trenching).

10.3.3.4 The importance of underwater noise for marine mammals (including harbour porpoise, bottlenose dolphin, harbour seal and grey seal) is discussed in **Volume A2, Chapter 4: Marine Mammals** and **Volume A4, Annex 4.5: Subsea Noise Technical Report**. That information, together with the underwater noise that may result from the above activities (as discussed within both those reports) and how that may affect marine mammals, is drawn on here in the context of the conservation objectives for each relevant designated site. Each of these effects are discussed in turn below, including the relevance for the features identified.

Underwater Noise from Percussive Piling

Project Parameters

10.3.3.5 The MDS for marine mammals (**Appendix F**) included percussive piling during the installation of the foundation structures. It is the MDS that is applied here – the full project description is provided in **Volume A1 Chapter 4 Project Description**. Hornsea Four will include up to 180 WTGs (monopile foundations or jackets with three pin piles), OSS within the array area (three large and six small OSS on monopile foundations or pin piles, 16 or 24 respectively), a single accommodation platform (monopile foundation or 24 pile jacket) and three HVAC booster stations (on monopiles or 24 pin piled jackets).

10.3.3.6 The duration of piling per foundation is assumed to be 1.2 days per monopile (216 days in total), with just 4 hours piling time within that period. That increases slightly for the jackets to 1.5 days per foundation, 270 in total, again 4 hours actual piling duration. Equivalent durations are given for the OSS and accommodation platform within the array area. For the HVAC booster stations, 3.6 days of piling is assumed for monopiles (1.2 days per foundation) and 4.5 days if jacket foundations (1.5 days per jacket).

10.3.3.7 The construction window for piling is provided in **Section 6.5**, and is expected to fall within a 12 month window from Q4 2026-Q4 2027.

Project Mitigation

10.3.3.8 Project specific mitigation specifically included for pile driving is identified in **Table 3** and includes the following:

- Co85 - No more than a maximum of two foundations are to be installed simultaneously; and
- Co110 - A piling Marine Mammal Mitigation Protocol (MMMP) will be developed in accordance with the Outline MMMP and will be implemented during construction. The piling MMMP will include measures to ensure the risk of instantaneous permanent threshold shift (PTS) to marine mammals is negligible and will be in line with the latest relevant available guidance. The piling MMMP will include details of soft starts to be used during piling operations with lower hammer energies used at the beginning of the piling sequence before increasing energies to the higher levels.

10.3.3.9 Following best and established practice, the above measures are primarily focused on managing and mitigating any risk of PTS (injury) in marine mammals. As highlighted in **Section 8.2.3**, the Outline Site Integrity Plan (SIP) (**F2.11: F2.11:: Outline Southern North Sea Special Area of Conservation Site Integrity Plan**) that accompanies the Application and is provided for in Condition 13(1)(j) of the Draft DCO (**C1.1: Draft DCO Including Draft DML**), provides certainty that harbour porpoise risk with respect to disturbance will be managed appropriately going forward. The key points addressed within the SIP are identified in **Section 8.2.3**.

Project Level Underwater Noise

10.3.3.10 Underwater noise during construction of Hornsea Four has been studied specifically through the following, including that of direct relevance to marine mammals:

- **Volume A2, Chapter 4: Marine Mammals**; and
- **Volume A4: Annex 4.5: Subsea Noise Technical Report**.

10.3.3.11 **Volume A4, Annex 4.5: Subsea Noise Technical Report** provides the technical evidence base for underwater noise, with the ES chapter providing the context for marine mammals (including for harbour porpoise, bottlenose dolphin, harbour seal and grey seal), in relation to the potential for injury. Auditory injury is addressed in the ES through consideration of the risk of onset of PTS. The threshold values applied for PTS (with the background to the various thresholds provided in Section 4.10.4 of **Volume A2, Chapter 4: Marine Mammals**) in relation to impulsive noise within the ES are provided in **Table 10** below.

Table 10: Southall et al. (2019) Thresholds for PTS in Harbour Porpoise (VHF: Very High Frequency), bottlenose dolphin (HF: High Frequency) and harbour/grey seals (PCW: Phocid Carnivores in Water).

Species	PTS onset	
	weighted SEL_{cum} (dB re 1 $\mu Pa^2 s$)	unweighted SPL_{peak} (dB re 1μPa)
Impulse Noise		
LF cetacean	183	219
HF cetacean	185	230
VHF cetacean	155	202
PCW	185	218

10.3.3.12 Natural England and JNCC (JNCC et al. 2020) advise that a buffer of 26 km around the source location is used to determine the impact area from pile driving for monopiles and 15 km for pin piles with respect to disturbance of harbour porpoise in the Southern North Sea SAC[31], with that approach applied here in the context of the 20% daily/10% seasonal thresholds described in **Appendix D.** For bottlenose dolphin, **Volume A2, Chapter 4: Marine Mammals** describes the disturbance response, with the assessment based on an assumed density of bottlenose dolphin of 0.003 ind/km^2. The porpoise dose-response curve is applied as a proxy for bottlenose dolphins. For harbour seals and grey seals, **Volume A2, Chapter 4: Marine Mammals** describes the disturbance response in Section 4.10. The assessment of harbour seal and grey seal response to disturbance presented here draws on the findings of **Volume A2, Chapter 4: Marine Mammals** and the grey seal apportionment approach presented in **Appendix G**, in the context of the relevant designated sites and their conservation objectives (summarised in **Appendix D**).

10.3.3.13 The assessment of potential impact from risk of onset of PTS in harbour porpoise is presented in Section 4.11.1 of **Volume A2, Chapter 4: Marine Mammals**. The assessment draws on results from underwater noise modelling at four separate locations (three within the Hornsea Four array area, the fourth location within the HVAC booster station search area). The ranges presented are unmitigated ranges – i.e. these represent the

[31] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

maximum in the absence of any mitigation. It is important to note that the project is committed to a piling MMMP (as referenced here in **Table 3**, and delivered through the DMLs), with Section 4.11.1 of the ES finding that the mitigation will reduce the potential for impact with regards PTS in harbour porpoise, bottlenose dolphin, harbour seal and grey seal to negligible and therefore 'not significant as defined in the assessment of significance matrix (**Table 4.13**) and is therefore not considered further in this assessment'.

10.3.3.14 As an unmitigated maximum value, the MDS predicted PTS onset impact ranges for harbour porpoise as presented within ES for SPLpeak reach 2.6 km for the east location and 1.3 km for the north west, east and HVAC modelled locations for pin piles (SPLpeak), for SELcum reducing to <100m for monopiles and up to to 4.6 km at the east location for pin piles (shown in Table 4.19 in **Volume A2, Chapter 4: Marine Mammals**). The maximum unmitigated number of harbour porpoise predicted to be within the PTS onset impact area, and therefore at risk of auditory injury, is 33 animals (aerial and SCANS III) or 43 animals (acoustic and SCANS III) (both 0.01% MU) for monopiles at the northwest of the array area, or for pin piles up to 69 (acoustic and SCANS III also at the north west of the array.

10.3.3.15 The effect of the planned mitigation within the piling MMMP (a combination of the soft start approach and use of ADDs) on the potential impact ranges is described in Section 4.11.1 of the ES, which will reduce the risk of PTS-onset to negligible levels. It is also considered highly likely that the presence of vessels and associated activity will ensure that the vicinity of the pile is free of harbour porpoise by the time that piling begins.

10.3.3.16 The risk of onset of PTS in bottlenose dolphin is considered in **Volume A2, Chapter 4: Marine Mammals** in Section 4.11.1. The modelling locations are the same as those for harbour porpoise, with the ranges similarly being unmitigated. It is important to note that the project is committed to a piling MMMP (as referenced here in **Table 3**, and secured through the DMLs), with Section 4.11.1 of the ES finding that the mitigation will reduce the potential for impact with regards PTS in bottlenose dolphin to negligible.

10.3.3.17 As an unmitigated maximum value, the predicted PTS onset impact ranges for bottlenose dolphin for the MDS piling scenario presented within the ES for all instances and at all locations is < 100 m. The maximum number of bottlenose dolphin predicted to be within the PTS onset impact area, and therefore at risk of auditory injury, is <1 animal. In the context of the predicted range of unmitigated risk of onset of PTS, together with the planned mitigation within the piling MMMP the conclusion drawn is of negligible adverse significance for bottlenose dolphin, which is not significant in EIA terms.

10.3.3.18 The risk of onset of PTS in harbour seal and grey seal is considered in **Volume A2, Chapter 4: Marine Mammals** in Section 4.11.1. The modelling locations are the same as those for harbour porpoise, with the ranges similarly being unmitigated. It is important to note that the project is committed to a piling MMMP (as referenced here in **Table 3**, and secured through the DMLs), with Section 4.11.1 of the ES finding that the mitigation will reduce the potential for impact with regards PTS in seals to negligible.

10.3.3.19 As an unmitigated maximum value, the predicted PTS onset impact ranges for harbour seal and grey seal for the MDS piling scenario presented within ES for all instances and at all locations is at most 170 m. The maximum number of harbour seal or grey seal predicted to be within the PTS onset impact area, and therefore at risk of auditory injury, is <1 animal. In the context of the predicted range of unmitigated risk of onset of PTS, together with the planned mitigation within the piling MMMP the conclusion drawn is of negligible adverse significance for both seal species, which is not significant in EIA terms.

Project Level Underwater Noise – MDS Piling Scenario and Disturbance

10.3.3.20 **Volume A2, Chapter 4: Marine Mammals** also considers the potential for behavioural disturbance to occur, and the potential impact on harbour porpoise, bottlenose dolphin, harbour seal and grey seal (**Section 4.1.1.1**). For the purposes of the RIAA, the assessment presented here for harbour porpoise is based on the relevant EDR (and therefore is in a context of habitat availability and not numbers of animals). The absence of such a range for bottlenose dolphin and seals for HRA purposes means the assessment of disturbance here is based on consideration of individuals as presented in the ES, in the context of relevant designated sites and for grey seals and bottlenose dolphin with additional work undertaken by SMRU Consulting on site apportionment and site population (**Appendix G and I**). A summary of the information presented for bottlenose dolphin, harbour seal and grey seal within the ES is provided below.

10.3.3.21 For bottlenose dolphin (drawing on **Volume A2, Chapter 4: Marine Mammals, Section 4.11.1)**, the greatest risk of disturbance could occur during installation of monopiles under the MDS at the north west location, when up to 14 individual animals could be disturbed, representing 0.6% of the reference population. That falls to 9 individuals at the south location (0.4% of the reference population). For pin piles, the maximum risk is also at the north west location, being up to 12 individuals (0.5% of the reference population), falling to 8 individuals at the south location (4% of the reference population). It should be noted that not all of these dolphins may be associated with a specific designated site and includes both phenotypes – coastal and oceanic. For piling, the modelled locations most likely to impact coastal bottlenose dolphins (with dolphins connected to the Moray Firth SAC being primarily coastal[32]) is the northwest location within the array and the HVAC, with these locations closest to the inshore waters where animals with any connectivity to the SAC are most likely to be located. Such disturbance will be localised, short term and in an area with low density of animals.

10.3.3.22 For harbour seals, the highest disturbance levels for monopiles were predicted for the HVAC location, where a total of 5 harbour seals are predicted to be disturbed for the installation of a monopile, which represents 0.1% of the reference population (not all of which will be associated with a specific designated site). The equivalent number for pin piles at the same location is 4 animals (0.08% of the population), which represents the highest level of disturbance in temporal terms. Such disturbance will be intermittent within an overall 12 month period. In the context of the low density of harbour seals within the area, and an area considered of low importance for foraging for the species, any such short term and temporary disturbance and displacement was found in the ES to represent a negligible adverse significance, which is not significant in EIA terms and was not considered further in the ES.

10.3.3.23 For grey seals, the highest potential disturbance levels on a spatial basis were predicted for the HVAC location where up to 1,489 grey seals have the potential to be disturbed

[32] https://apps.snh.gov.uk/sitelink-api/v1/sites/8327/documents/59

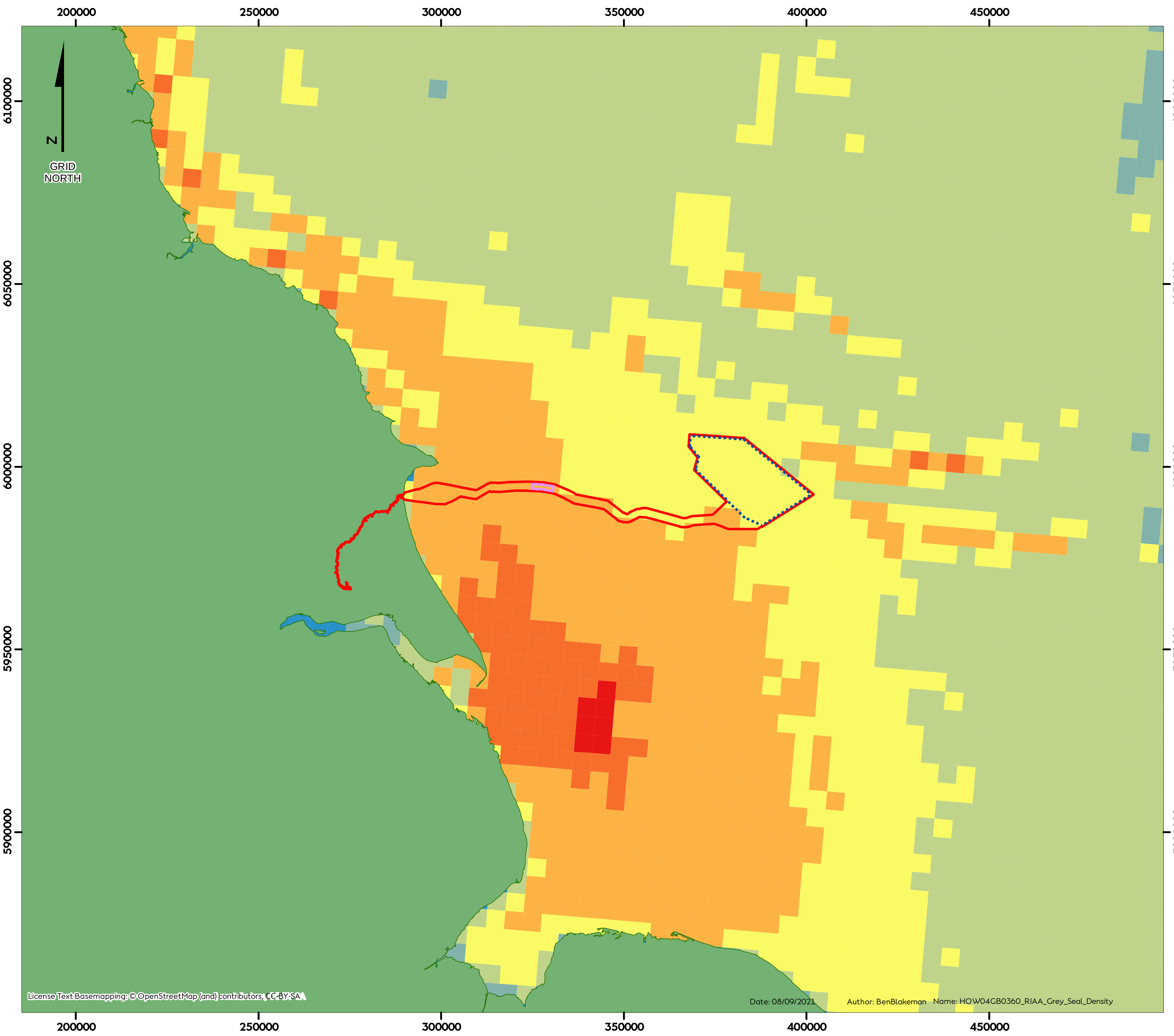
for the installation of a monopile if that monopile was located at the worst possible location for grey seal disturbance, which represents 2.3% of the reference population (i.e. all other foundation locations would result in a reduced level of effect). The equivalent number for pin piles at the same location is 1,291 animals (2.0% of the population) which represents the highest level of disturbance in temporal terms. As for harbour seals, not all of these seals will be associated with a designated site.

10.3.3.24 Overall, the ES found that the predicted impact (in the context of the number of animals that may be affected and both duration and frequency of effect) were such that although there is potential for a risk of a decline in fertility and survival of 'weaned of the year' for a very small proportion of the grey seal population if those animals are repeatedly displaced from foraging areas, it is not expected that the predicted level, frequency and duration of impact would be sufficient to result in a population level change. Given that grey seals are expected to return to their previous behavioural states/activities after the impact has ceased (within 2 hours), it is not expected that this will result in any significant impact on survival or fertility rates unless the same individual is exposed repeatedly across numerous days (Booth et al. 2019). In the unlikely event that individuals were repeatedly disturbed across the 12 month construction period, any affect on vital rates are expected to be limited to 1 breeding cycle for a very limited proportion of the management unit, and as such the magnitude is assessed as minor in the ES, since vital rates are very unlikely to be impacted to the extent that the population trajectory would be altered.

10.3.3.25 Further, the PEIR found that the at-sea usage data suggested that there is a potential foraging area to the northwest of the array area (Figure 5 in the draft RIAA at PEIR). That was based on the best available evidence on at sea usage by seals at the time (Russell et al 2017). Following that, a further publication (Carter et al 2020) has produced revised and updated at sea density maps for seals, which confirm a different density distribution for greys seal. Specifically, the density hot spot to the west of Hornsea Four is no longer apparent (**Figure 5**). The result is that the predictions of the number of seals that could be disturbed have changed from those presented in PEIR. The dose response curve used in ES for grey seal behavioural responses was produced from data obtained from tagged harbour seals only, as there is currently no grey seal dose response curve. The ES noted that grey seals are considered to be less sensitive to behavioural disturbance than harbour seals, with recent studies of tagged grey seals showing vast individual variation in responses to pile driving, with some animals not showing any evidence of a behavioural response when within 12 km of the pile driving location (Aarts et al. 2018). Therefore, the adoption of the harbour seal dose response curve for grey seals is precautionary as it is likely to over-estimate the potential for impact on grey seals.

10.3.3.26 This type of short-term, intermittent and temporary behavioural response will affect only a very small proportion of the population and, while energetic requirements may be slightly increased by the need to transit to another foraging location, survival and reproductive rates are very unlikely to be impacted.

10.3.3.27 Overall, the ES found that for grey seals, the effect from piling on behavioural disturbance is of slight adverse significance, which is not significant in EIA terms.



Hornsea Four

Figure 5

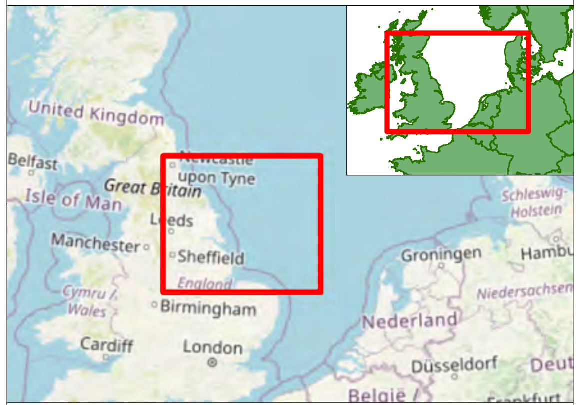
Grey Seal at Sea Density
(based on Carter *et al.* 2020)

Order Limits
Array Area
HVAC Booster Station Works Area

% British Isles at-sea population per 25 km²

Grey Seal Mean

- 0.00
- 0.00 - 0.001
- 0.001 - 0.005
- 0.005 - 0.01
- 0.01 - 0.025
- 0.025 - 0.05
- >0.05



Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

0 20 40 Kilometres

0 10 20 Nautical Miles

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Grey Seal
at Sea Density
Document no: HOW04GB0360
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Consideration of Harbour Porpoise for RIAA Purposes

10.3.3.28 A single site for harbour porpoise has been screened in for assessment – the SNS SAC.

10.3.3.29 The consideration of the risk of onset of PTS for harbour porpoise given above draws on **Volume A2, Chapter 4: Marine Mammals**, which is presented in the context of the total population of animals within the MU. The JNCC Advice[33], notes the following relevant points as regards harbour porpoise population, numbers and viability within the site:

- 'The variability of harbour porpoise distribution and abundance within sites is in part due to their mobility and wide-ranging nature as well as natural and anthropogenic changes in habitat and prey. Relevant and Competent Authorities are not required to undertake any actions to ameliorate changes in the condition of the site if it is shown that the changes result wholly from natural causes. It is therefore important to contextualise any apparent deterioration of harbour porpoise presence in the site in terms of natural variability and the abundance and distribution patterns at the population level (i.e. MU)' and
- 'The harbour porpoise in UK waters are considered part of a wider European population and the highly mobile nature of this species means that the concept of a 'site population' is not considered an appropriate basis for expressing Conservation Objectives for this species. Site based conservation measures will complement wider ranging measures that are in place for the harbour porpoise.'

10.3.3.30 Together with the final point, perhaps most pertinently, made under the description of Conservation Objective 1 (which deals with viability and therefore injury risk):

- 'Unacceptable levels can be defined as those having an impact on the FCS of the populations of the species in their natural range. The reference population for assessments against this objective is the MU population in which the SAC is situated (IAMMWG 2015).'

10.3.3.31 Therefore, the number of animals that may be at risk to onset of PTS (as presented above) has not been compared to any population attributed to the SNS SAC, because the number of harbour porpoise using the site naturally varies. Rather, the assessment considers whether any such PTS risk could impact on the FCS of the MU population (which in the context of the first conservation objective refers to measures that 'restrict the survivability and reproductive potential of harbour porpoise using the site').

10.3.3.32 Mitigation for risk of onset of PTS (injury) is provided for within the MMMP process (Co110 in **Table 3**), a process that is secured within the DML and requires sign off and regulator agreement and approval prior to works occurring. Mitigation for disturbance risk is provided for separately within the SIP (**Section 8.2.3**).

10.3.3.33 Given that the MMMP will provide for appropriate mitigation to minimise the risk of injury or mortality in harbour porpoise during pile driving to a level considered not significant in EIA terms even as a maximum (requiring prior approval by the regulator), with that conclusion drawn with respect to the MU population, it is concluded that Hornsea Four alone does not have the potential to restrict the survivability and reproductive potential

[33] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

of harbour porpoise using the site. There will not, therefore, be an AEoI on the viability of harbour porpoise as a result of mortality or injury resulting from pile driving at Hornsea Four alone in relation to the SNS SAC and therefore, subject to natural change, harbour porpoise will be maintained as a 'viable component' of the site in the long-term.

10.3.3.34 The second conservation objective for the SNS SAC refers to 'no significant disturbance of the species', and as highlighted above that disturbance is assessed here through the application the relevant EDR, which for monopiles is 26 km but for pin piles is 15 km.

10.3.3.35 The seasonal nature of the SNS SAC is important here, with the Hornsea Four array area being more than 26 km distant from the winter extents of the SNS SAC at its closest point. As such, any noisy activity within the Hornsea Four array area that takes place in the winter season (October-March inclusive) would fall outside the need for assessment here. Any noisy activity within the Hornsea Four array area during the summer season (April-September inclusive) would, however, require consideration through the HRA process. For noisy activity at the HVAC booster station search area, this requires consideration through the HRA process at all times of the year.

10.3.3.36 For pile driving within the Hornsea Four array area, the maximum overlap per monopile foundation location within the summer extents of the SNS SAC would be 2,124 km^2 (7.87% of the summer extents), or depending on location of the foundation as low as 1,930 km^2 (7.15%) (see **Figure 6**). For pin piled foundations, that reduces to a maximum of 707km^2 (2.6%) or a minimum of 706 km^2 (2.6%) (see **Figure 7**). There is therefore capacity within the threshold (20% per 24 hours), when considering the project alone, for piling to occur at more than one foundation location per 24 hours.

10.3.3.37 As a 'maximum design scenario for disturbance from piling', piling could occur at up to two separate foundation locations per 24 hours, termed concurrent piling. No project level separation distance has been set (which would limit the distance between two concurrent piling events and therefore limit the combined footprint of effect), however there remains potential for a separation distance to be applied to the project as mitigation, if required, and as highlighted within the Outline SNS SAC SIP.

10.3.3.38 As a maximum design scenario, should concurrent pile driving occur at two separate foundation locations in 24 hours, with a separation distance limited only by the Hornsea Four array area, the maximum area of overlap for monopiles would be 3,683 km^2 (13.6%) (**Figure 10**) and for pin piles would be 1,414 km^2 (5.24%) (**Figure 11**).

10.3.3.39 No overlap with the winter extents would result from pile driving within the Hornsea Four array area, regardless of the type or number of foundations.

10.3.3.40 For pile driving at the HVAC booster station search area, there is potential for overlap with the summer and winter extents of the SNS SAC. In the summer season for monopiles, that overlap would be between 384 km^2 (1.4%) and 620 km^2 (2.3%) (**Figure 8**) for a monopile or between 42 km^2 (0.2%) and 165 km^2 (0.6%) (**Figure 9**) for pin piles. In the winter season, the potential for overlap for monopiles is between 277 km^2 (2.2%) and 352 km^2 (2.8%) (**Figure 8**) and between 49 km^2 (0.38%) and 122 km^2 (0.96%) for pin piles (see **Figure 9**).

10.3.3.41 For the 10% temporal value, the anticipated duration of pile driving is within an overall window of 12 months. For assessment purposes, and as a maximum design scenario for the 10% temporal value, it is therefore assumed that pile driving of monopiles would occur within the array by a single piling rig, which for worst case assessment purposes has been assumed to occur each day of a single summer season. Should concurrent piling be utilised, or more than one foundation installed in a day, the number of days required for piling would fall (and in any case, logistics dictate that there will be non-piling days to account for weather and trips to port etc). The maximum seasonal effect in the summer from piling in the array only (assuming the maximum 7.87% per day for every day of the season), would therefore be 7.87%, well within the 10% seasonal threshold.

10.3.3.42 For piling at the HVAC booster station search area, it is assumed as a maximum design scenario that up to 10 days total would be required for piling, installing monopiles, across the overall piling window of a single season. The maximum seasonal effect in the winter from piling at the HVAC booster station search area (assuming up to 2.77% per day for up to 10 days of a 182 day winter season) would be 0.15%. The maximum seasonal effect in the summer from piling at the HVAC booster station search area (assuming up to 2.30% per day for up to 10 days of a 183 day summer season) would be 0.13%. Both values are precautionary (assuming a maximum-case of effect each time) and well within the 10% seasonal threshold, with capacity within the threshold for additional piling days at the HVAC booster station search area if needed.

10.3.3.43 Should all piling at the HVAC and within the array (WTG or OSS) occur (with monopiles) within the same summer season, the combined effect would be 8%, still within the 10% seasonal threshold.

10.3.3.44 Therefore, it is concluded that there will not be an AEoI in relation to disturbance on the Conservation Objective for harbour porpoise for the SNS SAC as a result of pile driving from Hornsea Four alone under any pile driving scenario and therefore, subject to natural change, in the long-term, there will be no significant disturbance of harbour porpoise.

10.3.3.45 The third conservation objective is focused on maintaining the supporting habitats and processes, together with availability of harbour porpoise prey, within the SNS SAC. The Advice on Activities[34] refers to supporting habitats as 'the characteristics of the seabed and water column' in the context of 'ensuring prey is maintained within the site'. Potential for supporting habitats and processes to be affected are considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded the potential for effect to be slight adverse at most (and therefore not significant in EIA terms). The scale of any potential such effect is also found to be localised to the project and therefore spatially much smaller than the overall SNS SAC and of trivial consequence for physical processes at that scale.

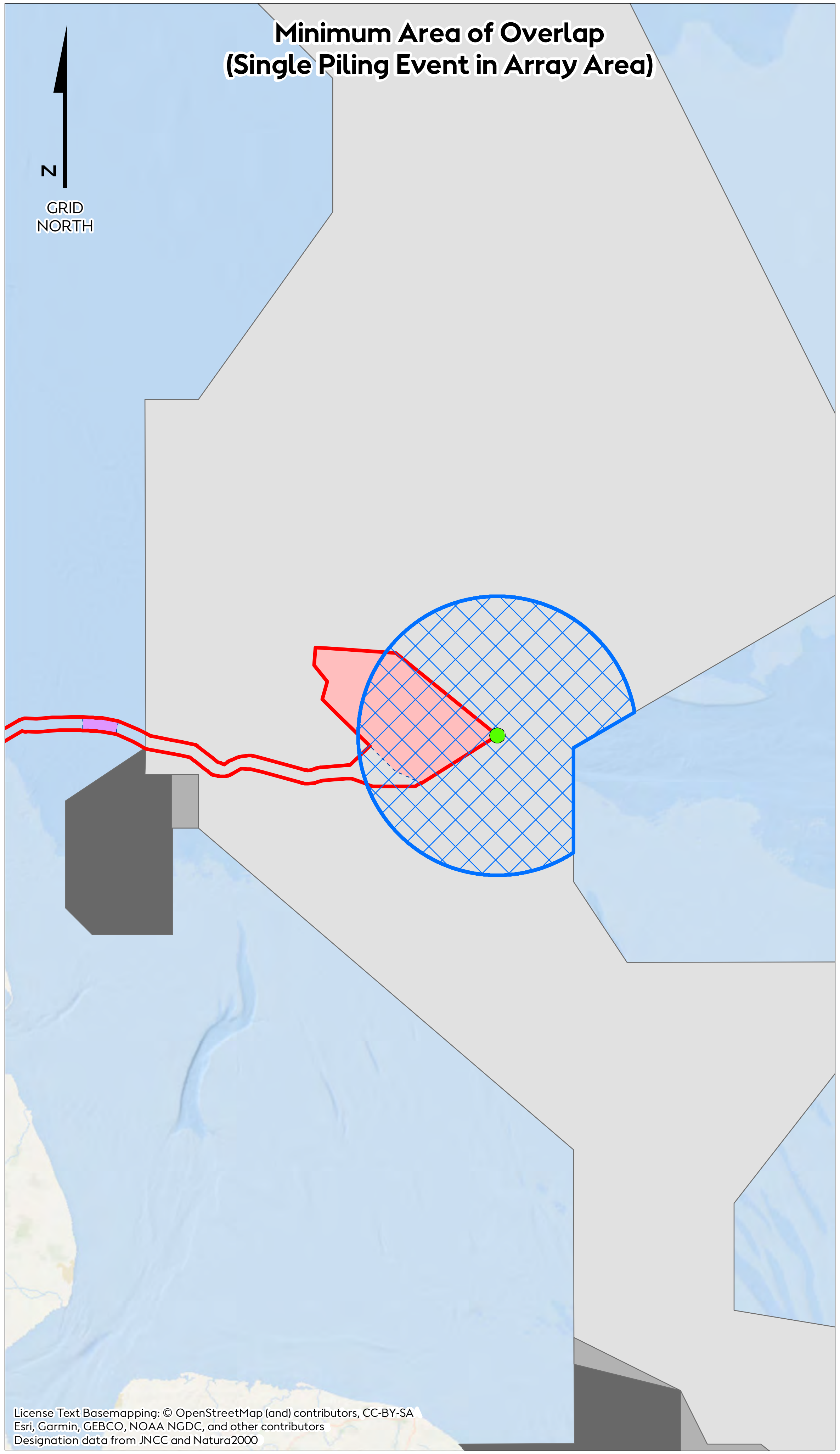
10.3.3.46 Although specific prey species for harbour porpoise in the SNS SAC are unknown, sandeels are a known prey item for harbour porpoise, with herring also taken[35]. The potential for impact to sandeel and herring are addressed in full in Section 3.11 of **Volume A2, Chapter 3: Fish and Shellfish Ecology.** Sandeel and herring are the primary focus of the assessment made. The scale, frequency and duration of construction works

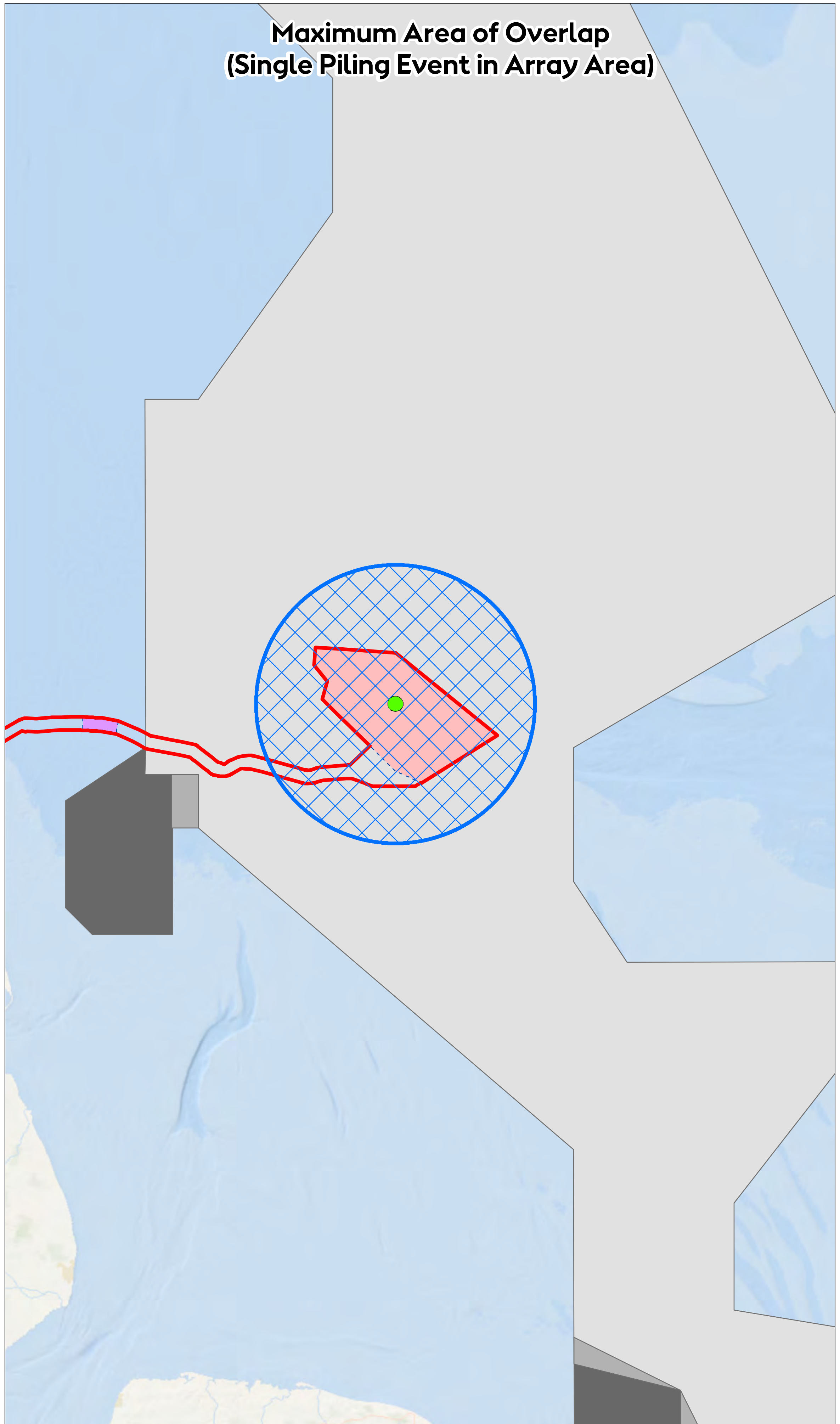
[34] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf
[35] http://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-SAC-selection-assessment-document.pdf

resulted in a conclusion of slight adverse at most and is therefore not significant in EIA terms. **Volume A2, Chapter 4: Marine Mammals** further considers fish and marine mammals during construction in the context of a potential reduction in foraging ability, resulting from issues around turbidity, visibility and the ability to locate prey. The magnitude of the impact is concluded to be negligible and have no significant effect. Given the conclusions in the ES, in the wider context of the scale of the SNS SAC relative to the scale of Hornsea Four, no potential for adverse effect has been identified.

10.3.3.47 As regards the concern expressed by Natural England (**Table 1**) that the construction of Hornsea Four will result in habitat loss within the SNS SAC, the concern is addressed below under **Section 10.3.4**, as the concern relates to the operation and maintenance phase and has been screened in for potential LSE in-combination only.

10.3.3.48 There is, therefore, no AEoI to the supporting habitats and processes relevant to harbour porpoise and their prey for the SNS SAC from Hornsea Four alone and therefore, subject to natural change, the availability and density of suitable harbour porpoise prey will be maintained in the long-term.





Date: 25/06/2021 Author: BenBlakeman Name: HOW04GB0113_RIAA_Piling_Overlap_with_SNS_SAC_Array

Hornsea Four

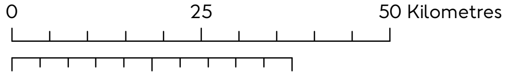
Figure 6

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single piling event (monopile) in the summer season – array area

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Foundation Location
- Area of Overlap with the Southern North Sea SAC

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area



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0 25 50 Kilometres

0 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	25/06/2021

Areas of Overlap with the SNS Single Piling Event
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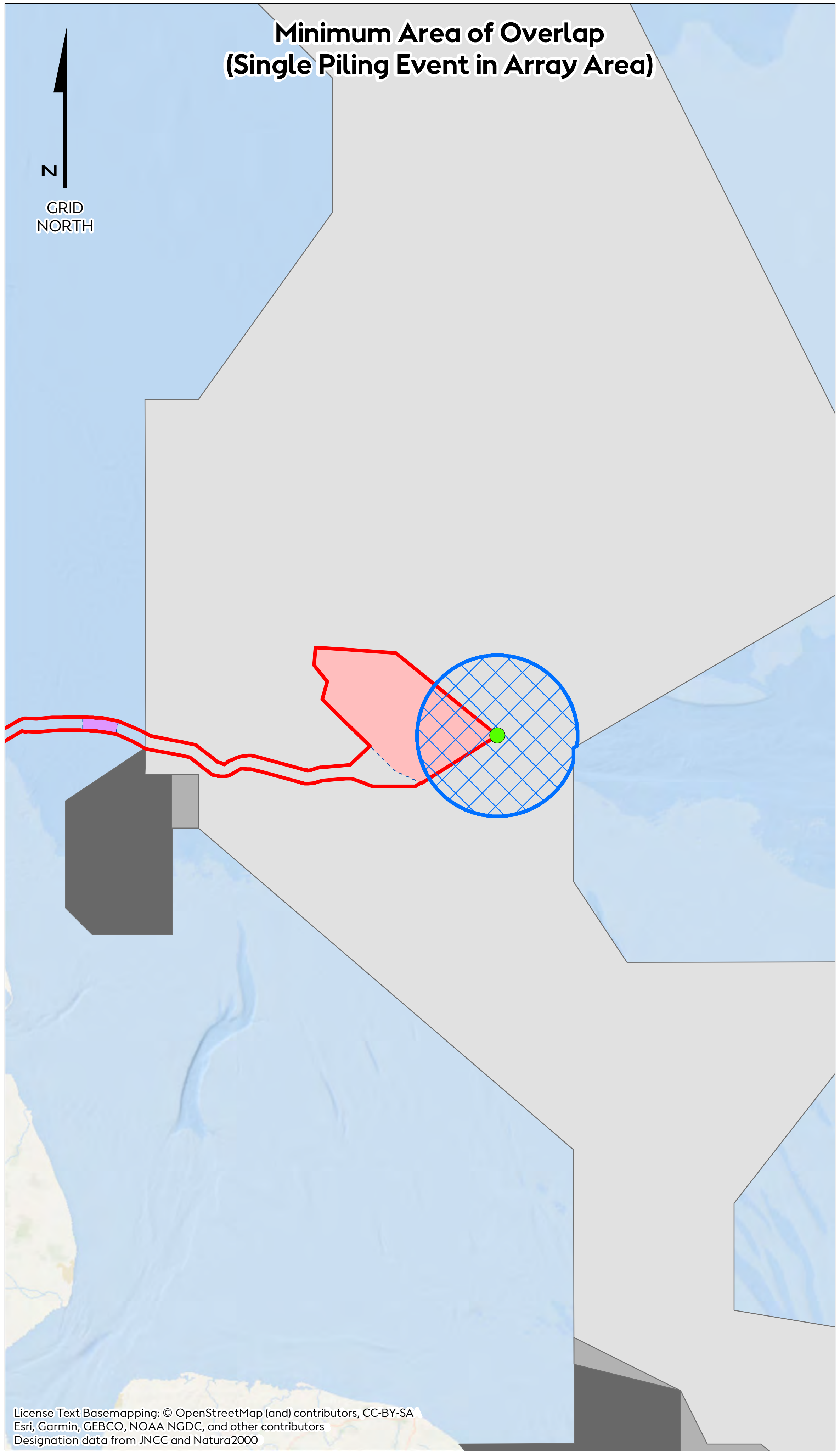
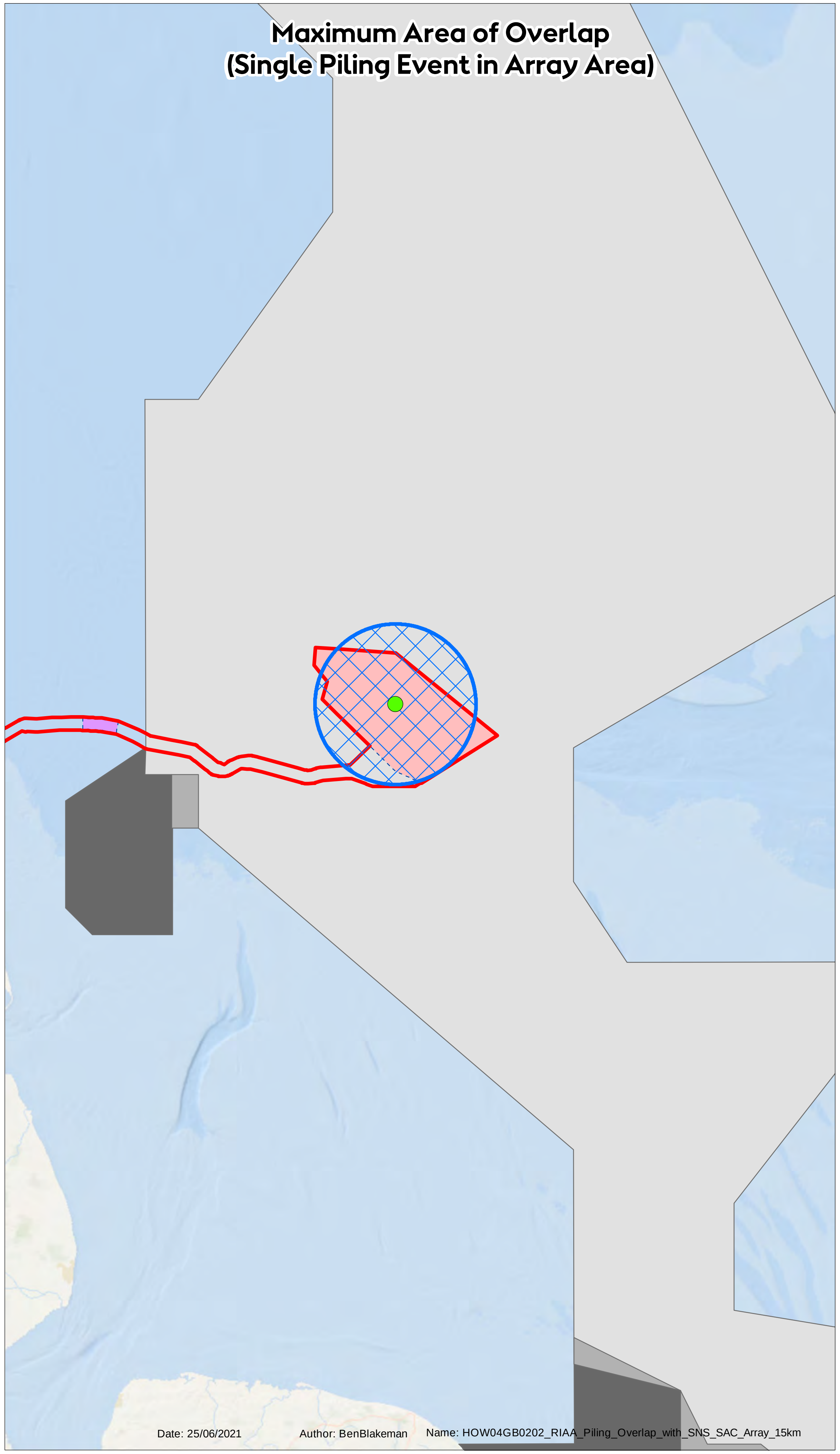
Created by: BPHB
Checked by: SK
Approved by: LK





Hornsea Four

Figure 7

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single piling event in the summer season (pin pile) – array area

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Foundation Location
- Area of Overlap with the Southern North Sea SAC

Southern North Sea SAC
- Summer Area
- Summer and Winter Area
- Winter Area

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

0 25 50 Kilometres

0 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	25/06/2021

Areas of Overlap with the
SNS Single Piling Event 15km
Document no: HOW04GB0202
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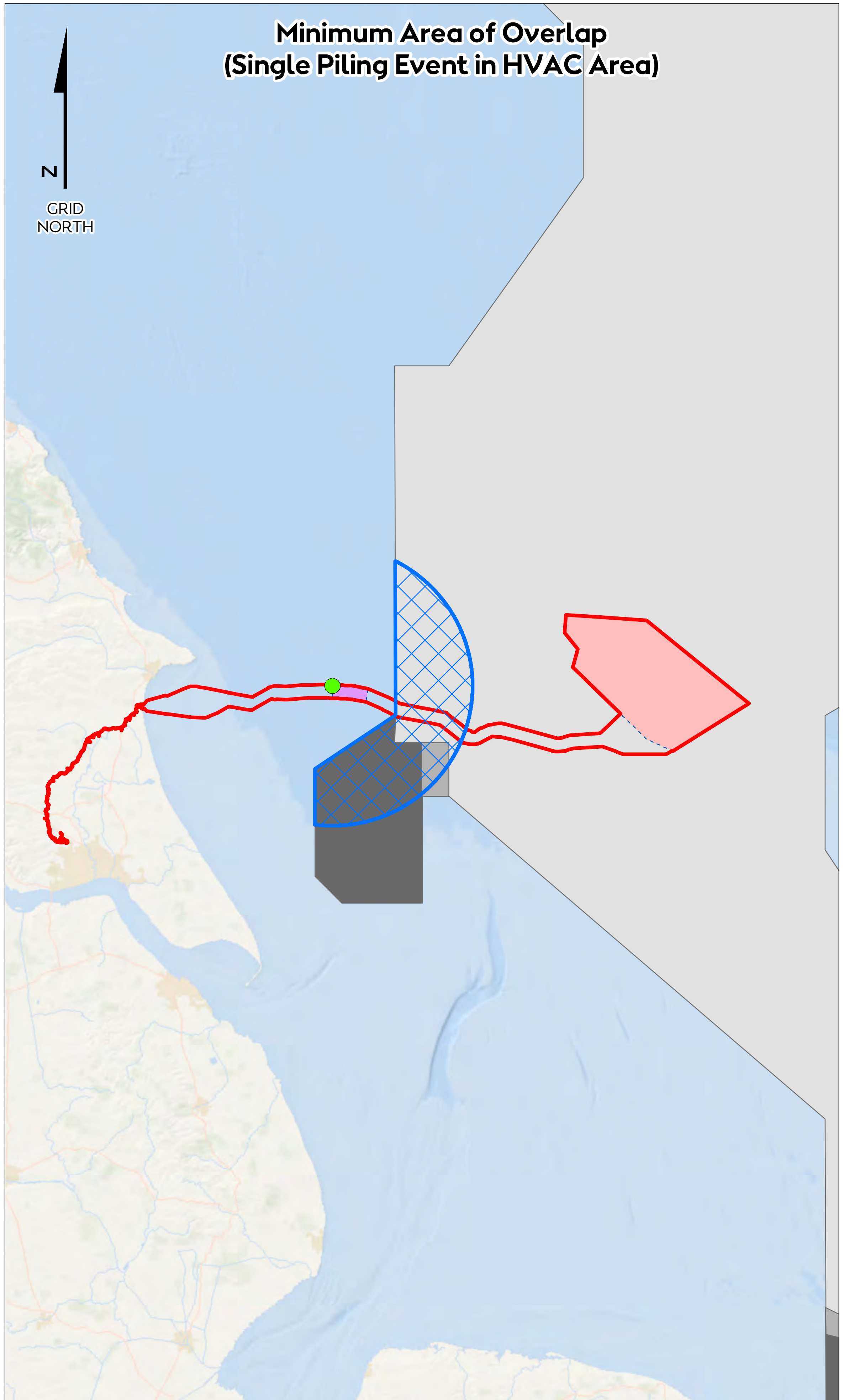

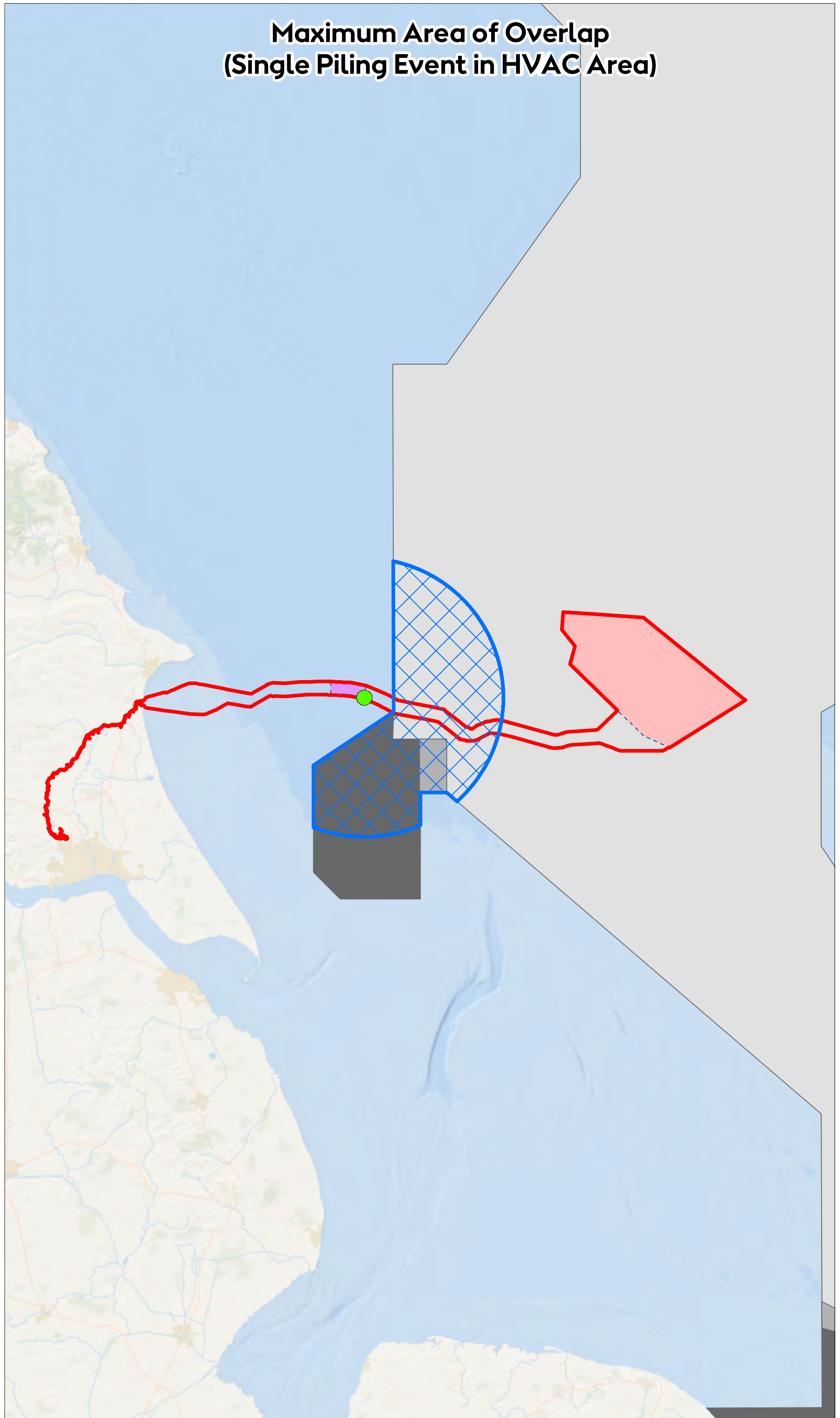

Date: 03/08/2021 Author: BenBlakeman Name: HOW04GB0114_RIAA_Piling_Overlap_with_SNS_SAC_HVAC

Hornsea Four

Figure 8

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single piling event (monopile) – HVAC area

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Foundation Location
- Area of Overlap with the Southern North Sea SAC

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

0 25 50 Kilometres

0 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
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Areas of Overlap with the
SNS Single Piling Event
Document no: HOW04GB0114
Created by: BPHB
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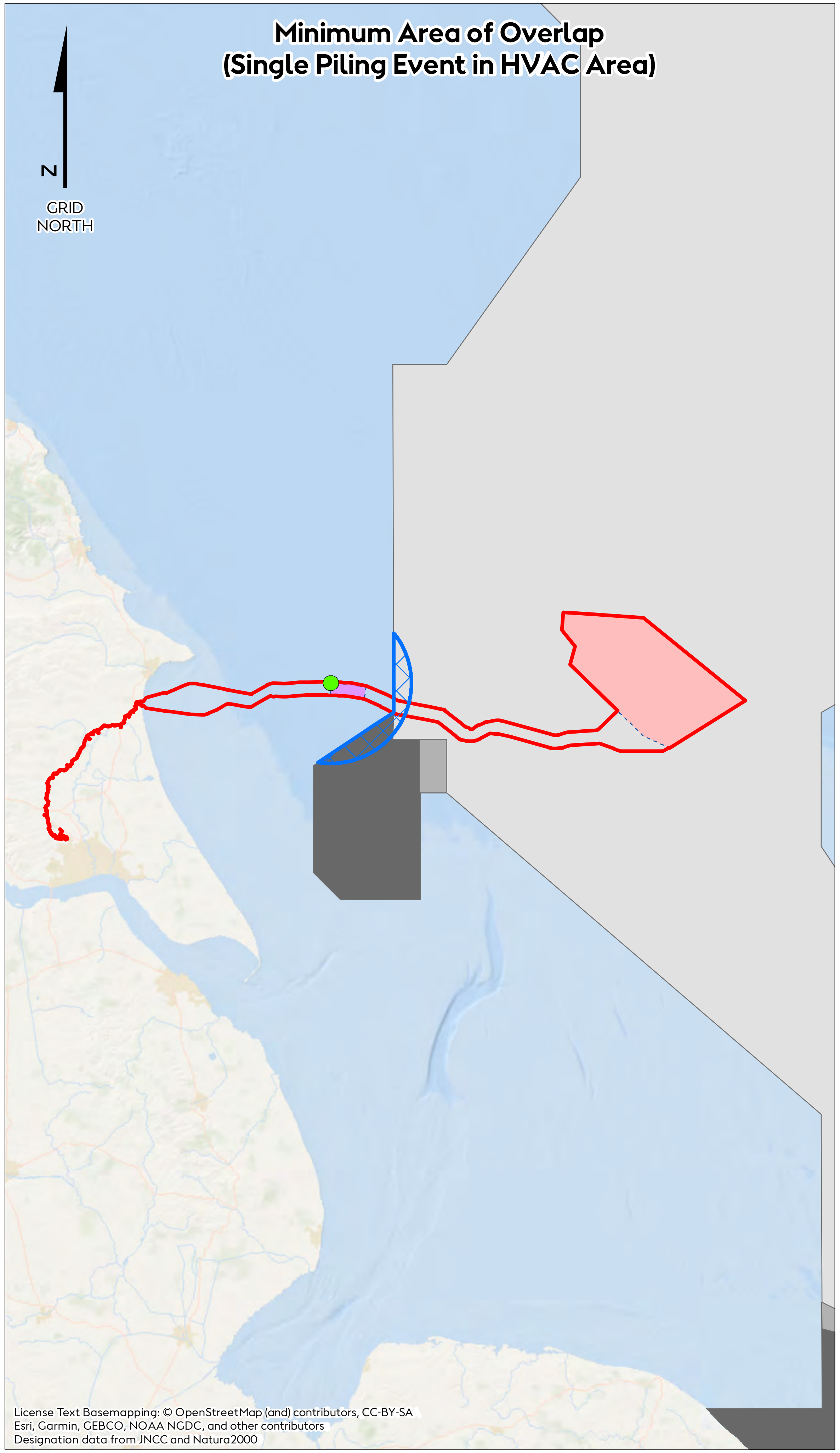
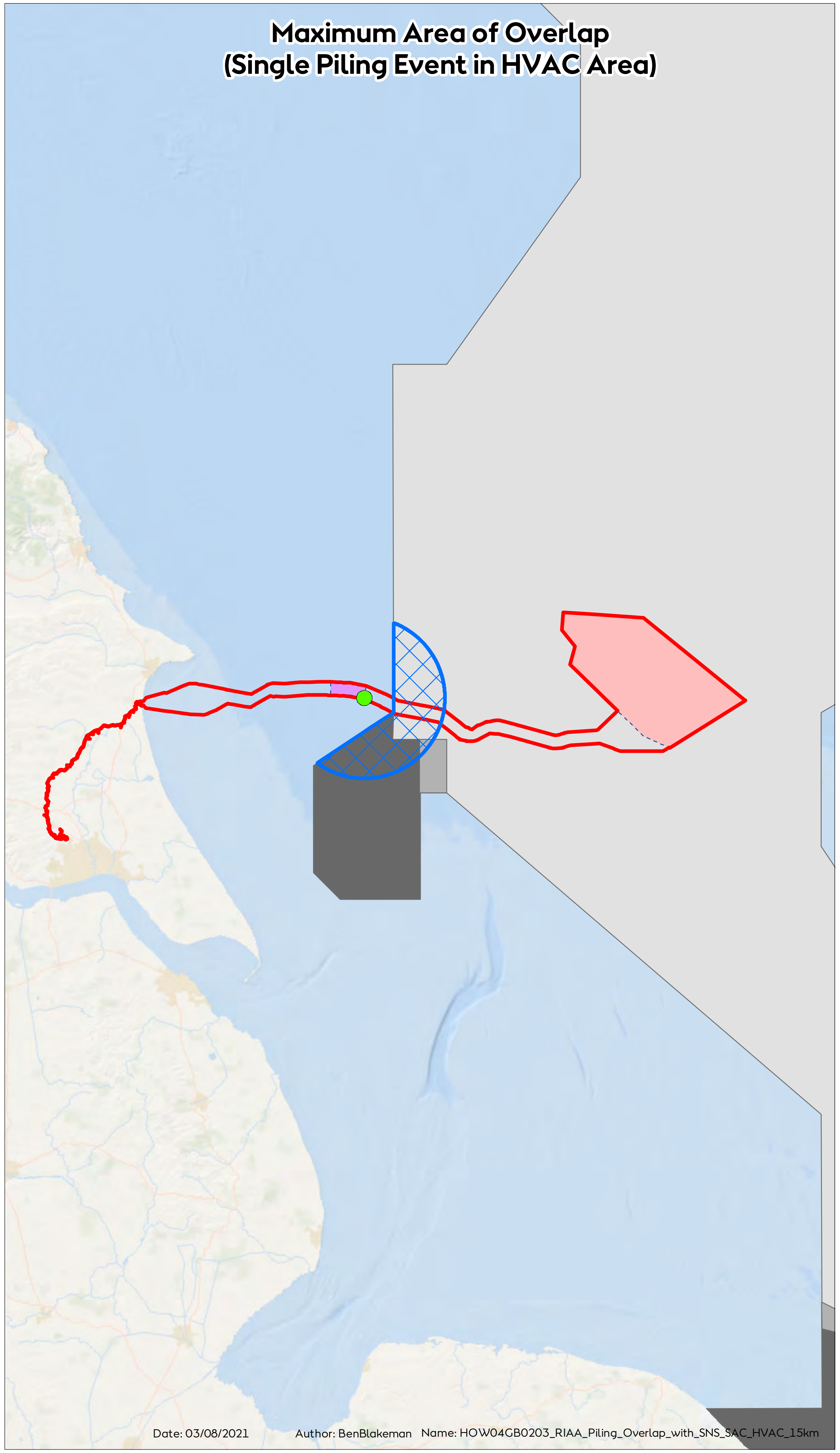
Approved by: LK





Date: 03/08/2021 Author: BenBlakeman Name: HOW04GB0203_RIAA_Piling_Overlap_with_SNS_SAC_HVAC_15km

Hornsea Four

Figure 9

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single piling event (pin pile) – HVAC area

Order Limits
Array Area
HVAC Booster Station Works Area
Foundation Location
Area of Overlap with the Southern North Sea SAC

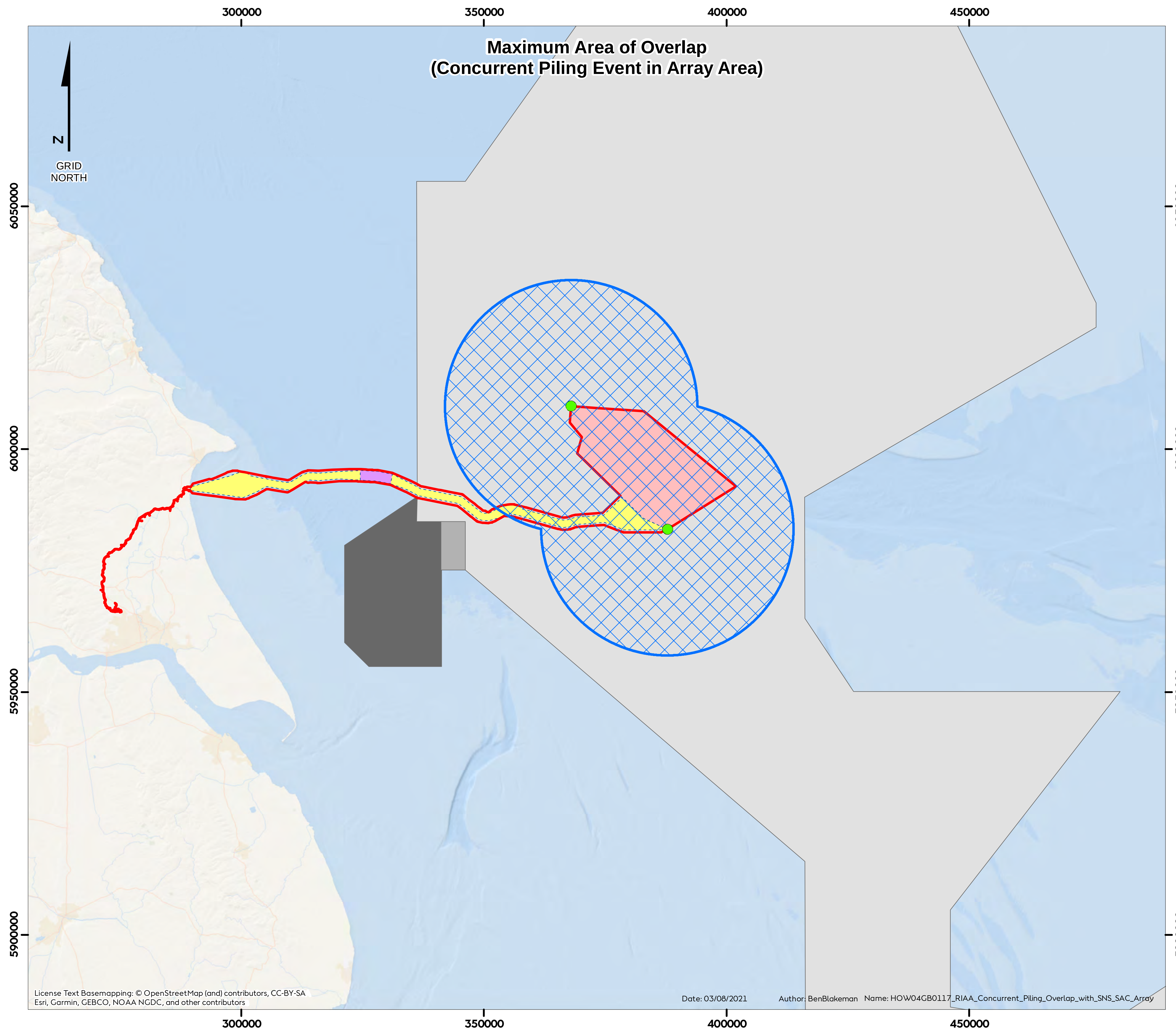
Southern North Sea SAC
Summer Area
Summer and Winter Area
Winter Area

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

0 25 50 Kilometres
0 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	03/08/2021

Areas of Overlap with the
SNS Single Piling Event 15km
Document no: HOW04GB0203
Created by: BPHB
Checked by: SK
Approved by: LK



Hornsea Four

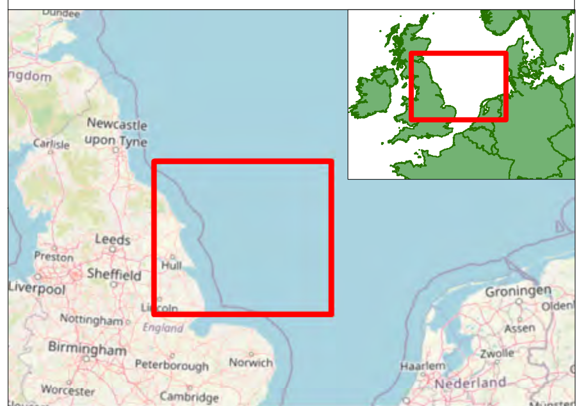
Figure 10

Areas of Overlap with the SNS SAC as a result of a concurrent (two) piling events (monopile) in the summer season – array area

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Offshore Export Cable Corridor
- Foundation Location
- Area of Overlap with the Southern North Sea SAC

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area



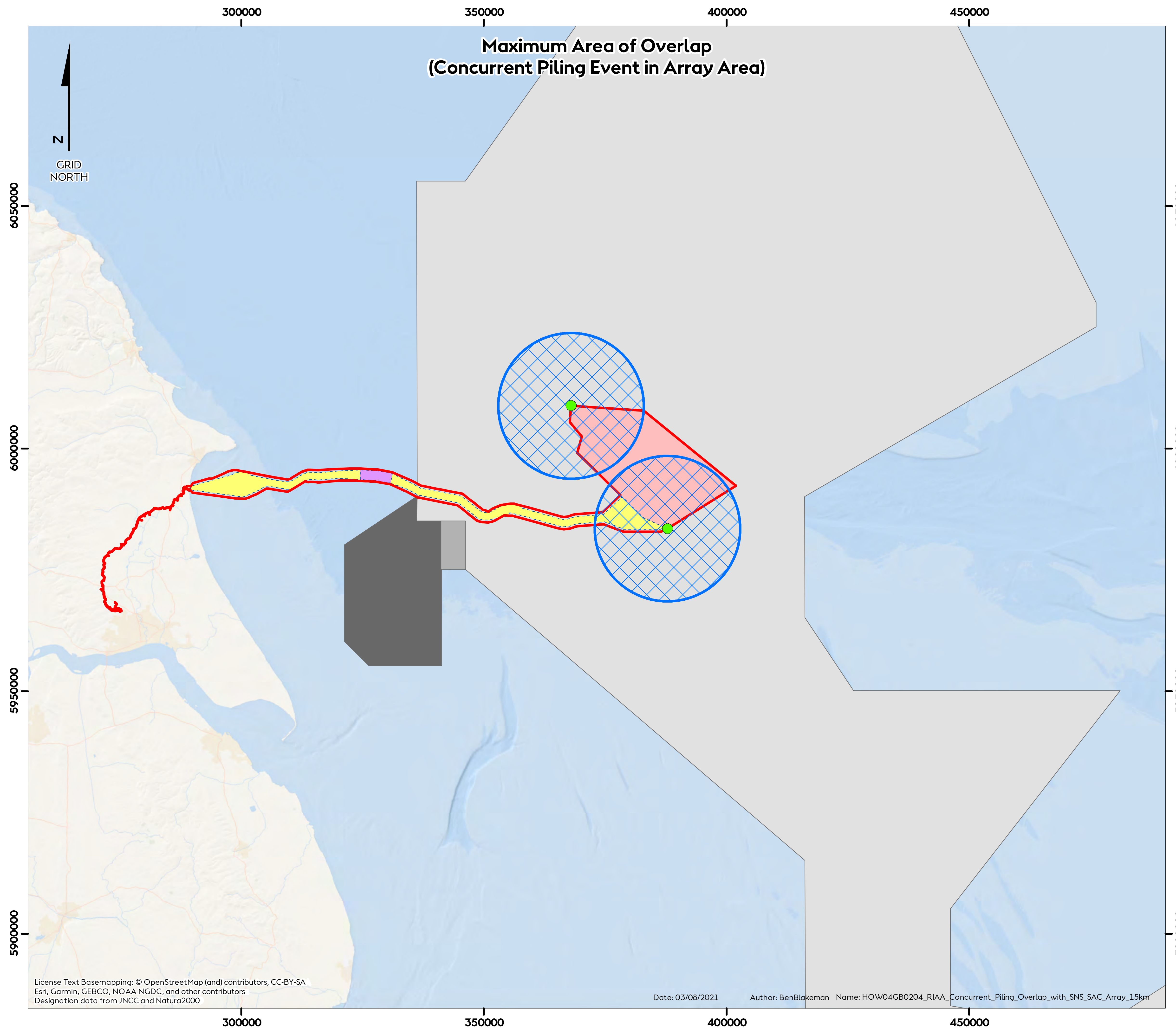
Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:750,000

0 20 40 Kilometres

0 10 20 Nautical Miles

REV	REMARK	DATE
...	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	03/08/2021

Area of Overlap with the SNS SAC as a Result of a Concurrent Piling Event
Document no: HOW04GB0117
Created by: BPHB
Checked by: SK
Approved by: LK



Date: 03/08/2021 Author: BenBlakeman Name: HOW04GB0204_RIAA_Concurrent_Piling_Overlap_with_SNS_SAC_Array_15km

Hornsea Four

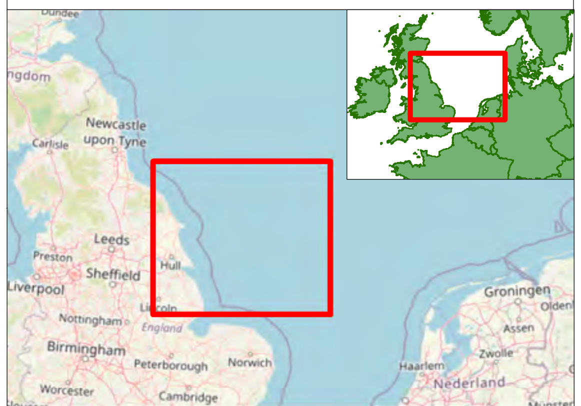
Figure 11

Areas of Overlap with the SNS SAC as a result of a concurrent (two) piling events (pin pile) in the summer season – array area

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Offshore Export Cable Corridor
- Foundation Location
- Area of Overlap with the Southern North Sea SAC

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area



Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:750,000

0 20 40 Kilometres
0 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	03/08/2021

Area of Overlap with the SNS SAC Concurrent Piling Event 15km
Document no: HOW04GB0204
Created by: BPHB
Checked by: SK
Approved by: LK

Consideration of Bottlenose Dolphin for RIAA Purposes

10.3.3.49 For bottlenose dolphin (drawing on **Volume A2, Chapter 4: Marine Mammals)**, given the lack of a density value for bottlenose dolphin in the Greater North Sea management unit (with no bottlenose dolphin recorded in the site specific surveys or within the relevant SCANS III area), a density of 0.003 ind/km^2 has been assumed. The potential for disturbance to result is based on the harbour porpoise dose response curve, applied as a proxy for bottlenose dolphins. The assumption made is therefore highly precautionary, as it assumes that bottlenose dolphin could occur through the relevant modelled contours; depite the SCANS III data for that sector and the site specific data collected for Hornsea Four not counting any individual bottlenose dolphin.

10.3.3.50 Further, the SCANS III data (on which the density value draws) based much of the bottlenose dolphin counts on individuals sited some distance from shore; bottlenose dolphin associated with the Moray Firth SAC are typically more coastal in nature, with the relevant advice noting that 'they are most often observed close to the shore (within 3 km of the coast) and can be in relatively shallow <20m water'[36] and Quick et al. 2014 finding that they mainly occur within 2 km of the coast. As such it is highly likely that dolphins that may have connectivity to the SAC would prepresent a proportion only of the total number that may be disturbed. Evidence for such coastal bottlenose dolphins is sourced from individual sightings information and does not have values such as effort or density attached (**Volume A2, Chapter 4: Marine Mammals** and **Appendix I**).

10.3.3.51 **Volume A2, Chapter 4: Marine Mammals** found that as a worst case, piling at Hornsea Four could result in the disturbance of up to 14 individuals, approximately 0.6% of the reference population. The Natura 2000 data form[37] for the SAC identifies a population of between 101 and 250 individuals. The online database[38] identified the feature to be in favourable condition (dated 21st September 2016), in contrast to the more recent Article 17 reporting from 2019 which found the condition of bottlenose dolphin overall to be 'unknown' excepting range which was favourable[39]. The most recent advice on the site was published in March 2021[40], which identifies the site as hosting the only resident population of bottlenose dolphin in the North Sea, and the most northerly such population in the world. A population estimate of 200 individuals was given, with individuals regularly travelling down the east coast of Scotland; individuals have also been reported in waters off Ireland and the Netherlands. Sensitivity of the species to underwater noise is noted (among other pressures). The Moray Firth SAC is located within the Central East Scotland management unit for bottlenose dolphin, with IAMMWG (2021) citing 189 individuals. An estimated population of 189 is applied here to the SAC.

10.3.3.52 As noted above, up to 14 individual bottlenose dolphin could be disturbed during monopile installation at the north west location (reducing to up to 12 at the eastern location and HVAC and nine at the southerly location). Those numbers reduce for pin piles to up to 12 individuals at the north west location, 11 at the HVAC, 10 at the east location and eight at the south location. Should all those individuals show connectivity to the SAC, that would equate to up to approximately 7% of the SAC population. However, it is clear that dolphins connected to the Moray Firth SAC are primarily coastal

[36] https://apps.snh.gov.uk/sitelink-api/v1/sites/8327/documents/59
[37] https://jncc.gov.uk/jncc-assets/SAC-N2K/UK0019808.pdf
[38] https://informatics.sepa.org.uk/ProtectedNatureSites/
[39] https://jncc.gov.uk/jncc-assets/Art17/S1349-UK-Habitats-Directive-Art17-2019.pdf
[40] https://apps.snh.gov.uk/sitelink-api/v1/sites/8327/documents/59

in nature, and it is therefore reasonable to consider what proportion of the total that may be disturbed could be considered coastal and therefore could show connectivity to the SAC (with that information provided by SMRU Consulting in **Appendix I**). **Table 11** below summarises the percentage of the reference population (2,211 individuals) and Moray Firth SAC population (189 individuals) at the four different piling locations (for monopiles) in relation to distance from the coast.

Table 11: Bottlenose dolphin that may be disturbed with distance from the coast.

Parameter Applied	NW location (up to 14 individuals in total)		East location (up to 12 individuals in total)		Southerly location (up to 9 individuals in total)		HVAC location (up to 12 individuals in total)	
	% Ref. Pop.	% SAC Pop.	% Ref. Pop.	% SAC Pop.	% Ref. Pop.	% SAC Pop.	% Ref. Pop.	% SAC Pop.
All bottlenose dolphin that may be disturbed per piling activity	0.6	7.4	0.5	6.3	0.4	4.8	0.5	6.3
% within the 25m depth contour	0	0	0	0	0	0	0.05	0.53
% within 3 km of the coast	0	0	0	0	0	0	0	0
% within 2 km of the coast	0	0	0	0	0	0	0	0

10.3.3.53 The above potential for disturbance of individual bottlenose dolphin should be considered in the context of the potential consequences of any such disturbance. That consideration draws on Smith (2018). The study considered the consequence of repeated and prolonged disturbance as a consequence of offshore wind farm construction on the population trajectory of species including bottlenose dolphin on the east coast of Scotland. The report considered disturbance occurring much closer to the Moray Firth SAC, specifically offshore wind development along the east coast of Scotland. Of particular note is the comment made by Smith (2018): 'When the proportion of the population vulnerable to disturbance is small, a small proportion of the population are subject to a relatively large amount of disturbance. However, a large proportion of the population is completely unaffected by disturbance. As a result, there is relatively little overall impact on the population.'

10.3.3.54 Further, the potential for disturbance to the Moray Firth SAC bottlenose dolphin population has been well studied as part of the Moray West and Moray East projects, both considerably closer to the SAC boundary (17 km and 36 km respectively) compared to 522 km for Hornsea Four. For the Moray East Appropriate Assessment, the Competent Authority found that there would be 'no long-term effects from underwater noise disturbance on the bottlenose dolphin population of the Moray Firth SAC'[41], with the more recent project level assessment for Moray West undertaking iPCOD modelling[42]

[41] https://marine.gov.scot/sites/default/files/appropriate_assessment_.pdf
[42] http://www.marine.gov.scot/sites/default/files/riaa_report_with_appendices.pdf

under six different scenarios; all of which found no long term change in the population trajectory. Both projects were consented on a conclusion of no AEoI.

10.3.3.55 Any such disturbance resulting from Hornsea Four would be localised and, assuming any individual that may be disturbed has connectivity to the Moray Firth SAC, likely to be at the limit of the range of the SAC feature outside the boundary of the site (with such sightings of bottlenose dolphin not extending much further south). The disturbance will also be very short term. Further, on the basis that bottlenose dolphin associated with the Moray Firth SAC are considered to be coastal in nature (with the relevant advice on activities[43] noting within 3 km of the coast and the 20 m depth contour), it is clear from **Table 11** above that very few, if any of the dolphins that may be disturbed are likely to have any connectivity to the SAC. As noted above, piling at the HVAC is assumed to require just 3.6 days for monopiles and 4.5 days if jacket foundations (noting that actual piling time within that overall window will be less). Further, Co190 (**Table 3**) limits the seasonality of piling at the HVAC, with no impact piling within the HVAC between 1st September and 16th October unless otherwise agreed with the relevant stakeholders. Duration of piling within the array will necessarily be longer, but intermittent across a 12 month period.

10.3.3.56 The conservation objectives (**Appendix D**) mirror those for the SNS SAC and harbour porpoise and are discussed in turn with respect to disturbance from piling. The first objective relates to the viability of bottlenose dolphin and, as for harbour porpoise, is addressed through the PTS-onset measure above. The second objective relates to maintenance of the distribution of bottlenose dolphin throughout the site. The distance between the site and Hornsea Four is such that no disturbance within the Moray Firth SAC will result from Hornsea Four, with any disturbance having a short term and highly localised effect on individuals that may travel the 522 km between the SAC boundary and Hornsea Four. Assuming dolphins showing connectivity to the Moray Firth SAC remain within 3km of the coast and the 20 m depth contour (assessed down to 25m here for precaution), at most, 1 individual during installation of monopiles at the HVAC location only (0.53% of the approximate 189 individuals associated with the SAC) may be subject to such disturbance on a temporary and short term basis. All other modelled locations would affect fewer individuals. Such a level of disturbance will not be significant to the distribution of bottlenose dolphin within the SAC, will occur at the limit of the range of the individuals and will result in a short term and temporary potential for such disturbance. Disturbance from piling will therefore not have a significant affect on the second conservation objective.

10.3.3.57 With respect to the third conservation objective, the consideration of supporting habitats, processes and prey made above for harbour porpoise are directly relevant, with the significant distance between the SAC and Hornsea Four resulting in even less potential for such interaction.

10.3.3.58 There will not, therefore, be an AEoI on the viability, distribution with the SAC (disturbance) or supporting habitats, processes and prey of bottlenose dolphin as a result of disturbance resulting from pile driving at Hornsea Four alone in relation to the Moray Firth SAC and therefore, subject to natural change, bottlenose dolphin will be maintained as a 'viable component' of the site in the long-term.

[43] https://apps.snh.gov.uk/sitelink-api/v1/sites/8327/documents/59

Consideration of Harbour Seal for RIAA Purposes

10.3.3.59 Harbour seal are screened in for potential LSE with respect to underwater noise during construction and decommissioning for the following sites:

- The Wash and North Norfolk Coast SAC; and
- Transboundary sites (specifically Doggersbank (Netherlands) SAC and Klaverbank SCI).

10.3.3.60 Variable information exists on the conservation objectives, with the following drawn from UK sites where, subject to natural change, the following applies:

- 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.

10.3.3.61 The objectives for transboundary sites are:

- Conserve the area and quality of supporting habitat; and
- Conserve the population size.

10.3.3.62 Of the above conservation objectives, it is clear that the transboundary objectives are contained within those for the UK sites – therefore the assessment that follows is presented following the UK conservation objective requirements to minimise repetition.

10.3.3.63 As regards the conservation objectives that address the natural habitats of harbour seal (the first four bullet points for UK site conservation objectives), these are concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes Chapter**. That chapter has concluded at most a slight adverse effect (which is not significant in EIA terms) and that does not extend to the designated sites themselves. Similarly, **Volume A2, Chapter 4: Marine Mammals** further considers fish and marine mammals during construction in the context of a potential reduction in foraging ability, resulting from issues around turbidity, visibility and the ability to locate prey. The magnitude of the impact is concluded to be negligible and have no significant effect. Given the conclusions in the ES, in the wider context of the scale of the available habitat and the distribution of harbour seal at sea relative to Hornsea Four (Russell 2017), all relative to the scale of Hornsea Four, no potential for adverse effect has been identified.

10.3.3.64 There is, therefore, no AEoI to the supporting habitats relevant to harbour seal and their prey for the Wash and North Norfolk Coast SAC, Doggersbank (Netherlands) SAC or Klaverbank SCI from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for harbour seal and their prey will be maintained in the long-term.

10.3.3.65 The potential to affect the population and distribution of harbour seal is considered within **Volume A2, Chapter 4: Marine Mammals** with respect to potential for injury (risk of onset of PTS) and disturbance. The following assessment takes account of that, in the context of the relevant SACs and their conservation objectives.

10.3.3.66 As for consideration of harbour porpoise and bottlenose dolphin above, the risk of onset of PTS in all marine mammal species will be addressed in the MMMP (referenced here under Co110 in **Table 3**), which will provide for appropriate mitigation to minimise the risk of injury or mortality in harbour seal during percussive piling operations (with prior approval by the regulator). Therefore, it is concluded that Hornsea Four alone does not have an AEoI on harbour seal as a result of mortality or injury resulting from percussive piling at Hornsea Four alone.

10.3.3.67 **Volume A2, Chapter 4: Marine Mammals** considers the number of harbour seal potentially disturbed by unmitigated pile driving at each modelled location for both monopiles and pin piles. The highest unmitigated disturbance levels were predicted for the HVAC location, where a total of 5 harbour seals are predicted to be disturbed for the installation of a monopile, which represents 0.10% of the reference population. The equivalent unmitigated number for pin piles at the same location is 4 animals (0.08% of the reference population), which represents the highest level of disturbance in temporal terms. The numbers potentially disturbed are lowest for the north west and east locations for both monopile and pin pile, being 1 individual (0.02% of the population).

10.3.3.68 In relation to harbour seals associated with the Wash and Norfolk Coast SAC, and to place the population level numbers in context, the JNCC cites the harbour seal population at the Wash as being 7% of the UK total[44], which is given by the JNCC as 48,000-56,000[45]. These numbers would indicate that the Wash population stands at around 3,360-3,920. If all the harbour seal disturbed originate from the Wash, that would indicate that in an unmitigated scenario and for the worst case noted above (mono piles at the HVAC location) of 5 individual seals, between 0.1% and 0.15% of the Wash SAC population of harbour seal may be temporarily disturbed. That number reduces to 0.03% for all other piling locations. The most recent report from SCOS (SCOS, 2020[46]) identifies that the harbour seal population of the Wash has been relatively constant since 2012 (following recovery from phocine distemper) until 2019, when it fell by approximately 25% (considered to have occurred across a 2 year period). The 2019 count for the coast between Donna Nook and Scroby Sands was 3,081. Should the lower population of 3,081 be applied, that would result in up to between 0.03 to 0.16% being subject to temporary disturbance depending on pile type and location.

10.3.3.69 For the Doggersbank and Klaverbank SCIs, there are an estimated 6,000 harbour seal in the Dutch section of the North Sea and Wadden Sea[47]. No population level for either SCI has been sourced (the standard data forms both read a population of zero).

10.3.3.70 The conservation objectives refer to the population of the species and the distribution of that species within the site. As any effect is predicted to be at distance from both transboundary harbour seal sites, it will not have a direct effect on the distribution of

[44] http://jncc.defra.gov.uk/protectedsites/sacselection/sac.asp?EUCode=UK0017075
[45] http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?FeatureIntCode=S1365
[46] http://www.smru.st-andrews.ac.uk/files/2021/06/SCOS-2020.pdf
[47] https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/gebieden/doggersbank/dogger-bank/beschermde-soorten/mammals/kopie-harbour-seal/

individuals within the sites. Further, the effect will be both temporary and small scale, being at most 5 individuals. Even if all those individuals were attributed to the Dutch section of the North Sea and Wadden Sea (with an estimated population of 6,000 individuals in the context of the population that would as an unrealistic worst case still be <1%. Therefore, no detectable change is predicted with respect to harbour seals associated with transboundary sites.

10.3.3.71 **Volume A2, Chapter 4: Marine Mammals** found that the area of sea within which noise sufficient to result in disturbance of harbour seal has a low density of harbour seals, and is not considered an important foraging ground for the species. Therefore, any disturbance and displacement is unlikely to result in a significant reduction in energy intake. In addition, as noted in the ES chapter, data collated during windfarm construction has shown that harbour seal density quickly recovers once piling has ceased, and so any disturbance that does occur is likely to be short lived and temporary in nature. Further, the number of animals temporarily affected is small in the context of both the overall population and at designated site level populations (where known).

10.3.3.72 There is, therefore, no AEoI for the harbour seal population and distribution with respect to the Wash and North Norfolk Coast SAC, Doggersbank (Netherlands) SAC or Klaverbank SCI from Hornsea Four alone and therefore, subject to natural change, the population of harbour seal will be maintained in the long-term.

Consideration of grey seal for RIAA purposes

10.3.3.73 Grey seal are screened in for potential LSE with respect to underwater noise during construction and decommissioning, together with vessel disturbance and vessel collision risk during construction, operation & maintenance and decommissioning for the following sites:

- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal); and
- Berwickshire and North Northumberland Coast SAC (grey seal).

10.3.3.74 Grey seals are also screened in for potential LSE with respect to underwater noise during construction and decommissioning and for vessel disturbance during construction, operation & maintenance and decommissioning for the following sites:

- Transboundary sites (twelve sites for grey seal, specifically Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres, Vlaamse Banken, SBZ 1, SBZ 2, SBZ 3, Vlakte van de Raan, Westerschelde & Saeftinghe, Voordelta, Noordzeekustzone and Waddenzee).

10.3.3.75 Variable information exists on the conservation objectives for individual sites, with the following drawn from UK sites (noting that no conservation objectives exist for the Humber Estuary Ramsar, with those for the Humber Estuary SAC applied here instead) where, subject to natural change, the following applies:

- 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.

10.3.3.76 The objectives for transboundary sites (where available) are:

- Conserve the area and quality of supporting habitat; and
- Conserve the population size.

10.3.3.77 With the following also highlighted for the Voordelta SCI, Noordseekustzone SCI and Waddenzee SCI:

- Conservation of intertidal areas for resting grey seal.

10.3.3.78 Together with the following additional objective for the Noordseekustzone SCI (the second point also for the Waddenzee SCI):

- Improving the quality of habitat for marine mammals; and
- Maintain undisturbed resting places and optimal breeding habitat for grey seal.

10.3.3.79 Of the above conservation objectives, it is clear that the transboundary objectives are contained within those for the UK sites – therefore the assessment that follows is presented following the UK conservation objective requirements to minimise repetition.

10.3.3.80 As regards the conservation objectives that address the natural habitats of grey seal (the first four bullet points for UK site conservation objectives), these are concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded slight adverse significance at most in all cases (which is not significant in EIA terms), and in any case is insufficient to reach any designated site for seals. Similarly, **Volume A2, Chapter 4: Marine Mammals** further considers fish and marine mammals during construction in the context of a potential reduction in foraging ability. Resulting from issues around turbidity, visibility and the ability to locate prey. The magnitude of the impact is concluded to be negligible and have no significant effect. Given the conclusions in the ES, in the wider context of the scale of the available habitat relative to the scale of Hornsea Four, no potential for adverse effect has been identified.

10.3.3.81 Table 1.4 in **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** summarises the consultation responses received, including where the comments are addressed. These include comments with respect to the Humber Estuary SAC, SPA and Ramsar, which are addressed in the chapter in relation to effects along the Holderness Coast and nearshore pathways. No measurable change in wave conditions was found for the Holderness Coast (or Smithic Bank), which implies that there will be no impact to cliff erosion rates or patterns of longshore drift.

10.3.3.82 There is, therefore, no AEoI to the supporting habitats relevant to grey seal and their prey for the Humber Estuary SAC and Ramsar, Berwickshire and North Northumberland

Coast SAC, Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI and Waddenzee SCI from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for grey seal prey will be maintained in the long-term.

10.3.3.83 The potential to affect the population and distribution of grey seal during construction is considered within **Volume A2, Chapter 4: Marine Mammals** with respect to potential for injury (risk of onset of PTS), disturbance and vessel collision risk.

10.3.3.84 As for consideration of harbour porpoise, bottlenose dolphin and harbour seal above, the risk of onset of PTS in all marine mammal species will be addressed in the MMMP (referenced here in **Table 3**), which will provide for appropriate mitigation to minimise the risk of injury or mortality in grey seal during percussive piling (requiring prior approval by the regulator). Therefore, it is concluded that Hornsea Four alone does not have an AEoI on grey seal as a result of mortality or injury resulting from percussive piling at Hornsea Four alone.

10.3.3.85 Section 4.11.1 of **Volume A2, Chapter 4: Marine Mammals** considers the number of grey seal potentially disturbed by unmitigated pile driving at each modelled location for both monopiles and pin piles. The assessment is made using a dose-response curve calculated for harbour seals, in the absence of a similar dataset for grey seals. Grey seals are considered to be less sensitive to behavioural disturbance than harbour seals (see Section 4.11.1 of **Volume A2, Chapter 4: Marine Mammals**), and recent studies of tagged grey seals have shown that there is vast individual variation is responses to pile driving, with some animals not showing any evidence of a behavioural response when within 12 km of the pile driving location (Aarts et al, 2018). Therefore, the adoption of the harbour seal dose response curve for grey seals is likely to over-estimate the potential for impact on grey seals.

10.3.3.86 Given the precautionary caveats above, the highest disturbance levels in grey seals were predicted for the HVAC location, where up to 1,489 grey seals are predicted to be disturbed during the installation of a monopile, which represents 2.3% of the reference population. The equivalent number for pin piles at the same location is 1,291 animals (2.0% of the reference population) which represents the highest level of disturbance in temporal terms. Piling at the HVAC is very short term. The numbers potentially disturbed are lowest for the southerly location of the array for both monopile and pin pile, being 703 individuals (1.1% of the reference population) or 585 individuals (0.9%) respectively. As noted above, it is clear that **Volume A2, Chapter 4: Marine Mammals** identifies that survival of individuals and reproductive rates are very unlikely to be impacted.

10.3.3.87 To place the population level numbers in context, additional work has been undertakenby SMRU Consulting to explore potential grey seal site apportionment (included here as **Appendix G**). The Humber Estuary SAC citation[48] gives the grey seal population at the Humber as being 1,800 individuals (no population number is given in the Humber Estuary RIS[49]), with the citation for the Berwickshire and North Northumberland Coast SAC[50] giving the population as 501-1,000. The most recent report from SCOS (SCOS, 2021) identified that the grey seal population of the Humber

[48] http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0030170.pdf
[49] http://jncc.defra.gov.uk/pdf/RIS/UK11031.pdf
[50] http://jncc.defra.gov.uk/protectedsites/sacselection/n2kforms/UK0017072.pdf

Estuary (numbers counted at Donna Nook) has increased in recent years, from below 1,000 in 2005 to some 5,265 hauled out in August 2019. Similarly, SCOS 2018[51] identified an increase in the grey seal numbers counted in north east England (the 'Tees data', which covers Coquet Island to Berwick), increasing from 1,100 individuals in 2000-2006 to 7,004 in 2008-2017. The SCOS report for 2019 (SMRU 2020[52]) discussed grey seal pup production at Donna Nook and East Anglia (therefore including the Humber), finding an increase of 8.5% from 2014 to 2016, with an 18.3% at the Farne Islands in the same period. For the purposes of estimating grey seal population levels, SCOS (2020) estimated that 23.9% of the population was hauled out and therefore counted, with the implication being that the actual grey seal populations are in the order of 76.1% higher than those counted.

10.3.3.88 For the transboundary grey seal sites, population estimates have been sourced where available (from the standard data forms[53]) for sites in Dutch waters (Doggersbank (Netherlands) SAC (gives a population of 0), Klaverbank SCI (gives a population of 0), Westerschelde & Saeftinghe SCI (1-20), Voordelta SCI (50-200), Noordzeekustzone SCI (2,040) and Waddenzee SCI (1,800)). For the site in French waters (Bancs des Flandres SCI (none given)) and those in Belgian waters (Vlaamse Banken SCI (gives a population of 0), SBZ 1 SCI (gives a population of 0), SBZ 2 SCI (gives a population of 0), SBZ 3 SCI (gives a population of 0 and Vlakte van de Raan SCI (0-400))

10.3.3.89 There is therefore a significant variation in the population numbers for grey seal recorded at haul out for both UK SACs screened in. The difference between the citation populations and the current grey seal counts was discussed in the Evidence Plan Process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**), with the conclusion that the citation population should be provided for reference (as above) with reference to the relevant conservation objective which, subject to natural change, is to maintain the population, with the assessment carried out on the current population.

10.3.3.90 For transboundary sites, many do not have a population given in the standard data forms and those that do, population levels vary between 1 and >2,000. The assessment for these sites therefore draws on the conclusions for the closest site (Humber Estuary SAC and Ramsar) in the context of the transboundary site location (further offshore and/ or at greater distance) and with less connectivity to Hornsea Four than adjacent UK sites).

10.3.3.91 **Appendix G** details the importance of 'at sea' grey seals when considering a grey seal population. Relying solely on haul out counts of the population effectively ignores the grey seals that are at sea at the time of the count. Specifically, the 2019 August haul-out count can be scaled to account for the proportion of the population at sea at the time of the survey, using the scalar in Russell et al. (2016) (0.239, 95% CI: 0.192 – 0.286) to produce an estimate of 22,029 grey seals using the Humber Estuary SAC (95% CI: 18,409 – 127,422). Therefore, using the estimated population size at the time of SAC designation against which to assess potential impacts is considered to be inappropriate as it is not reflective of the current level of grey seal usage within the SAC. The RIAA will therefore apply a population of 22,029 grey seals to the Humber Estuary SAC and Ramsar when making the assessment of effect.

[51] http://www.smru.st-andrews.ac.uk/files/2020/08/SCOS-2019.pdf
[52] http://www.smru.st-andrews.ac.uk/files/2020/08/SCOS-2019.pdf
[53] http://natura2000.eea.europa.eu

10.3.3.92 A similar process can be followed for the Berwickshire and North Northumberland SAC, which has seen an even greater increase in grey seal haulout numbers in recent years. That results in the most recent hauled out count of 7,004 individuals being scaled to 29,305.

10.3.3.93 The second aspect explored in **Appendix G** is site connectivity. Grey seals are a wide ranging species and frequently travel over 100 km between haul-out sites and across Seal Management Areas (e.g. Thompson et al. 1996). Therefore, it is clear that grey seals are not resident at one specific haul-out site, and as such, there is no such thing as a 'Humber Estuary SAC grey seal'. Instead, grey seals have associations with SACs (i.e.: they have recorded telemetry positions within an SAC) and may associate more with one haul out site over another. To this end, the SMRU seal telemetry database was examined to investigate the connectivity between the Hornsea Four project area and the Humber Estuary SAC relative to other haul out areas.

10.3.3.94 When determining site connectivity to the Humber Estuary, parameters considered were:

- Grey seals tagged and recorded within a 37.6 km buffer of Hornsea Four (representing the maximum disturbance impact area);
- A review of the location data for these seals; and
- The relative usage of Humber SAC haulout sites by these seals.

10.3.3.95 From the data analysed, 39% were apportioned to the Humber Estuary SAC and Ramsar, with 32% apportioned to the Berwickshire and North Northumberland SAC. On a precautionary basis, it is therefore assumed that the remaining grey seals (29%) could be apportioned to the transboundary sites screened in for assessment.

10.3.3.96 The measure to be considered here is whether or not the above potential for disturbance would result in a potential effect on the population and distribution of grey seal, sufficient to affect the conservation objectives of the designated sites. At population level, that question is addressed in **Volume A2, Chapter 4: Marine Mammals** in Section 4.11.1 and summarised below, with the implications for the relevant designated sites following.

10.3.3.97 Overall, the ES found that the predicted impact (in the context of the number of animals that may be affected and both duration and frequency of effect) were such that although there is potential for a risk of a decline in fertility and survival of 'weaned of the year' for a very small proportion of the grey seal population if those animals are repeatedly displaced from foraging areas, it is not expected that the predicted level, frequency and duration of impact would be sufficient to result in a population level change. Given that grey seals are expected to return to their previous behavioural states/activities after the impact has ceased (within 2 hours), it is not expected that this will result in any significant impact on survival or fertility rates unless the same individual is exposed repeatedly across numerous days (Booth et al. 2019). In the unlikely event that individuals were repeatedly disturbed across the 12 month construction period, any affect on vital rates are expected to be limited to 1 breeding cycle for a very limited proportion of the management unit, and as such the magnitude is assessed as minor in the ES, since vital rates are very unlikely to be impacted to the extent that the population trajectory would be altered.

10.3.3.98 The dose response curve used for grey seal behavioural responses was produced from data obtained from tagged harbour seals only, and there is currently no grey seal dose response curve available. Grey seals are considered to be less sensitive to behavioural disturbance than harbour seals (see Section 4.11.1 of **Volume A2, Chapter 4: Marine Mammals**), and recent studies of tagged grey seals have shown that there is vast individual variation is responses to pile driving, with some animals not showing any evidence of a behavioural response when within 12 km of the pile driving location (Aarts et al. Therefore, the adoption of the harbour seal dose response curve for grey seals is likely to over-estimate the potential for impact on grey seals.

10.3.3.99 The at-sea usage data (see **Figure 5**) suggest that the highest at seal densities are to the south and west of the array, as shown by the higher predicted densities in the grid cells. Given the wide ranging behaviour of grey seals, travelling over 100 km between haul-out sites and with foraging trips lasting up to 30 days (SCOS 2017), it is highly likely that any grey seals temporarily disturbed sufficiently to result in displacement will be able to compensate by travelling to a different foraging patch. Telemetry data obtained from grey seals tagged at Donna Nook in the Humber Estuary SAC/ Ramsar (depicted in Figure 1 in **Appendix G**) show several such potential foraging areas, characterised by high densities of location fixes with tight turning angles in tracks.

10.3.3.100 Similarly it is expected that some grey seals may be displaced around the HVAC location at the time of piling, however pile driving at this site will be highly temporary in nature (limited to a few days) and since not all seals are predicted to respond they will still be expected to transit through and around this area from the Humber Estuary SAC and Ramsar (or other haul out location) in order to reach foraging sites.

10.3.3.101 With respect to the Humber Estuary SAC and Ramsar, the population for assessment purposes is 22,029 individual grey seals. The potential for disturbance per foundation is at most 1,489 individual seals, with that disturbance being a temporary and short term effect (being at the HVAC, for monopiles limited to just 3.6 days in total). Of those 1,489 seals, 39% are apportioned to the Humber Estuary – with the remainder apportioned elsewhere. Therefore, the assessment is based on a worst case of 580.7 individual grey seals, which represents 2.6% of the Humber Estuary SAC and Ramsar population. For the array piling, which would occur intermittently for a 12 month period, the worst case location is the north west location, where monopile foundations would disturb up to 864 individuals. Of these, 337 could be apportioned to the Humber Estuary, with the remainder apportioned elsewhere. That represents up to 1.5% of the of the Humber Estuary SAC and Ramsar population.

10.3.3.102 With respect to the Berwickshire and North Northumberland SAC, the population for assessment purposes is 29,305 individuals. Of the total number of seals which may be disturbed per foundation (worst case of 1,489 individual seals at the HVAC location or 864 for the north west array location), 32% are apportioned to the Berwickshire and North Northumberland SAC. Therefore, the assessment is based on a worst case of 476.5 (HVAC) or 276.5 (north west array) individual grey seals, which as a worst case represents 1.6% (HVAC location) or 0.9% (north west array) of the Berwickshire and North Northumberland SAC.

10.3.3.103 For the 12 transboundary sites, a variable level of information is provided in citation literature as regards the site level population, with several not giving a population number at all. However, for assessment purposes, if it is assumed that of the remaining grey seals that may be disturbed, at the HVAC would mean up to 1,489 individuals less 580.7 for the Humber and less 476.5 for Berwick and North Northumberland SAC, leaving 431.8 individuals for the transboundary sites. That would reduce at the north west location in the array to 864 individuals less 337 for the Humber and less 276.5 for Berwick and North Northumberland SAC, leaving 250.5 individuals for the transboundary sites. Should an equal apportionment be assumed between the 12 sites that would equate to 21-36 individual seals per site. In the context of the European grey seal population (excluding the UK) of 12,400 (SCOS 2018), either the 21-36 individual number or the 250.5-431.8 total number of seals is inconsequential (particularly when noting that no at sea scalar has been applied to that population count).

10.3.3.104 This type of short-term, intermittent and temporary behavioural response will affect only a very small proportion of the overall population for short, intermittent periods, at the HVAC for 3.5 days and for the array for up to 12 months and, while energetic requirements may be slightly increased by the need to transit to another foraging location, survival and reproductive rates are very unlikely to be impacted. The test that needs to be met is the conservation objectives for the SACs or Ramsar (as raised above), which is concerned about 'a potential effect on the population and distribution of grey seal'. In the context of the above, it can therefore be concluded that the proposed works would not result in an effect at population level or (other than in the localised and short term) on the distribution of grey seal.

10.3.3.105 In a site based context, and as a worst case, approximately 2.6% of the grey seal population of the Humber Estuary SAC and Ramsar population could be disturbed during the piling at the HVAC, being just 1.5% as a worst case for piling in the array, both on a temporary and short term basis. The assessment for the Berwickshire and North Northumberland SAC found as a worst case1.6% (HVAC) or 0.9% (north west array) of the population also potentially disturbed on a temporary and short term basis. The potential for disturbance of seals associated with transboundary sites is even less. All in a context of such disturbance being short term, temporary and intermittent across a period of up to 12 months, with the worst case HVAC location being just 3.5 days, being based on a precautionary dose-response curve and with not all of the individuals subject to the noise showing a disturbance response.

10.3.3.106 There is, therefore, no AEoI for grey seal population and distribution with respect to the Humber Estuary SAC and Ramsar, Berwickshire and North Northumberland Coast SAC, Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI and Waddenzee SCI from Hornsea Four alone and therefore, subject to natural change, the population of grey seal will be maintained in the long-term.

Underwater Noise from UXO Clearance

10.3.3.107 Experience from other OWF projects in the southern North Sea, together with specific and recent experience from Hornsea One and Two, suggests that there is the potential for UXO to occur within the array and export cable corridor for Hornsea Four and that it is likely that UXO clearance work may be required in some cases; this would need to be confirmed by site-specific pre-construction surveys and a separate Marine Licence (with associated EPS Licence application) will be applied for pre-construction for the clearance of any UXO, if required.

10.3.3.108 It should be noted that the preferred action for the Applicant is for no UXO clearance to occur; however, should UXO be detected during the pre-construction geophysical survey, clearance (including a detonation option) may be required prior to construction as a safety measure. Any required UXO clearance would take place within the pre-construction phase (broadly Q1 2026 – Q3 2026), with the proposed date for piling being ~Q4 2026-Q4 2027. Therefore, the earliest any such clearance may occur is anticipated to be in early 2026.

10.3.3.109 As there is no certainty regarding the number, location or nature of any UXO found (and requiring clearance) precautionary assumptions are made here for assessment purposes, based on experience at other Hornsea projects. That assumption is for a total of 86 targets that will require detonation at an assumed rate of between one and five per 24 hours. On a precautionary basis, UXO clearance for the purposes of this assessment is considered to involve the high-order detonation of the UXO in situ to make it safe to undertake construction works in the surrounding area.

10.3.3.110 Consideration of impact from UXO is made on a risk of injury basis (defined as risk of onset of PTS) and a disturbance element. **Volume A2, Chapter 4: Marine Mammals** considers how onset of PTS is defined and predicted in Section 4.11.1, with that information not repeated here. Depending on the charge weight of the UXO, it is clear (based on Table 4.57 of that Chapter) that the potential range of PTS for an unmitigated high order detonation is potentially high. Given that should PTS occur it would be unrecoverable, and in line with the ES, it is expected that should UXO clearance be required Hornsea Four, there will be a requirement to implement a UXO specific MMMP to ensure that the risk of PTS is reduced to negligible. The exact mitigation measures contained with the UXO MMMP are yet to be determined and will be agreed with Natural England and the MMO.

10.3.3.111 Further, although not currently proposed, the Project is aware of the potential option for UXO clearance using low-order detonation (small shape charge to penetrate the casing and vaporize the explosive material) as opposed to the commonly used high-order detonation where the explosive material is detonated. It is understood that the potential for this approach (and others) and evidence of its noise impact ranges are currently being investigated further within a project under BEIS and through the SEA process, with initial findings indicating that as detonation is much smaller, impact ranges will be significantly reduced (through the Offshore Energy SEA Sub-Contract OESEA-19-107).

10.3.3.112 Natural England and JNCC advise that a buffer of 26 km around the source location is used to determine the impact area from UXO clearance with respect to disturbance of harbour porpoise in the Southern North Sea SAC. In the absence of agreed metrics for the use of other marine mammal species for disturbance and given a lack of empirical data on the likelihood of response to explosives, this 26 km radius has been applied for all species. This approach is consistent with **Volume A2, Chapter 4: Marine Mammals**.

10.3.3.113 Section 4.11.1 of **Volume A2, Chapter 4: Marine Mammals** concluded the significance of impact for all marine mammals from the risk of PTS from UXO detonation to be negligible, rising slightly to slight for disturbance in harbour porpoise, bottlenose dolphin, harbour seal and grey seal.

10.3.3.114 In HRA terms, the potential for impact will further depend on the location(s) of any UXO relative to a designated site, particularly for harbour porpoise and the SNS SAC. The assessment below is made for each of the designated sites and marine mammal species screened in for potential LSE for underwater noise during construction and decommissioning.

Consideration of Harbour Porpoise for RIAA Purposes

10.3.3.115 Designated sites screened in for harbour porpoise are limited to the SNS SAC. The conservation objectives for that site are given in **Appendix D**.

10.3.3.116 Given that the anticipated requirement for a UXO-MMMP will provide for appropriate mitigation to minimise the risk of injury or mortality in harbour porpoise during UXO clearance (with prior approval by the regulator), it is concluded that Hornsea Four alone does not have an AEoI on the viability of harbour porpoise as a result of mortality or injury (the first conservation objective) resulting from UXO clearance at Hornsea Four alone in relation to the SNS SAC and therefore ensures that, subject to natural change, harbour porpoise will be maintained as a 'viable component' of the site in the long-term.

10.3.3.117 The second conservation objective for the SNS SAC refers to 'no significant disturbance of the species', and as highlighted above that disturbance is assessed here through the application of the 26 km EDR.

10.3.3.118 The seasonal nature of the SNS SAC is important here, with the Hornsea Four array area being more than 26 km distant from the winter extents of the SNS SAC at its closest point. As such, any UXO clearance within the array that takes place in the winter season (October-March inclusive) would fall outside the need for assessment here. Any UXO clearance within the Hornsea Four array area during the summer season (April-September inclusive) would, however require consideration through the HRA process. For UXO clearance within the offshore ECC, any that fall within 26 km of the SNS SAC boundary would require consideration through the HRA process – with seasonal variability depending on UXO location relative to the seasonal extents of the SNS SAC (see **Figure 12**). Towards the western end of the export cable corridor, provided any UXO are more than 26 km distant from the SNS SAC boundary (summer and/or winter seasonal extents), there would similarly be areas where HRA considerations would not apply or only apply in the summer season (see **Figure 13** and **Figure 14**). The assessment below is made based on maximum design scenario assumptions.

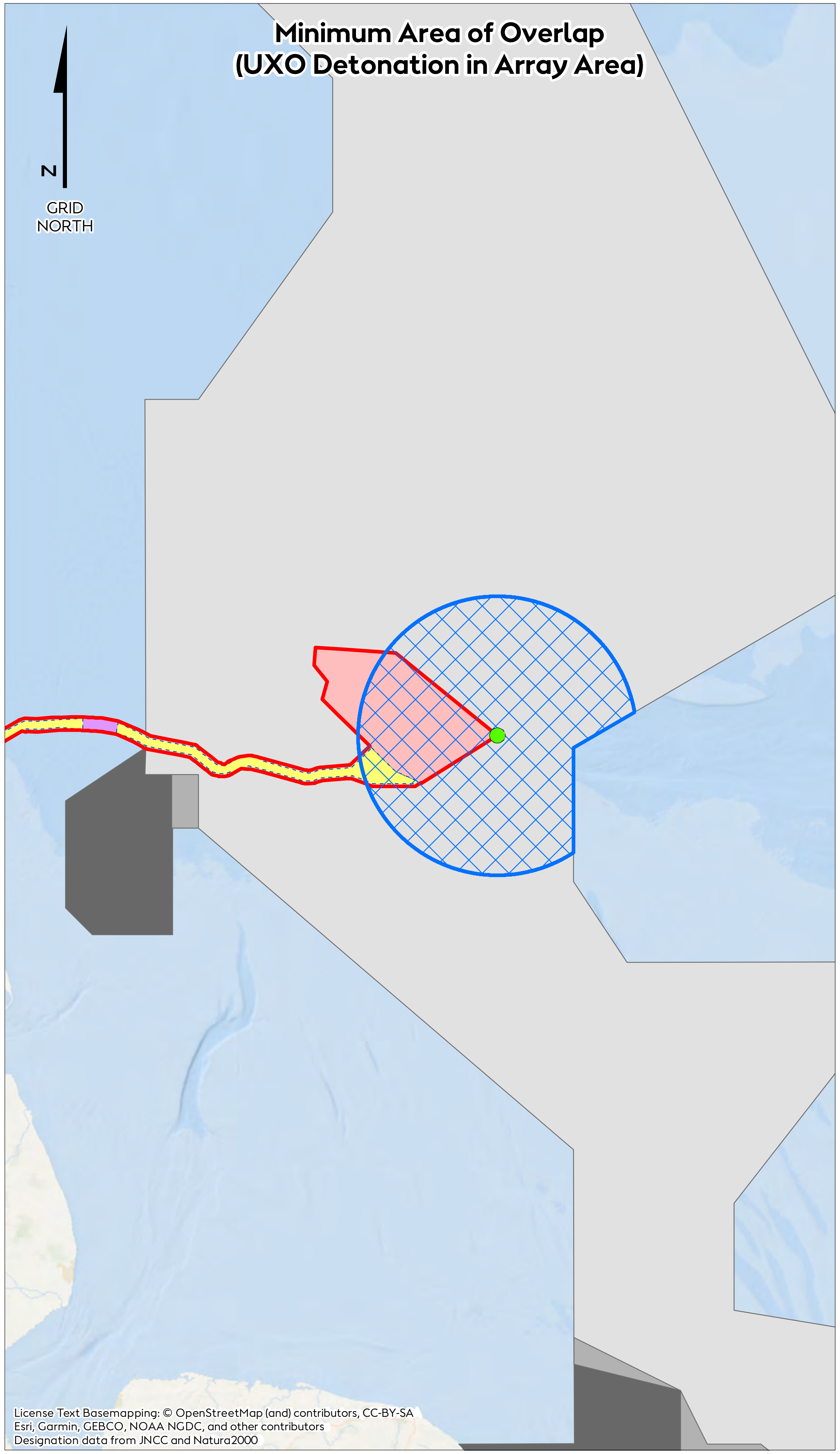
10.3.3.119 For UXO clearance within the Hornsea Four array area, the maximum overlap per individual UXO clearance with the summer extents of the SNS SAC would be 2,124 km^2 (7.87% of the summer extents), or depending on location of the UXO as low as 1,930 km^2 (7.15%) (see **Figure 12**). Should five UXO be cleared within a single day, located such to result in the maximum possible footprint within the summer extents, that could result in up to 20.3% of the summer extent being affected. Such locations would be managed through the SIP process to avoid any such threshold exceedance. There is therefore capacity within the threshold (20% per 24 hours) for more than one UXO detonation to occur within the Hornsea Four array area, with the maximum number of potential detonations that could be cleared within the threshold being dependant on location and in-combination risk. The use of a SIP will ensure that should multiple UXO be cleared per day, locations would be managed to ensure the thresholds would not be exceeded.

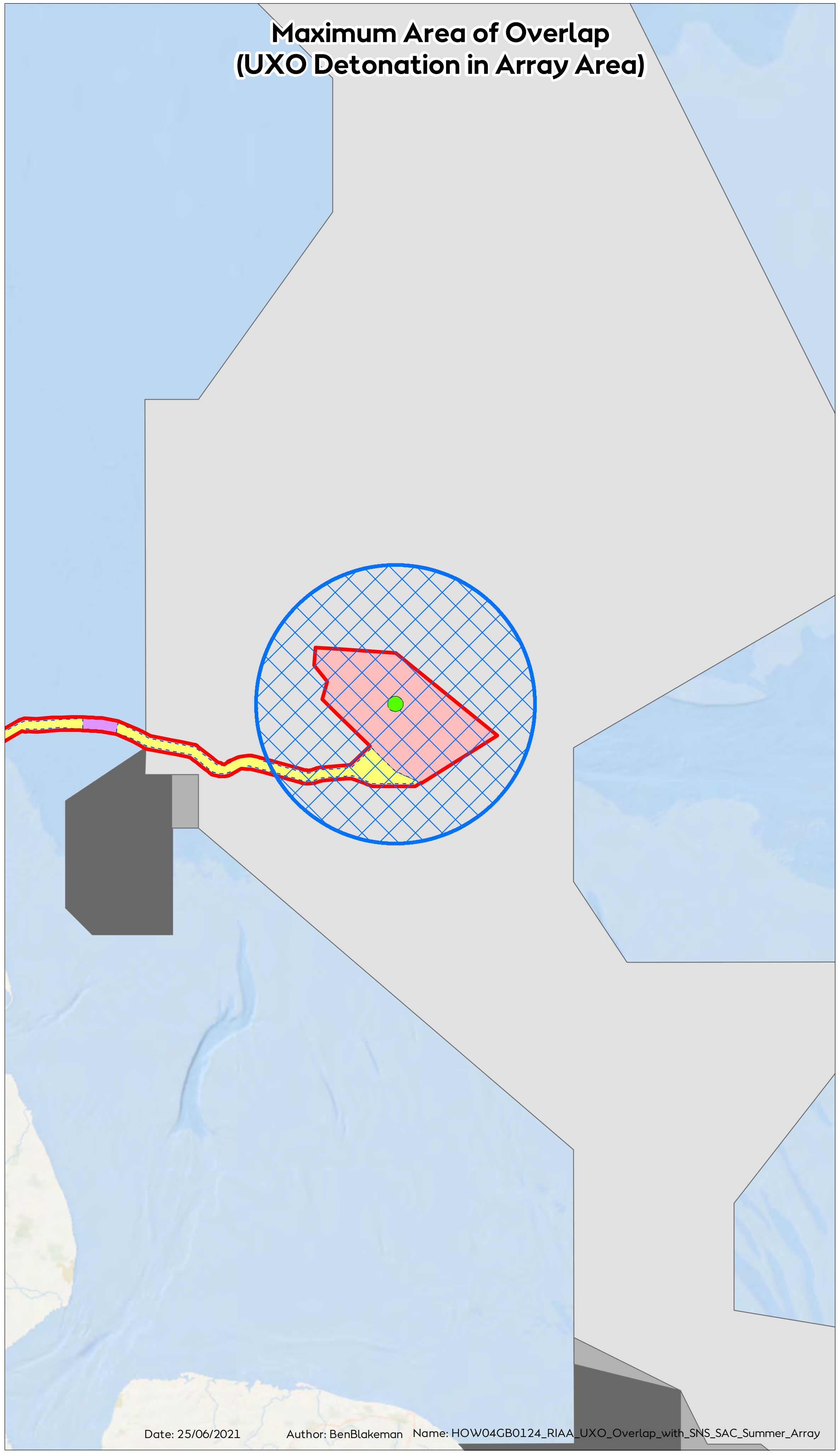
10.3.3.120 For a UXO detonation within the export cable corridor, the potential for overlap with the summer or winter extents of the SNS SAC varies with proximity (the further west the UXO is located, the smaller the potential for overlap). The potential for overlap for a UXO detonated within the HVAC location would result in an overlap of 384 km^2 (1.4%) to 620 km^2 (2.3%) with the summer extents or 277 km^2 (2.2%) to 352 km^2 (2.8%) with the winter extents. For UXO clearance in the overall export cable corridor, the values in the summer season vary (depending on location) between 0km^2 (0%) and 2,124 km^2 (7.87%). In the winter season, UXO clearance in the cable corridor similarly varies, being as a minimum 0 km^2 (0%) and as a maximum 352 km^2 (2.8%). As noted above, it is clear that capacity exists for clearance of more than one UXO within the Hornsea Four Order Limits per 24 hours without exceeding the 20% daily threshold (dependant on location and in-combination risk), with the use of a SIP ensuring that should multiple UXO be cleared per day, locations would be managed to ensure the thresholds would not be exceeded.

10.3.3.121 For the 10% temporal value, it is pertinent to note that on any given day the 10% value could only be exceeded if multiple UXO were detonated within that timeframe (a single UXO as a maximum would result in 7.87% of effect). The anticipated duration of UXO clearance will be up to 86 days (assuming a single UXO cleared per 24 hours). For assessment purposes, and as a maximum design scenario for the 10% temporal value, it is therefore assumed that up to 86 days of UXO clearance within the overall window would be required, wholly within a winter season or wholly within a summer season. Should UXO clearance be undertaken at a rate greater than one per day (including up to the five per day noted above), this would reduce the seasonal contribution by condensing the timeframe of works.

10.3.3.122 The maximum seasonal effect in the summer (assuming up to 7.87% per day for up to 86 days of a 183 day season) would therefore be 3.7%, with the maximum seasonal effect in the winter (assuming up to 3.57% per day for up to 86 days of a 182 day season) being 1.68%. Both values are precautionary (assuming a worst-case of effect each time) and well within the 10% seasonal threshold.

10.3.3.123 Therefore, it is concluded that there will not be an AEoI in relation to disturbance on the Conservation Objective for harbour porpoise for the SNS SAC as a result of UXO clearance from Hornsea Four alone and therefore, subject to natural change, in the long-term, there will be no significant disturbance of harbour porpoise.





Hornsea Four

Figure 12

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single UXO detonation – array area

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Foundation Location
- Area of Overlap with the Southern North Sea SAC

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

0 25 50 Kilometres

0 5 10 20 Nautical Miles

REV	REMARK	DATE
...	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	25/06/2021

Areas of Overlap with the SNS UXO Detonation Array
Document no: HOW04GB0124
Created by: BPHB
Checked by: SK
Approved by: LK

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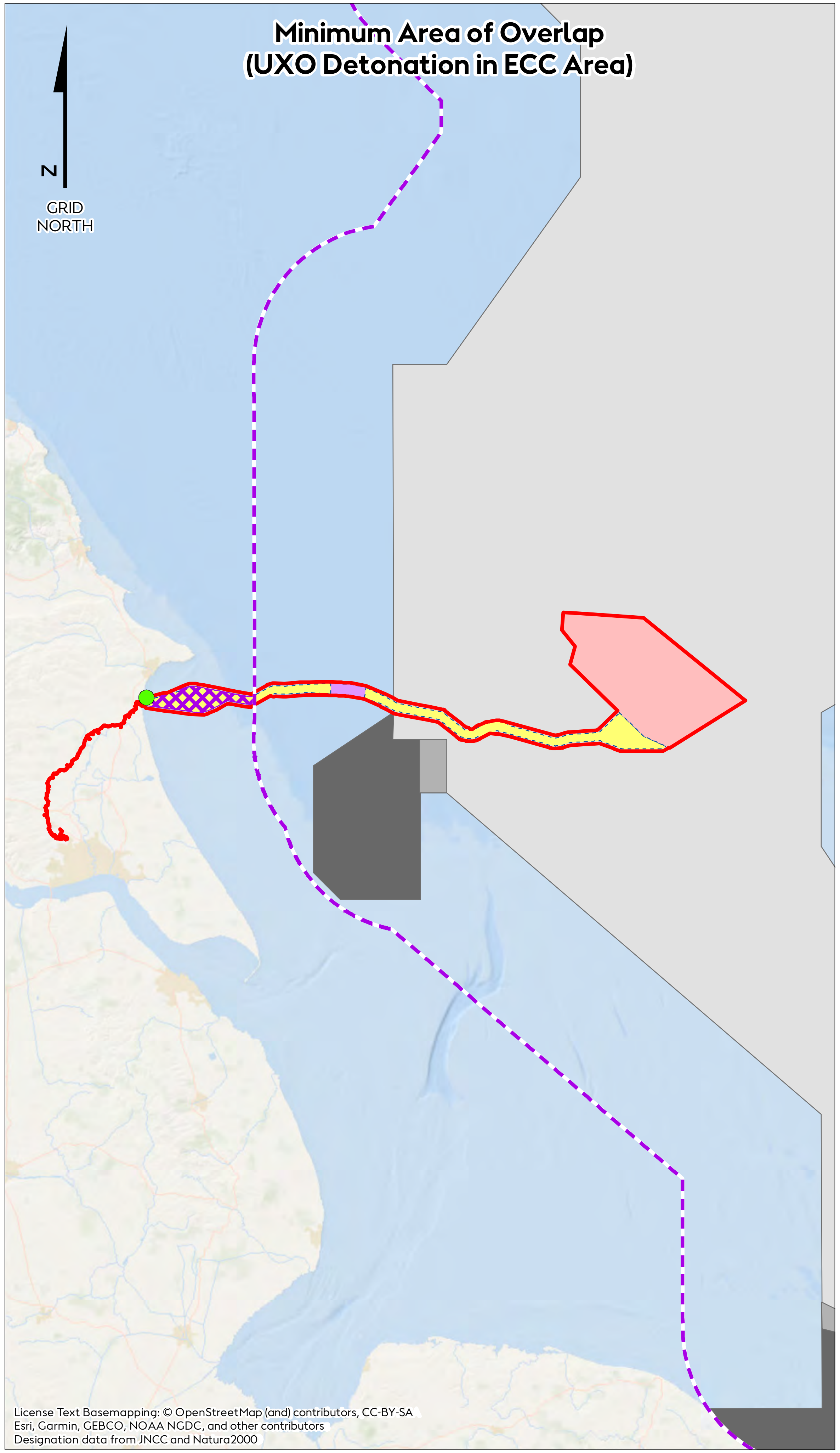
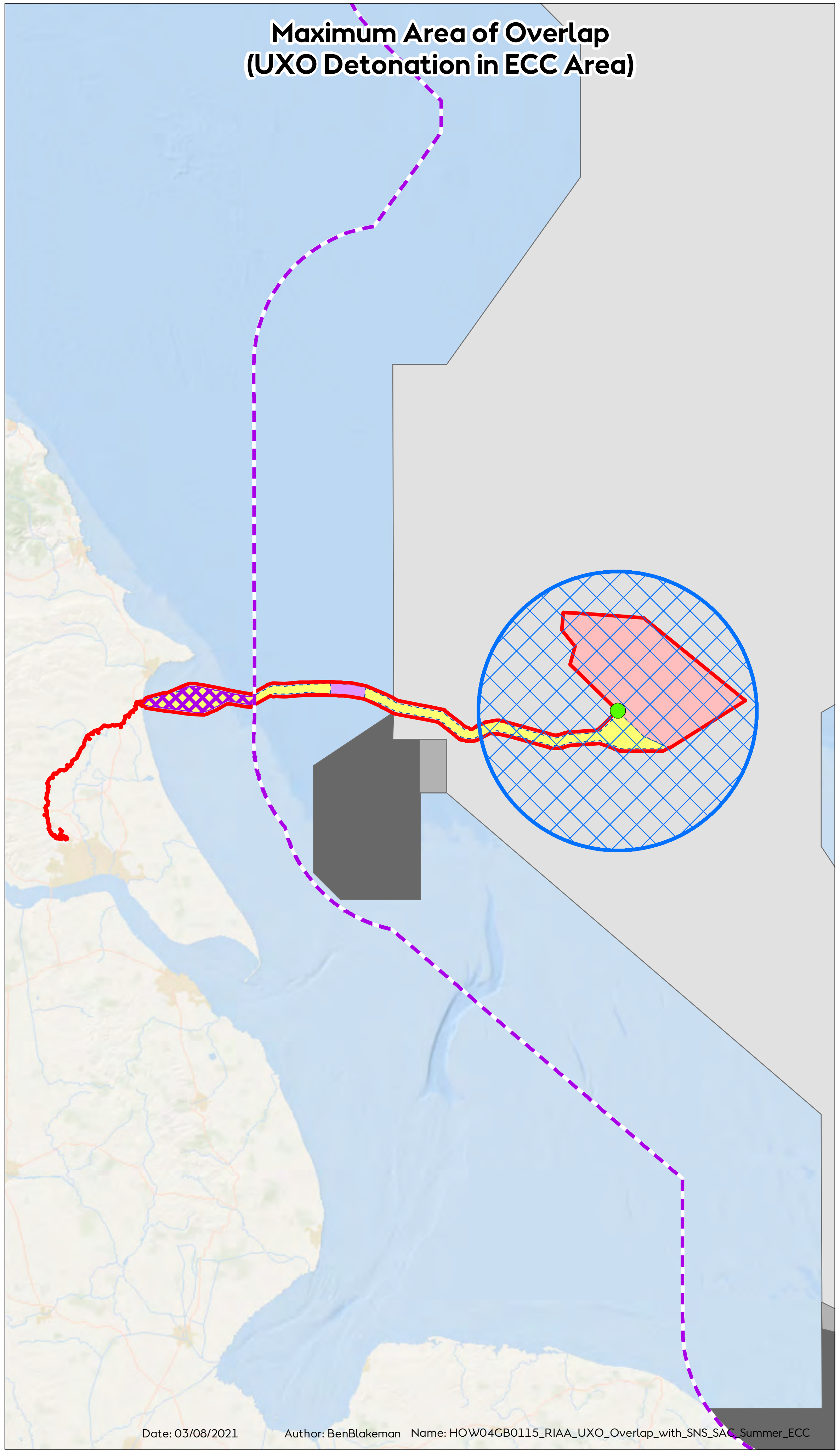




Date: 03/08/2021 Author: BenBlakeman Name: HOW04GB0115_RIAA_UXO_Overlap_with_SNS_SAC_Summer_ECC

Hornsea Four

Figure 13

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single UXO detonation (summer) - ECC

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Offshore Export Cable Corridor
- UXO Detonation
- Area of Overlap with the Southern North Sea SAC (Summer Extent)
- 26km Buffer from Southern North Sea SAC Summer extent
- Area of ECC beyond 26km from Southern North Sea SAC Summer Extent

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area

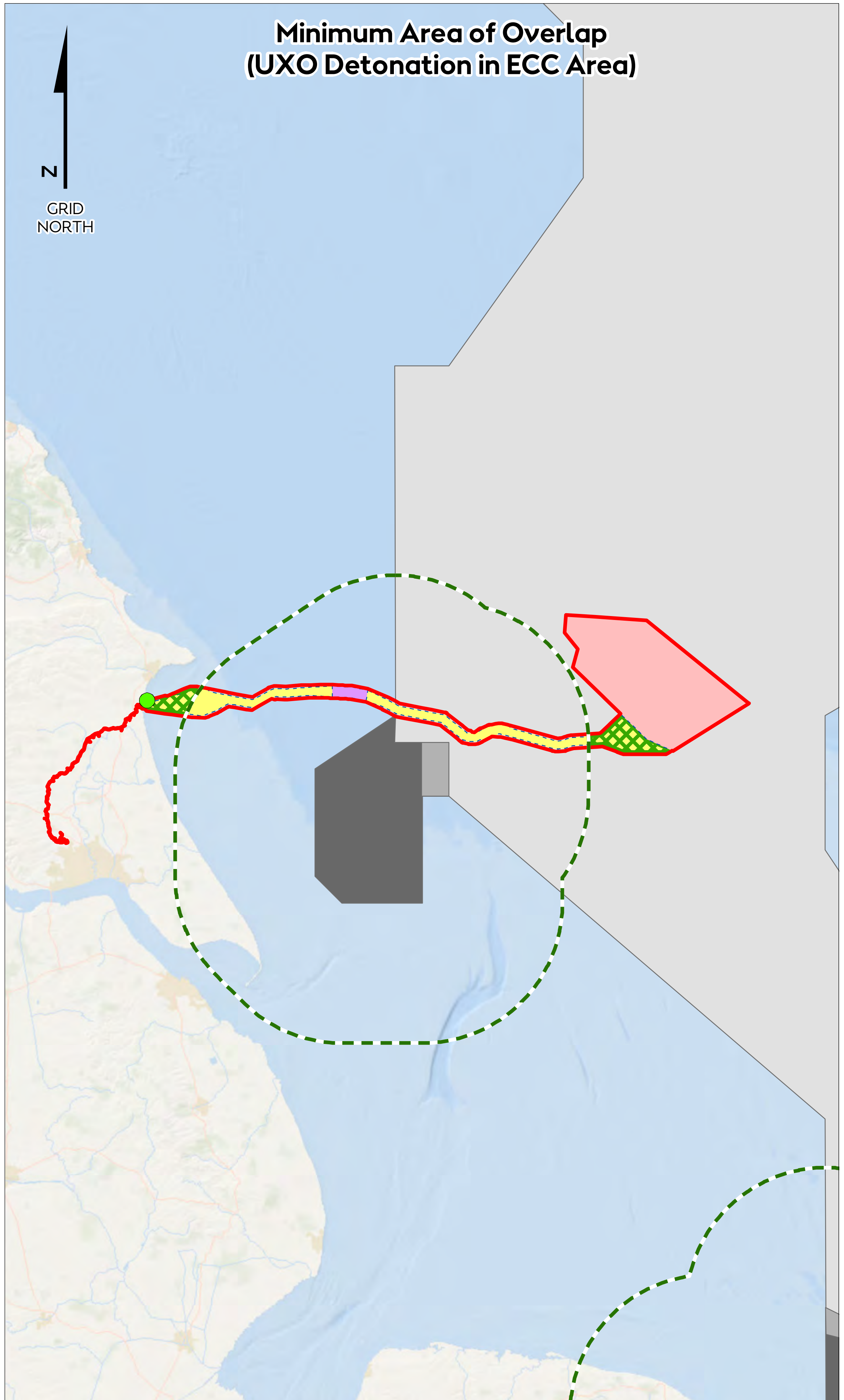
Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

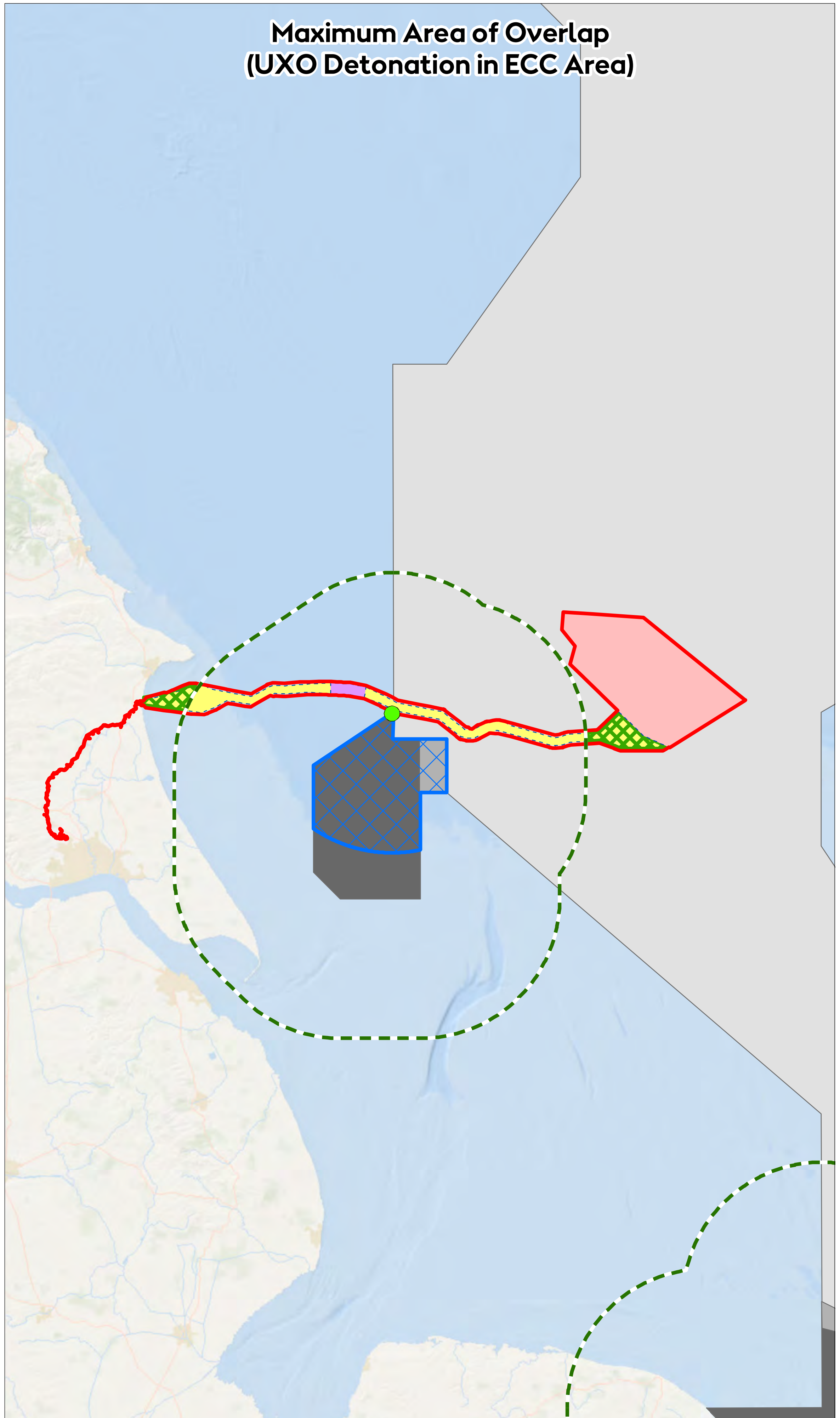
0 25 50 Kilometres

0 5 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	03/08/2021

Areas of Overlap with the SNS Single UXO Detonation
Document no: HOW04GB0115
Created by: BPHB
Checked by: SK
Approved by: LK





Date: 03/08/2021 Author: BenBlakeman Name: HOW04GB0123_RIAA_UXO_Overlap_with_SNS_SAC_Winter_ECC

Hornsea Four

Figure 14

Maximum and Minimum Areas of Overlap with the SNS SAC as a result of a single UXO detonation (winter) - ECC

- Order Limits
- Array Area
- HVAC Booster Station Works Area
- Offshore Export Cable Corridor
- UXO Detonation
- Area of Overlap with the Southern North Sea SAC (Winter Extent)
- 26km Buffer from Southern North Sea SAC Winter extent
- Area of ECC beyond 26km from Southern North Sea Winter Extent

Southern North Sea SAC

- Summer Area
- Summer and Winter Area
- Winter Area

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:1,000,000

0 25 50 Kilometres

0 5 10 20 Nautical Miles

REV	REMARK	DATE
....	First Issue	24/06/2019
A	Updated following PEIR consultation, for DCO	03/08/2021

Areas of Overlap with the SNS Single UXO Detonation Winter
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Checked by: SK
Approved by: LK

10.3.3.124 The third conservation objective is focused on maintaining the supporting habitats and processes, together with availability of harbour porpoise prey, within the SNS SAC. The Advice on Activities[54] refers to supporting habitats as 'the characteristics of the seabed and water column' in the context of 'ensuring prey is maintained within the site'. Potential for supporting habitats and processes to be affected are considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded at most a slight adverse effect (which is not considered significant in EIA terms). For example, the chapter concluded no measureable effect on wave conditions at the coast and no impact on longshore drift. The scale of any potential effect on habitat and physical processes specific to the SNS SAC from individual UXO clearance would be highly localised to the UXO, contained within the scale of any wider project level effect, would be spatially much smaller than the overall SNS SAC and therefore of trivial consequence for physical processes at that scale.

10.3.3.125 There is, therefore, no AEoI to the supporting habitats and processes relevant to harbour porpoise and their prey for the SNS SAC from Hornsea Four alone and therefore, subject to natural change, the availability and density of suitable harbour porpoise prey will be maintained in the long-term.

Consideration of bottlenose dolphin for RIAA purposes

10.3.3.126 A single site is screened in for potential LSE with respect to underwater noise, as highlighted above; the Moray Firth SAC, including the sites conservation objectives.

10.3.3.127 As regards the conservation objective that address the natural habitats of bottlenose dolphin, this is concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded slight adverse significance in all cases (which is not significant in EIA terms), certainly insufficient to reach any habitat designated for bottlenose dolphin. Similarly, **Volume A2, Chapter 4: Marine Mammals** found the potential for effect in relation to marine mammal prey availability to be negligible at most, with the effect therefore not taken forward further in the assessment, as it will not lead to a significant effect. The Moray Firth SAC is located at distance from Hornsea Four (at least 522 km), with the potential for effect on the habitats within the site therefore inconsequential.

10.3.3.128 There is, therefore, no AEoI to the supporting habitats relevant to bottlenose dolphin and their prey for the Moray Firth SAC from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for bottlenose dolphin prey will be maintained in the long-term.

10.3.3.129 The potential to affect the population and distribution of bottlenose dolphin is considered here with respect to potential for injury (risk of onset of PTS) and disturbance.

10.3.3.130 As for consideration of harbour porpoise above, the risk of onset of PTS in all marine mammal species will be addressed by the anticipated requirement for a UXO-MMMP, which will provide for appropriate mitigation to minimise the risk of injury or mortality in bottlenose dolphin during UXO clearance (requiring prior approval by the regulator).

[54] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

Therefore, it is concluded that Hornsea Four alone does not have an AEoI on bottlenose dolphin as a result of mortality or injury resulting from UXO clearance at Hornsea Four alone.

10.3.3.131 **Volume A2, Chapter 4: Marine Mammals** applies the 26 km EDR for disturbance from UXO detonation for all marine mammal species; the chapter provides counts of individual animals that may be subject to disturbance and places this in the context of the overall population. Such counts will vary with size of UXO (with such variability within the 26 km EDR), however given the very short duration, intermittent nature and high reversibility of the effect, the significance was concluded to be negligible, which is not significant in EIA terms.

10.3.3.132 With respect to the potential to effect bottlenose dolphin with potential connectivity to the Moray Firth SAC, as above the species density applied is 0.003 ind km^{-2} and the site population is assumed to be 189 individuals. However, not all individuals that may be subject to disturbance would be expected to show connectivity to the Moray Firth SAC For an assumed EDR of 26km, that assumes individuals within an area of 2,124 km^2 could be disturbed on a very short term and temporary basis. Based on the assumed density of individuals, that could be up to 6 individuals, some 3 % of the SAC population (if all individuals disturbed were connected to the SAC). However, as for the assessment in relation to piling above, not all individuals present are likely to show connectivity to the SAC. Given the distance from shore for the array, and the coastal nature of bottlenose dolphin associated with the SAC, disturbance as a result of UXO clearance within the array (based on the 26km EDR) would not reach the coastal waters within 2km or 3km or the 25m depth contour as defined in **Appendix I**. For any UXO clearance within the ECC, only UXO clearance from the proximity of the HVAC landwards would be sufficiently close inshore to potentially disturb bottlenose dolphin that may be associated with the SAC; for any UXO cleared within this area, only a proportion of the bottlenose dolphin would be associated with the SAC. Therefore, the potential for UXO clearance from Hornsea Four alone to result in significant disturbance of bottlenose dolphin with connectivity to the SAC is limited to a small proportion of the ECC only (and therefore for a small proportion of the expected 86 clearances) and for less than 3% of the SAC population per clearance.

10.3.3.133 The potential for such a small proportion of the population, for very short term, temporary and intermittent occurrences, all located within an area of sea at the extreme southerly limit of bottlenose dolphin that may show connectivity to the Moray Firth SAC, means that the potential for effect is considered not significant.

10.3.3.134 There is, therefore, no AEoI for the bottlenose dolphin population and distribution with respect to the Moray Firth SAC from Hornsea Four alone and therefore, subject to natural change, the population of bottlenose dolphin will be maintained in the long-term.

Consideration of harbour seal for RIAA purposes

10.3.3.135 The sites for which harbour seal are screened in for potential LSE with respect to underwater noise are highlighted under the assessment for piling above, including confirmation that the conservation objectives as applied to UK sites encompass the relevant measures for transboundary sites. Therefore, the assessment that follows is presented following the UK conservation objective requirements to minimise repetition.

10.3.3.136 As regards the conservation objectives that address the natural habitats of harbour seal, these are concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded slight adverse significance in all cases (which is not significant in EIA terms), certainly insufficient to reach any habitat designated for harbour seal. Similarly, **Volume A2, Chapter 4: Marine Mammals** found the potential for effect in relation to harbour seal prey availability to be negligible at most, with the effect therefore not taken forward further in the assessment, as it will not lead to a significant effect. The harbour seal SACs are all located at distance from Hornsea Four (at least 78 km for the closest, the Klaverbank SCI), with the potential for effect on the habitats within the sites therefore inconsequential.

10.3.3.137 There is, therefore, no AEoI to the supporting habitats relevant to harbour seal and their prey for the Wash and North Norfolk Coast SAC, Doggersbank (Netherlands) SAC or Klaverbank SCI from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for harbour seal prey will be maintained in the long-term.

10.3.3.138 The potential to affect the population and distribution of harbour seal is considered within **Volume A2, Chapter 4: Marine Mammals** with respect to potential for injury (risk of onset of PTS) and disturbance.

10.3.3.139 As for consideration of harbour porpoise and bottlenose dolphin above, the risk of onset of PTS in all marine mammal species will be addressed by the anticipated requirement for a UXO-MMMP, which will provide for appropriate mitigation to minimise the risk of injury or mortality in harbour seal during UXO clearance (requiring prior approval by the regulator). Therefore, it is concluded that Hornsea Four alone does not have an AEoI on harbour seal as a result of mortality or injury resulting from UXO clearance at Hornsea Four alone.

10.3.3.140 **Volume A2, Chapter 4: Marine Mammals** applies the 26 km EDR for disturbance from UXO detonation for all marine mammal species; the chapter provides counts of individual animals that may be subject to disturbance and places this in the context of the overall population. Such counts will vary with size of UXO (with such variability within the 26 km EDR), however given the very short duration, intermittent nature and high reversibility of the effect, the significance was concluded to be slight, which is not significant in EIA terms.

10.3.3.141 With respect to the potential to effect harbour seals associated with a specific designated site, neither the Klaverbank SCI citation[55] nor the Doggersbank (Netherlands) citation[56] provide a population size. For the Wash and North Norfolk SAC, the citation has a population of 1,001-10,000. SCOS (2018) found that the population had risen between 2006 and 2012, with the more recent SCOS (2019) indicating the Wash harbour seal population is at or approaching carrying capacity, with the most recent counts for the Wash being similar to pre PDV epidemic levels recorded in 1988 and 2002. As noted

[55] http://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=NL2008002
[56] https://natura2000.eea.europa.eu/Natura2000/SDF.aspx?site=NL2008001&release=10

above, these numbers indicated a Wash population of around 3,360-3,920. However, as noted above, the most recent counts[57] suggest the population has fallen by 25% since to approximately 3,081. In a similar manner to the grey seal assessment, when seals at sea are included the population associated with individual sites would be expected to be larger.

10.3.3.142 The ES calculated numbers of harbour seal at risk from onset of PTS and disturbance during UXO clearance, with the former being less than one individual regardless of the UXO charge size and the latter being 11 individuals (equivalent to 0.21% of the Management Unit reference population). With respect to the Wash and North Norfolk SAC citation population, 11 individuals represents approximately 0.28-0.36% of the population (based on a range of 3,081-3,920). The potential for such a small proportion of the population (with that population likely to be a significant underestimate given that it does not include seals at sea), for very short term, temporary and intermittent occurrences, all located within an area of sea not considered important for harbour seals, means that the potential for effect is considered not significant.

10.3.3.143 There is, therefore, no AEoI for the harbour seal population and distribution with respect to the Wash and North Norfolk Coast SAC, Doggersbank (Netherlands) SAC or Klaverbank SCI from Hornsea Four alone and therefore, subject to natural change, the population of harbour seal will be maintained in the long-term.

Consideration of grey seal for RIAA purposes

10.3.3.144 The sites for which grey seal are screened in for potential LSE with respect to underwater noise are highlighted under the assessment for piling above, including confirmation that the conservation objectives as applied to UK sites encompass the relevant measures for transboundary sites. Therefore, the assessment that follows is presented following the UK conservation objective requirements to minimise repetition.

10.3.3.145 As regards the conservation objectives that address the natural habitats of grey seal (the first four bullet points for UK site conservation objectives), these are concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded slight adverse significance in all cases (which is not significant in EIA terms), certainly insufficient to reach any habitat designated for grey seal. Similarly, **Volume A2, Chapter 4: Marine Mammals** found the potential for effect in relation to grey seal prey availability to be negligible at most, with the effect therefore not taken forward further in the assessment, as it will not lead to a significant effect. Given the distance between designated sites and Hornsea Four, combined with the large overall habitat availability, the slight or negligible changes found in the ES, no significant effect for grey seal habitat or prey, and in the context of relevant designated sites, no potential for significant or adverse effect has been identified.

10.3.3.146 There is, therefore, no AEoI to the supporting habitats relevant to grey seal and their prey for the Humber Estuary SAC and Ramsar, Berwickshire and North Northumberland Coast SAC, Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI,

[57] http://www.smru.st-andrews.ac.uk/files/2021/06/SCOS-2020.pdf

Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI and Waddenzee SCI from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for grey seal prey will be maintained in the long-term.

10.3.3.147 The potential to affect the population and distribution of grey seal is considered within **Volume A2, Chapter 4: Marine Mammals** with respect to potential for injury (risk of onset of PTS) and disturbance.

10.3.3.148 As for consideration of harbour porpoise, bottlenose dolphin and harbour seal above, the risk of onset of PTS in all marine mammal species will be addressed by the anticipated requirement for a UXO-MMMP, which will provide for appropriate mitigation to minimise the risk of injury or mortality in grey seal during UXO clearance (requiring prior approval by the regulator). Therefore, it is concluded that Hornsea Four alone does not have an AEoI on grey seal as a result of mortality or injury resulting from UXO clearance at Hornsea Four alone.

10.3.3.149 **Volume A2, Chapter 4: Marine Mammals** applies the 26 km EDR for disturbance from UXO detonation for all marine mammal species; the chapter provides counts of individual animals that may be subject to disturbance and places this in the context of the overall population. Such counts will vary with size of UXO (with such variability within the 26 km EDR). For grey seal, that count was found to be up to 2,028 individuals, representing 3.2% of the reference population. The total assumes a coastal clearance of UXO and therefore represents a worst case scenario (with more offshore clearances affecting a smaller numbers of animals). However, given the very short duration, intermittent nature and high reversibility of the effect, the significance was concluded to be negligible, which is not significant in EIA terms.

10.3.3.150 In a similar manner as for the assessment of piling related disturbance for grey seal presented above, the number of individual grey seal that may be disturbed temporarily from the clearance of an individual UXO represents a small proportion of the overall population associated with individual designated sites. The same apportionment approach taken for piling and grey seals has been applied here. Therefore approximately 39% of the temporarily disturbed grey seals may be apportioned to the Humber Estuary, being 791 individuals, representing approximately 3.6% of the Humber grey seal population (22,029 individuals). For the remaining individuals, 32% are apportioned to the Berwickshire and North Northumberland SAC, being approximately 2.2% of the population (assuming 29,305 individuals). For the 12 transboundary sites, it would equate to approximately 588 across all the sites, which if apportioned equally between sites would be on average 49 grey seal per site. In the absence of any site based populations, this is deemed inconsequential in the context of the European grey seal population (excluding the UK) of 12,400 (SCOS 2018), regardless of whether or not the proportion or total value is applied, and particularly when noting that no at sea scalar has been applied to that population count.

10.3.3.151 Each individual UXO clearance will result in a very short term source of noise, occurring intermittently for a period of up to 86 individual days across the pre-construction phase (broadly Q1 2026 – Q3 2026). The number of anmials that may be disturbed as a result of a single clearance is a worst case for a coastal UXO clearance. As noted above, should grey seals respond to the noise in terms of temporary displacement, alternative feeding grounds are available. Such a very short duration, intermittent and fully reversible effect on such a small proportion of individual site populations is therefore not considered sufficient to result in more than a short term, localised and temporary change in the distribution of grey seal associated with individual designated sites.

10.3.3.152 There is, therefore, no AEoI for grey seal population and distribution with respect to the Humber Estuary SAC and Ramsar, Berwickshire and North Northumberland Coast SAC, Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI and Waddenzee SCI from Hornsea Four alone and therefore, subject to natural change, the population of grey seal will be maintained in the long-term.

Underwater Noise from Geophysical & Seismic Survey

10.3.3.153 Geophysical survey, by definition, results in the emission of underwater noise. The pre-construction geophysical survey for Hornsea Four is likely to occur within the pre-construction phase, broadly Q1 2026 – Q3 2026, however no specific information is yet available (in terms of timing, nature, extent or duration). As noted above, the use of a SIP ensures that the assessment for the SNS SAC will be revisited for Hornsea Four according to the timeframe set out within the Outline SNS SAC SIP and will therefore include geophysical survey known at that time.

10.3.3.154 The type of geophysical survey carried out for OWF is not typically considered likely to result in PTS in marine mammals, as such a risk is mainly derived from surveys in water >200m and/or using airguns[58]. If a risk were deemed to be present (which would be related to the type and nature of any seismic survey eventually proposed) that risk would be addressed through appropriate licensing measures at that time. With respect to PTS risk for all marine mammal species, a conclusion of no AEoI for all sites and marine mammal features screened in can therefore be drawn.

10.3.3.155 In the final guidance on noise disturbance inthe SNS SAC[59] found that some types of marine survey can be sufficient to result in an EDR, with airgun surveys connected to an EDR of 12 km and some sub-bottom and multi beam surveys connected to an EDR of 5 km. It is clear that the need for an individual geophysical survey to be subject to HRA would need to be assessed on a case by case basis (to be addressed for Hornsea Four through the SIP process, as noted above).

10.3.3.156 To that end, the potential for disturbance in marine mammals from geophysical surveys (given that any such surveys for Hornsea Four are as yet unknown) are addressed further in the in-combination section only (where plans for such surveys are known). Should the requirement for surveys become clear in time for the application, this assessment will be updated to reflect that. If not, the need for such surveys will be known and addressed within the SIP process.

[58] http://archive.jncc.gov.uk/pdf/jncc_guidelines_seismicsurvey_aug2017.pdf
[59] http://data.jncc.gov.uk/data/2e60a9a0-4366-4971-9327-2bc409e09784/JNCC-Report-654-FINAL-WEB.pdf

Underwater Noise from Seabed Preparation and Cable Installation

10.3.3.157 While percussive piling and UXO clearance will be the worst-case noise source during the construction phase, there will also be several other construction activities that will produce underwater noise. These include dredging, drilling, cable laying, rock placement and trenching (vessel disturbance is assessed separately).

10.3.3.158 A simple assessment of the noise impacts from non-piling noise is presented in **Volume A4, Annex 4.5: Subsea Noise Technical Report**. Using the non-impulsive weighted SEL_{cum} PTS and TTS thresholds from Southall et al. (2019) resulted in estimated PTS and TTS impact ranges of <100 m for all marine mammals species for each non-piling construction activity. These values mean that animals would have to stay within these very small ranges for 24 hours before they experienced injury, which is an extremely unlikely scenario as it is far more likely that any marine mammal within the injury zone would move away from the vicinity of the vessel and the construction activity.

10.3.3.159 The potential effects of cabling techniques used in the offshore wind farm industry was reviewed in a report by BERR in association with DEFRA (BERR and DEFRA 2008). The report reviewed various cable types and installation methods including burial ploughs, machines, ROVs and sleds and the burial methods themselves including jetting, rock ripping, and dredging. The review concluded that it would be "highly unlikely that cable installation would produce noise at a level that would cause a behavioural reaction in marine mammals". It is also highly likely that the presence of vessels will act as a deterrent and disturb marine mammals out of the area before any non-piling construction activity begins (as has been documented for harbour porpoise, Brandt et al. 2018). The minimal potential for impact is supported by the conclusion in the ES (within Table 4.8 of **Volume A2, Chapter 4: Marine Mammals**, which summarises impacts scoped out of assessment), which found that no likely significant effects were identified at PEIR and therefore the effect is not considered in detail within the ES.

10.3.3.160 Given the minimal potential for impact, a conclusion of no AEoI to all marine mammals in relation to underwater noise during seabed preparation and cable laying from Hornsea Four alone has been drawn and therefore, subject to natural change, the marine mammal features associated with all relevant sites will be maintained in the long term.

All sources of Underwater Noise from Hornsea Four Alone

10.3.3.161 It is clear that the proposed works resulting in underwater noise would, independently of each other, not result in an AEoI with respect to the sites and features screened in for marine mammals. Specific to the SNS SAC, even as a worst-case there would be no exceedance of the 20% daily or 10% seasonal thresholds. For clarity, it can be confirmed that such activity (in terms of percussive piling and UXO activity) will be managed through the SIP process in such a manner as to preclude threshold exceedance temporally and will therefore not lead to a 'project alone in-combination effect'. Such an effect could occur, should for example UXO clearance occur in the same timeframe as percussive piling or multiple UXO clearances in a single day (with the values calculated demonstrating potential for threshold exceedance). The Outline SNS SAC SIP (which, as noted here in **Section 8.2.3**, is provided for in the DCO) includes as part of its purpose the need to confirm that the project parameters applied for the RIAA assessment alone remain valid and, if these parameters change, that the existing RIAA conclusions of no AEoI similarly remain valid. Therefore, the Outline SNS SAC SIP includes provision to confirm these conclusions.

Vessel Disturbance

10.3.3.162 The potential for an AEoI as a result of vessel disturbance on marine mammals during construction and decommissioning relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to and potentially less than those outlined in the construction phase.

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- The Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary sites (two sites for harbour seal); and
- Transboundary sites (twelve sites for grey seal).

10.3.3.163 The potential for vessel related disturbance on marine mammals alone has been assessed within the existing project literature (see **Volume A2, Chapter 4: Marine Mammals**), with a summary of that provided here.

10.3.3.164 The area surrounding Hornsea Four already experiences a reasonable amount of vessel traffic throughout the year, with an average of 11 vessels per day passing through the array area in the summer and 7 in the winter (see **Volume A2, Chapter 8: Shipping and Navigation**). Therefore, the introduction of vessels during construction is not a novel impact for marine mammals present in the area.

10.3.3.165 Increased vessel traffic during construction has the potential to result in disturbance of marine mammals. Disturbance from vessel noise is only likely where noise from vessel movements is greater than the background ambient noise. The busiest period during construction in terms of vessel traffic would be when up to eight vessels are present in a given 5 km^2 block. This level of activity is unlikely to occur across the entire Hornsea Four array area at any one time, rather this intensity is expected across approximately three or four 5 km^2 blocks. The piling window is expected to fall within the window of ~Q4 2026 - ~Q4 2027. During the period of piling operations, it is considered unlikely that vessel noise will impact marine mammal receptors at levels additional to the piling activity itself.

10.3.3.166 The magnitude and characteristics of vessel noise varies depending on ship type, ship size, mode of propulsion, operational factors and speed. Vessels of varying size produce different frequencies, generally becoming lower frequency with increasing size. The distance at which animals may react is difficult to predict and behavioural responses can vary a great deal depending on context.

10.3.3.167 There are very few studies that indicate a critical level of activity in relation to harbour porpoise density, but an analysis presented in Heinänen and Skov (2015) suggested that harbour porpoise density was significantly lower in areas with vessel transit rates of greater than 80 per day. Vessel traffic in the Hornsea Four area, even considering the addition of construction traffic, will still be below this figure.

10.3.3.168 It is therefore not expected that the level of vessel activity during the construction of Hornsea Four would cause a significant increase in the risk of disturbance by vessels or collision risk with vessels. The adoption of a vessel management plan (Commitment Co108) that includes preferred transit routes and guidance for vessel operations in the vicinity of marine mammals and around seal haul-outs will minimise the potential for any impact. The impact is predicted to be of local, short term duration and intermittent. It is expected that any marine mammals that are disturbed as a result of vessel presence will return to the area once the vessel disturbance has ended.

10.3.3.169 Overall, **Volume A2, Chapter 4: Marine Mammals** found that the effect (in terms of disturbance) is of slight adverse significance, which is not significant in EIA terms.

Consideration of Harbour Porpoise for RIAA Purposes

10.3.3.170 The existing vessel traffic movements within the Hornsea Four array area (an average of 11 vessels per day passing through the array area in the summer and 7 in the winter), combined with up to 8 vessels per $5km^2$ block during construction, remains well below the approximately 80 movements per day cited in Heinänen and Skov (2015) as having potential to lead to a negative effect on harbour porpoise density.

10.3.3.171 The relevant conservation objectives for harbour porpoise are cited in **Appendix D**.

10.3.3.172 The first two conservation objectives address risk of injury and disturbance. **Volume A2, Chapter 4: Marine Mammals** found (in the context of existing shipping levels, the increase in those levels proposed during construction at Hornsea Four and the relevant project mitigation) the increased vessel traffic associated with construction (and decommissioning) of Hornsea Four is insufficient to result in mortality, injury or significant disturbance in marine mammals. That conclusion is supported at a site based level by Heinänen and Skov (2015) as above.

10.3.3.173 The third conservation objective is focused on maintaining the supporting habitats and processes, together with availability of harbour porpoise prey, within the SNS SAC. The Advice on Activities[60] refers to supporting habitats as 'the characteristics of the seabed and water column' in the context of 'ensuring prey is maintained within the site'. Shipping will not lead to a direct impact on the habitats and processes.

10.3.3.174 There is, therefore, no AEoI relevant to harbour porpoise for the SNS SAC from Hornsea Four alone and therefore, subject to natural change, the harbour porpoise will be maintained in the long-term.

Consideration of Bottlenose Dolphin for RIAA Purposes

10.3.3.175 The potential for vessel disturbance to affect bottlenose dolphin is limited to individuals that may show connectivity to the Moray Firth SAC.

[60] http://jncc.defra.gov.uk/pdf/SNorthSea_ConsAdvice.pdf

10.3.3.176 The relevant conservation objectives for bottlenose dolphin are cited in **Appendix D**.

10.3.3.177 As regards the conservation objectives that address the natural habitats of bottlenose dolphin, these are concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded slight adverse significance in all cases (which is not significant in EIA terms) and certainly insufficient to reach habitats designated for marine mammals. Similarly, **Volume A2, Chapter 4: Marine Mammals** found the potential for effect in relation marine mammal prey availability to be negligible at most, with the effect therefore not taken forward further in the assessment, as it will not lead to a significant effect.

10.3.3.178 There is, therefore, no AEoI to the supporting habitats relevant to bottlenose dolphin and their prey for the Moray Firth SAC from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for bottlenose dolphin prey will be maintained in the long-term.

10.3.3.179 The potential to affect the population and distribution of bottlenose dolphin is considered within **Volume A2, Chapter 4: Marine Mammals** with respect to potential for mortality, injury (risk of onset of PTS) and disturbance. No indication was found that disturbance from shipping can result in risk of onset of PTS in marine mammals, with consideration given to the risk of disturbance below.

10.3.3.180 As regards the risk of disturbance, it is clear from the summary presented above (which draws on **Volume A2, Chapter 4: Marine Mammals**) that (in the context of existing shipping levels, the increase in those levels proposed during construction at Hornsea Four and the relevant project mitigation) the increased vessel traffic associated with construction (and decommissioning) of Hornsea Four is insufficient to result in mortality, injury or significant disturbance in marine mammals.

10.3.3.181 There is, therefore, no AEoI relevant to bottlenose dolphin from the Moray Firth SAC from Hornsea Four alone and therefore, subject to natural change, the bottlenose dolphin will be maintained in the long-term.

Consideration of Harbour Seal and Grey Seal for RIAA Purposes

10.3.3.182 Harbour seal and grey seal are screened in for potential LSE with respect to vessel disturbance during construction and decommissioning for the following sites:

- The Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary harbour seal sites (Doggersbank (Netherlands) SAC and Klaverbank SCI); and
- Transboundary grey seal sites (Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI, Waddenzee SCI).

10.3.3.183 The relevant conservation objectives for harbour seal and grey seal are cited in **Appendix D**.

10.3.3.184 As regards the conservation objectives that address the natural habitats of harbour seal and grey seal, these are concerned with the physical habitat and the species contained within. The potential for impact on the physical habitat is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded slight adverse significance in all cases (which is not significant in EIA terms) and certainly insufficient to reach habitats designated for harbour and grey seal. Similarly, **Volume A2, Chapter 4: Marine Mammals** found the potential for effect in relation to harbour seal and grey seal prey availability to be negligible at most, with the effect therefore not taken forward further in the assessment, as it will not lead to a significant effect.

10.3.3.185 There is, therefore, no AEoI to the supporting habitats relevant to harbour seal and their prey for the Wash and North Norfolk Coast SAC, Doggersbank (Netherlands) SAC or Klaverbank SCI or for grey seal and their prey for Humber Estuary SAC and Ramsar, Berwickshire and North Northumberland Coast SAC, Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI and Waddenzee SCI from Hornsea Four alone and therefore, subject to natural change, the supporting habitat for harbour seal and grey seal prey will be maintained in the long-term.

10.3.3.186 The potential to affect the population and distribution of harbour seal and grey seal is considered within **Volume A2, Chapter 4: Marine Mammals** with respect to potential for mortality, injury (risk of onset of PTS) and disturbance. No indication was found that disturbance from shipping can result in risk of onset of PTS in marine mammals, with consideration given to the risk of disturbance below.

10.3.3.187 As regards the risk of disturbance, it is clear from the summary presented above (which draws on **Volume A2, Chapter 4: Marine Mammals**) that (in the context of existing shipping levels, the increase in those levels proposed during construction at Hornsea Four and the relevant project mitigation) the increased vessel traffic associated with construction (and decommissioning) of Hornsea Four is insufficient to result in mortality, injury or significant disturbance in marine mammals. Therefore, even if all such disturbance were attributed to a single SAC population, no significant effect would result.

10.3.3.188 There is, therefore, no AEoI relevant to harbour seal for the Wash and North Norfolk Coast SAC, Doggersbank (Netherlands) SAC or Klaverbank SCI or for grey seal for Humber Estuary SAC and Ramsar, Berwickshire and North Northumberland Coast SAC, Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres SCI, Vlaamse Banken SCI, SBZ 1 SCI, SBZ 2 SCI, SBZ 3 SCI, Vlakte van de Raan SCI, Westerschelde & Saeftinghe SCI, Voordelta SCI, Noordzeekustzone SCI and Waddenzee SCI from Hornsea Four alone and therefore, subject to natural change, the harbour seal and grey seal will be maintained in the long-term.

Vessel Collision Risk

10.3.3.189 The potential for an AEoI as a result of vessel collision risk with marine mammals during construction and decommissioning relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to and potentially less than those outlined in the construction phase. It should be noted that the potential for collision risk is limited to individuals that may come into direct contact with vessels, in comparison to consideration of, for example, disturbance from underwater noise, where individuals could be disturbed at distance from source. The sites screened in for potential LSE for collision risk are therefore limited to those where potential for direct connectivity between individuals from a designated site and the Hornsea Four array and or ECC are identified.

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal); and
- Berwickshire and North Northumberland Coast SAC (grey seal).

10.3.3.190 The potential for vessel collision risk with marine mammals alone has been assessed within the existing project literature (see **Volume A2, Chapter 4: Marine Mammals**), with a summary of that provided here.

10.3.3.191 The area surrounding Hornsea Four already experiences a reasonable amount of vessel traffic throughout the year, with an average of 11 vessels per day passing through the array area in the summer and seven in the winter (see **Volume A2, Chapter 7: Shipping and Navigation**). Therefore, the introduction of additional vessels during construction is not a novel impact for marine mammals present in the area.

10.3.3.192 During construction of the wind farm, a potential source of impact from increased vessel activity is physical trauma from collision with a boat or ship. These injuries include blunt trauma to the body or injuries consistent with propeller strikes. The risk of collision of marine mammals with vessels would be directly influenced by the type of vessel and the speed with which it is travelling (Laist et al. 2001) and indirectly by ambient noise levels underwater and the behaviour the marine mammal is engaged in.

10.3.3.193 There is currently a lack of information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality. There is little evidence from marine mammals stranded in the UK that injury from vessel collisions is an important source of mortality. As reported in **Volume A2, Chapter 4: Marine Mammals**, of the harbour porpoise reported stranded in the period 2005-2010 just 0.2% were recorded as resulting from vessel collision, with this increasing slightly to 0.8% for the period 2011-2015. No data were presented for bottlenose dolphin or harbour and grey seal. Therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post mortem examinations.

10.3.3.194 Harbour porpoises, dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (e.g. Nowacek et al. 2001; Lusseau 2003; 2006). The vessel management plan (Commitment Co108) will ensure that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals.

10.3.3.195 Further, it is highly likely that a proportion of vessels will be stationary or slow moving throughout construction activities for significant periods of time. Therefore, the actual increase in vessel traffic moving around the site and to/from port to the site will occur over short periods of the offshore construction activity.

10.3.3.196 Overall, **Volume A2, Chapter 4: Marine Mammals** found that the effect is of slight adverse significance, which is not significant in EIA terms.

Consideration of Harbour Porpoise for RIAA Purposes

10.3.3.197 The existing vessel traffic movements within the Hornsea Four array area (an average of 11 vessels per day passing through the array area in the summer and seven in the winter), combined with up to eight vessels per $5km^2$ block during construction, remains below the approximately 80 movements per day cited in Heinänen and Skov (2015) as having potential to lead to a negative effect on harbour porpoise density.

10.3.3.198 The relevant conservation objectives for harbour porpoise are cited in **Appendix D.**

10.3.3.199 The first two conservation objectives address risk of injury and disturbance. **Volume A2, Chapter 4: Marine Mammals** found (in the context of existing shipping levels, the increase in those levels proposed during construction at Hornsea Four and the relevant project mitigation) the increased vessel traffic associated with construction (and decommissioning) of Hornsea Four is insufficient to result in an increase in the risk of mortality or injury in marine mammals as a result of collisions. That assessment applies equally to harbour porpoise associated with the SNS SAC, given the localised nature of any effect together with the location of that effect relative to the SAC.

10.3.3.200 The third conservation objective is focused on maintaining the supporting habitats and processes, together with availability of harbour porpoise prey, within the SNS SAC. Vessel collision risk does not have the potential to affect such habitats or processes.

10.3.3.201 There is, therefore, no AEoI relevant to harbour porpoise for the SNS SAC from Hornsea Four alone and therefore, subject to natural change, the harbour porpoise will be maintained in the long-term.

Consideration of Bottlenose Dolphin for RIAA Purposes

10.3.3.202 Bottlenose dolphin are screened in for potential LSE with respect to vessel collision risk during construction and decommissioning for the the Moray Firth SAC. The relevant conservation objectives for bottlenose dolphin are cited in **Appendix D**.

10.3.3.203 **Volume A2, Chapter 4: Marine Mammals** found (in the context of existing shipping levels, the increase in those levels proposed during construction at Hornsea Four and the relevant project mitigation) the increased vessel traffic associated with construction (and decommissioning) of Hornsea Four is insufficient to result in an increase in the risk of mortality or injury in marine mammals as a result of collisions. That assessment applies equally to bottlenose dolphin that may be connected to the Moray Firth SAC, given the localised nature of any effect, the distance between Hornsea Four and the Moray Firth SAC (at least 522 km) and the location of Hornsea Four (at the extreme southern end of potential range for Moray Firth dolphins).

10.3.3.204 There is, therefore, no AEoI relevant to bottlenose dolphin for the Moray Firth SAC from Hornsea Four alone and therefore, subject to natural change, the bottlenose dolphin will be maintained in the long-term.

Consideration of Grey Seal for RIAA Purposes

10.3.3.205 Grey seal are screened in for potential LSE with respect to vessel collision risk during construction and decommissioning for the following sites:

- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal); and
- Berwickshire and North Northumberland Coast SAC (grey seal).

10.3.3.206 The relevant conservation objectives for grey seal are cited in **Appendix D**.

10.3.3.207 **Volume A2, Chapter 4: Marine Mammals** found (in the context of existing shipping levels, the increase in those levels proposed during construction at Hornsea Four and the relevant project mitigation) the increased vessel traffic associated with construction (and decommissioning) of Hornsea Four is insufficient to result in an increase in the risk of mortality or injury in marine mammals as a result of collisions. That assessment applies equally to grey seal that may be connected to the Humber Estuary SAC and Ramsar or the Berwickshire and North Northumberland Coast SAC, given the localised nature of any effect.

10.3.3.208 There is, therefore, no AEoI relevant to grey seal for the Humber Estuary SAC and Ramsar or the Berwickshire and North Northumberland Coast SAC from Hornsea Four alone and therefore, subject to natural change, the grey seal will be maintained in the long-term.

Accidental Pollution

10.3.3.209 The potential for an AEoI as a result of accidental pollution on marine mammals during construction and decommissioning relates to the following designated site and the relevant feature (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to and potentially less than those outlined in the construction phase.

- Southern North Sea SAC (harbour porpoise).

10.3.3.210 The potential for accidental pollution to affect marine mammals was not considered in the ES (**Volume A2, Chapter 4: Marine Mammals**), given the project specific mitigation (contained within Table 4.9 of that chapter) and conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the ES. The reason for that is given as the development of a Marine Pollution Contingency Plan (MPCP), which will form part of a wider CPEMMP. The CPEMMP is provided for under Co111. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (Table 1).

10.3.3.211 It is noted that the above plans are included through Co111 (Table 3) and secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d).

10.3.3.212 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, enables the conclusion that there is, therefore, no AEoI to marine mammals in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the marine mammal feature will be maintained in the long term with respect to the potential for accidental pollution. and maintenance.

10.3.4 Operation and Maintenance

Underwater Noise

10.3.4.1 The potential for an AEoI as a result of an increase in underwater noise (operational noise) on marine mammals during operation & maintenance relates to the following designated site and the relevant feature (i.e. that feature screened in for potential LSE).

- Southern North Sea SAC (harbour porpoise).

10.3.4.2 The relevant conservation objectives for harbour porpoise are cited in Appendix D.

10.3.4.3 Operational WTGs will produce underwater noise as a result of vibration from the rotating machinery in the turbines, which is transmitted through the structure of the pile and foundations.

10.3.4.4 The MMO (2014) review of post-consent monitoring at OWFs found that available data on the operational WTG noise, from the UK and abroad, in general showed that noise levels from operational WTGs are low and the spatial extent of the potential impact of the operational WTG noise on marine receptors is generally estimated to be small, with behavioural response only likely at ranges close to the WTG. This is supported by several published studies which provide evidence that marine mammals are not displaced from operational wind farms. For example, a number of reviews have concluded that operational wind farm noise will have negligible effects (Madsen et al. 2006; Teilmann et al. 2006; CEFAS 2010; Brasseur et al. 2012). In addition, studies have shown that porpoise are detected regularly within operational offshore wind farms (Diederichs et al. 2008; Scheidat et al. 2011) and may be attracted to offshore wind farms for increased foraging opportunities (Lindeboom et al. 2011).

10.3.4.5 The potential for operational noise to affect marine mammals is noted in Volume A2, Chapter 4: Marine Mammals in Table 4.8, where it is concluded that since no likely significant effect was identified at PEIR, it is therefore not considered in detail in the ES. Specifically, that the non-impulsive weighted SELcum PTS and TTS thresholds from Southall et al. (2019) resulted in estimated PTS and TTS impact ranges of <100 m for all marine mammal species (being the minimum range feasible when producing modelled outputs for the SEL_{cum} values – in other words the potential range of effect is within that distance, not necessarily out to that distance). Given the evidence of their presence in and around existing operational offshore wind farms, marine mammals are deemed to be of low vulnerability and have high recoverability to the impact of operational noise.

10.3.4.6 As regards the conservation objectives for the SNS SAC, it is considered that there is no risk of injury resulting from PTS in harbour porpoise. The risk of injury (defined as onset of PTS) as well as the risk of TTS is given as occurring in a range of <100m, a highly precautionary range, and within which the animal would need to stay for a 24 hour period for sufficient noise exposure to result in an effect. Such an occurrence is extremely unlikely and would be atypical behaviour for such a highly mobile species. It should be noted that as the range of risk of onset of TTS is also <100m, the range of onset of PTS would be well within that limit (although the models are not sensitive enough to enable such differentiation at such close range to source).

10.3.4.7 With respect to the potential for disturbance to result in displacement of individuals, and given existing evidence which demonstrates that harbour porpoise are not displaced from offshore wind farms in general following construction, it is therefore anticipated that, in line with a number of studies conducted to date, any such disturbance response would be in close proximity to turbines only.

10.3.4.8 The final consideration is that of risk to habitat and prey from operational noise. Underwater noise is not considered a risk to the habitat of harbour porpoise. The risk to harbour porpoise prey, in terms of fish, is also considered (see **Volume A4, Annex 4.5: Subsea Noise Technical Report**), finding that the risk of TTS (over a period of 12 hours) is <50m. Further consideration is given to fish in **Volume A2, Chapter 3: Fish and Shellfish Ecology**, including during operation, with a behavioural response only expected at very close range.

10.3.4.9 It can therefore be concluded that there is no AEoI to harbour porpoise in relation to operational noise from Hornsea Four alone and therefore, subject to natural change, the marine mammal feature will be maintained in the long term.

Vessel Disturbance

10.3.4.10 The potential for an AEoI as a result of vessel disturbance on marine mammals during operation & maintenance relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE).

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- The Wash and North Norfolk SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary sites (two sites for harbour seal); and
- Transboundary sites (twelve sites for grey seal).

10.3.4.11 The relevant conservation objectives for harbour porpoise, bottlenose dolphin, harbour seal and grey seal are cited in **Appendix D**.

10.3.4.12 The potential for vessel disturbance (and any associated vessel collision risk) in marine mammals during operation and maintenance is considered in Table 4.8 of **Volume A2, Chapter 4: Marine Mammals**. The conclusion is that given the PEIR assessment of no likely significant effect, operational disturbance from vessels is not considered in detail in the ES. Specifically, it is not expected that the level of vessel activity during the operation and maintenance of Hornsea Four would cause a significant increase in the risk of disturbance by vessels. The adoption of a vessel management plan (Co108 within **Table 3**), that includes preferred transit routes and guidance for vessel operations in the vicinity of marine mammals and around seal haul-outs, will minimise the potential for any impact.

10.3.4.13 Given the localised, temporary and intermittent nature of the effect, the conclusions of the ES are considered to be directly relevant to the designated sites under consideration. As such, given that the operation and maintenance vessel movements are not expected to result in a significant change on existing conditions, and in light of the conclusions drawn above with respect to vessel disturbance during construction, of no AEoI for all marine species screened in (when potential for vessel related disturbance is greater), it can be concluded that the same conclusion of no AEoI applies equally during the operation & maintenance phase of works.

Vessel Collision Risk

10.3.4.14 The potential for an AEoI as a result of vessel collision risk with marine mammals during operation & maintenance relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE).

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal); and
- Berwickshire and North Northumberland Coast SAC (grey seal).

10.3.4.15 The relevant conservation objectives for harbour porpoise and grey seal are cited in **Appendix D**.

10.3.4.16 Table 4.8 of **Volume A2, Chapter 4: Marine Mammals** notes that given the conclusions drawn at PEIR (of no likely significant effect), the potential for vessel collision with marine mammals is not considered in detail in the ES. Specifically, it is not expected that the level of vessel activity during construction would cause an increase in the risk of mortality from collisions. The adoption of a vessel management plan (Commitment Co108 within **Table 3**) will minimise the potential for any impact.

10.3.4.17 Given that, in the context of existing shipping levels, the increase in vessel traffic proposed during operation and maintenance at Hornsea Four (in the context of relevant project mitigation) is insufficient to result in an increase in the risk of mortality or injury in marine mammals as a result of collisions. That assessment applies equally to all marine mammals and therefore includes harbour porpoise that may be associated with the SNS SAC, bottlenose dolphin that may be associated with the Moray Firth SAC or grey seal that may be connected to the Humber Estuary SAC and Ramsar or the Berwickshire and North Northumberland Coast SAC, given the localised nature of any effect.

10.3.4.18 There is, therefore, no AEoI relevant to harbour porpoise and the SNS SAC, bottlenose dolphin associated with the Moray Firth SAC or to grey seal for the Humber Estuary SAC and Ramsar or the Berwickshire and North Northumberland Coast SAC from Hornsea Four alone and therefore, subject to natural change, the harbour porpoise, bottlenose dolphin and grey seal will be maintained in the long-term.

Accidental Pollution

10.3.4.19 The potential for an AEoI as a result of accidental pollution on marine mammals during operation and maintenance relates to the following designated site and the relevant feature (i.e. those features screened in for potential LSE).

- Southern North Sea SAC (harbour porpoise).

10.3.4.20 The potential for accidental pollution to affect marine mammals was not considered in the ES (**Volume A2, Chapter 4: Marine Mammals**), given the project specific mitigation (contained within Table 4.9 of that chapter) and conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the ES. The reason for that is given as the development of a Marine Pollution Contingency Plan (MPCP), which will form part of a wider CPEMMP. The CPEMMP is provided for under Co111. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**).

10.3.4.21 It is noted that the above plans are included through Co111 (**Table 3**) and secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d).

10.3.4.22 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, enables the conclusion that there is, therefore, no AEoI to marine mammals in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the marine mammal feature will be maintained in the long term with respect to the potential for accidental pollution.

10.4 Offshore Ornithology

10.4.1 Assessment Criteria

10.4.1.1 The assessment has been based on the relevant guidance for conducting HRA and assessing offshore wind farms (e.g. European Commission 2011; Maclean et al. 2009; Natural England 2010; PINS Advice Note Ten) and applied the criteria contained in that guidance where relevant to the interest features under consideration.

10.4.1.2 The screening criteria applied are precautionary and are:

- The occurrence of the species, as defined within the **Volume A5, Annex 5.1: Offshore and Intertidal Ornithology Baseline Characterisation Report**, in more than trivial numbers (where 'trivial' was single figures over the duration of the surveys) within the Hornsea Four Study Area, which included the site-specific data from the array area and 4 km buffer, wider data from the original Hornsea Four AfL and data collated through a desk study of the ECC and Cable Landfall area; and / or

- The species has been identified as sensitive to disturbance and displacement in relevant guidance (Bradbury et al. 2014; Furness and Wade 2012; Furness et al. 2013); and / or
- The species has been identified as sensitive to collision risk in relevant guidance (Bradbury et al. 2014; Furness and Wade 2012; Furness et al. 2013).

10.4.1.3 The determination of AEoI is based on the factors that contribute to the definition of maintaining integrity, namely that the ecological structure and function of the site is not adversely affected, that the ability of the habitat to sustain the bird species that are interest features is not adversely affected (i.e. that breeding, roosting and foraging locations are maintained and that food sources are maintained) and that the population of the interest feature is maintained both in numbers and across the area of the site.

10.4.1.4 Assessments also provide account of whether or not the conservation objectives for each SPA, described in more detail in **Appendix D**, assessed would be met when considering the level of potential effects predicted in this report. Where relevant, the long-term viability of the population has been assessed using population modelling in support of and to determine the outcome of such conclusions on the conservation objectives.

10.4.2 Description of Significance

10.4.2.1 A description of the significance of project level effects upon the receptors grouped under 'offshore ornithology', as relevant to the designated sites and their associated features screened in for LSE is provided below.

10.4.3 Construction and Decommissioning

Disturbance and Displacement

10.4.3.1 The potential for disturbance and displacement to result in an AEoI relates to the following designated sites and the relevant features:

- Greater Wash SPA; red-throated diver and common scoter during the non-breeding bio-season;
- Flamborough and Filey Coast SPA; gannet, guillemot, razorbill and puffin during the breeding and non-breeding bio-seasons;
- Coquet Island SPA; puffin during the breeding and non-breeding bio-seasons.
- Farne Islands SPA; guillemot during the non-breeding bio-season and puffin during the breeding and non-breeding bio-seasons; and
- Northumberland Marine SPA; guillemot during the non-breeding bio-season and puffin during the breeding and non-breeding bio-seasons.

10.4.3.2 The construction phase has the potential to affect birds in the marine environment through disturbance due to construction activities, including the installation of foundations, towers, blades, export cables and other infrastructure and the movement of vessels and helicopters. The disturbance created has the potential to result in displacement of birds from the site of construction, from an area around it and from routes used by vessels to access the construction site. This displacement would effectively result in temporary habitat loss through a reduction in the area available to birds for feeding, resting and moulting.

10.4.3.3 Any impacts resulting from disturbance and displacement from these activities are considered to be short-term, temporary and reversible in nature, lasting only for the duration of construction activity, as birds would return to the area once construction activities have ceased. Disturbance and displacement of birds during the construction phase is most likely to affect birds foraging in and around the construction area. The level of disturbance at each work location would differ dependent on the activities taking place, but there could be vessel movements at any time of day or night over the entire construction period.

10.4.3.4 There are a number of different measures used to assess bird disturbance and displacement from areas of sea in response to activities associated with an offshore wind farm. Garthe and Hüppop (2004) developed a scoring system for such disturbance factors, which is used widely in OWF EIAs. Furness and Wade (2012) developed disturbance ratings for particular species, alongside scores for habitat flexibility and conservation importance in Scottish waters. These factors were used to define an index value that highlights the sensitivity of a species to disturbance and displacement. As many of these references relate to disturbance from helicopter and vessel activities, these are considered relevant to this assessment. Bradbury et al. (2014) provided an update to the Furness and Wade (2012) paper to consider seabirds in English waters. More recently a joint SNCB interim displacement advice note (SNCBs 2017) provides the latest advice for UK development applications on how to consider, assess and present information and potential consequences of seabird displacement from OWFs.

10.4.3.5 Some species are more susceptible than others to disturbance from construction activities which may lead to subsequent displacement. Dierschke et al. (2016) noted both displacement and avoidance to varying degrees by some seabird species while others were attracted to offshore wind farms. Species such as divers have been noted to avoid shipping with one study identifying red-throated diver flushing at a median value of 400 m and a maximum value of 2 km (Bellebaum et al. 2006). Therefore, this species is considered further for the potential impact of displacement from cable laying vessels within the ECC during the construction phase of Hornsea Four. Gannet and auk species, in this instance guillemot, razorbill and puffin, have been noted to respond to OWF construction activities and be displaced as a consequence. Therefore, these species are considered further for the potential impact of displacement from the array area and species dependent differing degrees of buffers surrounding activities are applied in the assessment of the proposed construction phase of Hornsea Four.

10.4.3.6 The process for assessing displacement has been carried out for Hornsea Four based on a set of methods and results following a set of scenarios that recognise construction activities being restricted both temporally and spatially;

- Export cable laying activities being undertaken by only three vessels across the entire ECC;
- Construction activities being undertaken within only three to four blocks of 5 km^2 at any one time across the entire 468 km^2 array area;

- Any potential displacement is likely to only occur within the array area, where vessels and construction activities are present;
- Construction activities are restricted both temporally and spatially to approximately 3 years for a single phase of offshore construction, with individual elements being shorter' (see **Figure 3** of **Section 6.5**); and
- Large parts of the array area not being influenced by construction activities.

10.4.3.7 In recognition of the potential disturbance activities being of a lesser extent to that of an active offshore wind farm then the levels of displacement are also of lesser extent.

10.4.3.8 Few studies have provided definitive empirical displacement rates for the construction phase of offshore wind farm developments. Disturbance during construction phase is primarily centred around where construction vessels and piling activities are occurring with differences also seen for disturbance effects of non-operational versus operational turbines. For example, Krijgsveld et al. (2011) demonstrated higher flight paths of gannets next to operating vs non-operating turbines. Displacement rates for auks during construction have been shown to be either significantly lower or comparable to the operation phase (Royal Haskoning (2013) and Vallejo et al. (2017)). These studies would suggest that although the level of disturbance from construction activities can be high it is focussed around a limited area of the development site. Therefore, displacement rates for the entire site reflect reduced displacement within the site away from construction areas including areas where built non-operational turbines are present.

10.4.3.9 As actual rates of displacement during the construction of OWFs is difficult to determine from the available studies a proposed methodology was agreed with Natural England and the RSPB (OFF-ORN-2.13 **B1.1.1 Evidence Plan**). The method considers that as the construction phase of Hornsea Four is limited both spatially and temporarily, any potential impacts are unlikely to reach the same level as those estimated during the operational phase of Hornsea Four. Therefore, for the purpose of providing a precautionary approach to assessing the potential impacts on gannets and auks during the construction phase of Hornsea Four, it was agreed that the level to be used would be half that of the operational phase assessments.

10.4.3.10 Therefore, reference to the assessments within the operational and maintenance phase (**Section 10.4.4**) should be considered to understand the assessments for the construction phase in this section. The level of displacement for gannets and auk species are provided below:

- For gannet, consideration is provided to half of the operation and maintenance displacement rates (range of 60% to 80%), which is 30% to 40% displacement during the construction phase;
- For auk species (guillemot, razorbill and puffin) consideration is also provided to half of the operation and maintenance displacement rate of 50% displacement (with a range of 30% to 70%), which is 25% displacement (with a range of 15% to 35%) during the construction phase; and
- For gannet and auk species the level of mortality applied for this assessment is 1% of those displaced as impacts are temporally / spatially limited, though this is likely to be overly precautionary.

Precautionary Nature of Assessment

10.4.3.11 The assessments provided within this RIAA include a number of assumptions that contribute to the predicted impacts and potential effects being considered overly precautionary, including:

- The population assessed within each bio-season being the mean (or weighted mean; see **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis**) of the peaks from each survey year. This makes the assumption that such a high population is maintained for each of the months within the bio-season, whilst the actual abundance of each species is likely to be less than this for much of the bio-season;
- The maximum extent of displacement considered for each species is likely to be greater than actually experienced within the array area and buffer;
- The 1% mortality of birds displaced is highly unlikely, as the species assessed in this RIAA are not solely dependant upon the area within the Hornsea Four array area and buffer for all their foraging needs either within the breeding or non-breeding bio-seasons;
- That adult birds that are actively breeding will respond to displacement by putting themselves to further stress to the extent of dying rather than ceasing to breed (i.e. abandoning eggs or young) and surviving to breed in a later year; and
- Not all adult birds within the Hornsea Four array area and / or buffer will be from Flamborough and Filey Coast SPA.

10.4.3.12 For the purpose of this assessment the impacts from decommissioning are similar to and potentially less than those outlined in the construction phase. Therefore, they are not assessed in detail in this document, however the outcomes of the assessment are summarised in **Table 62**.

Greater Wash SPA – red-throated diver

10.4.3.13 Red-throated diver has been screened in for the assessment of the construction phase to assess the the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the SPA:

- Maintain the population of each of the qualifying features; and
- Maintain the distribution of qualifying features within the site.

10.4.3.14 Red-throated diver has been screened into the assessment of the construction phase on the basis of its sensitivity to vessel presence during the process of the export cable laying and in relation to those parts of the ECC in shallower water, closer to the coast, where red-throated diver are most likely to be found. Red-throated diver were not recorded in the Hornsea Four array area or 4 km buffer, so are not considered to be at risk from disturbance and displacement from the construction activities within the Hornsea Four array area.

10.4.3.15 The laying of the export cable between the array area and the cable landfall area for Hornsea Four would involve cable laying vessels being in situ for the entire offshore construction period of up to 36 months, potentially occurring in two consecutive non-breeding periods. Therefore, presence of the export cable laying vessel was identified as potentially displacing red-throated divers during the contruction phase of Hornsea Four.

10.4.3.16 The ECC route was selected so that it does not run directly through the Greater Wash SPA and as a result it avoids the areas known to hold the highest densities of this species (derived from an evaluation of the SeaMaST data set: Bradbury et al. 2014). In order to account for them potentially being within the ECC and a 2 km buffer, a separate method for estimating the potential abundance and density of this species was developed and agreed for use with Natural England (OFF-ORN 2.39 **B1.1.1 Evidence Plan**). The methods and corresponding data for red-throated diver within the ECC and 2 km buffer are presented in **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis**. Following the agreed methodology the data estimated and confirmed that red-throated diver occur in very low densities of between 0.004 and 0.005 birds per km^2. Based on the above densities it was estimated that between two and three red-throated divers would be present within a 2 km buffer of the cable laying vessel.

10.4.3.17 If a precautionary assessment is made assuming 100% displacement within the 2 km buffer area surrounding the cable laying vessel then between two and three red-throated divers would be displaced. With an assumed resultant mortality of 1% of displaced birds this would mean a maximum of 0.02 to 0.03 birds, which is less than a tenth of one bird. The Greater Wash SPA population is 1,407 individuals. Background annual survival of red-throated diver has been estimated as 0.84 (Robinson 2017). On this basis, 225 individuals out of the population of the Greater Wash SPA might be expected to die each year. The less than one individual identified above is a 0.04% increase in background mortality. This very small increase in mortality, that would be temporary given that it relates to the construction phase, would make no material difference to the long-term maintenance of the red-throated diver population of the Greater Wash SPA. Furthermore, such a trivial and inconsequencial effect on at most three red-throated divers, would not lead to a detectable change in the species distribution when considering the SPA population of 1,407 individuals throughout the area of sea within this SPA.

10.4.3.18 There is, therefore, no potential for an AEoI to the conservation objectives of the red-throated diver feature of Greater Wash SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, red-throated diver will be maintained as a feature in the long-term with respect to the potential for adverse effects from disturbance and displacement.

Greater Wash SPA – common scoter

10.4.3.19 Common scoter has been screened in for the assessment of the construction phase to assess the the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the SPA:

- Maintain the population of each of the qualifying features; and
- Maintain the distribution of qualifying features within the site.

10.4.3.20 Common scoter has been screened into the assessment of the construction phase on the basis of its sensitivity to vessel presence during the process of the export cable laying and in relation to those parts of the ECC in shallower water, closer to the coast, where common scoter are most likely to be found.

10.4.3.21 The laying of the export cable between the array area and the cable landfall area for Hornsea Four would involve cable laying vessels being in situ for the entire offshore construction period of up to 36 months, potentially occurring in two consecutive non-breeding periods.

10.4.3.22 In order to assess the potential impact on common scoter a displacement effect distance has to be determined. A 2 km buffer surrounding any cable laying vessel will be used to assess the extent of any displacement based on that being the agreed distance for red-throated diver and that common scoter is also known to be sensitive to disturbance by vessels.

10.4.3.23 The ECC does not run directly through the Greater Wash SPA and as a result it avoids the areas known to hold the highest densities of this species (derived from a visual evaluation of the common scoter density data that supported the classification of the Greater Wash SPA published in Lawson et al. 2016). An evaluation of that data confirmed that across the ECC common scoter occur in very low densities of between 0.00 and 0.70 birds per km^2. Although it is acknowledged that during passage periods common scoter may move up and down the coast in larger number than this, which may present higher densities on occasion as a result, they do not regularly occur in larger numbers and so any potential disturbance of such occurances from cable laying activities are deemed unlikely and if apparent on occasion would be of no consequence to the birds involved.

10.4.3.24 Based on the above typical densities it was estimated that in the ECC there would be between zero and nine common scoter present within a 2 km buffer of the cable laying vessel.

10.4.3.25 If on a worst-case basis the assessment is made assuming 100% displacement within the 2 km buffer area surrounding the cable laying vessel then between zero and nine common scoter would be displaced. With an assumed resultant mortality of 1% of displaced birds this would mean a maximum less than a tenth of one bird. The Greater Wash SPA population is 3,449 individuals. Background annual survival of common scoter has been estimated as 0.783 (Robinson 2017). On this basis 748 individuals out of the population of the Greater Wash SPA might be expected to die each year. The less than one tenth of an individual identified above is a 0.01% increase in background mortality. This level of potential mortality is beyond the limits of detection, would be temporary given that it relates to the construction phase and would make no material difference to the long-term maintenance of the common scoter population of the Greater Wash SPA. Furthermore, such a trivial and inconsequencial effect on at most nine common scoters, would not lead to a detectable change in the species distribution when considering the SPA population of 3,449 individuals throughout the area of sea within this SPA.

10.4.3.26 There is, therefore, no potential for an AEoI to the conservation objectives of the common scoter feature of Greater Wash SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, common scoter will be maintained as a feature in the long-term with respect to the potential for adverse effects from disturbance and displacement.

Flamborough and Filey Coast SPA – gannet

10.4.3.27 Gannet has been screened in for the assessment of the construction phase to assess the the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.3.28 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (NE, 2021b):

- Maintain the size of the breeding population at a level, which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts (Aitken et al. 2017).

10.4.3.29 The construction activities within the array area will be undertaken within only three to four works areas of 5 km^2 at any one time across the entire 468 km^2 array area and hence large parts of the array area will not be influenced by offshore construction activities over the approximate 36 month period.

10.4.3.30 In order to assess the potential impact on gannet, a displacement effect distance was determined to be within the array area and 2 km buffer, where construction activities are proposed to occur. Within that displacement effect area, the percentage of birds displaced was set as half that assessed in O&M phase (30 to 40% displacement) during all bio-seasons. The potential level of mortality consequential from construction displacement was set at a precuationary 1% during all bio-seasons.

10.4.3.31 The potential for impact on gannets from the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the migration-free breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max and mean max plus 1 SD foraging distances. Outside the migration-free breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the breeding bio-season the mean max foraging distance and the mean max plus 1 SD foraging distance from Woodward et al. (2019) determine which breeding colonies the birds may be apportioned to and in the non-breeding bio-seasons the information on populations contained in Furness (2015) is applied. Further details of the apportionment process for gannet to the FFC SPA can be found in **Section 10.4.4.42**.

Breeding Season

10.4.3.32 The number of gannets predicted to be displaced from the array area and a 2 km buffer is between 237 (237.24) and 316 (316.32) individuals (applying displacement rates of between 30% and 40%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at between two (2.37) and three (3.16) individuals. On the basis of 61% (**Section 10.4.4.42**) of all the birds predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at between one (1.45) and two (1.94) breeding adults.

10.4.3.33 When considering the potential impact of this loss to the FFC SPA (classified gannet population of 16,938 breeding adults, with an annual background mortality of 1,372 breeding adults), then using this prediction of one to two breeding adults suffering displacement consequent mortality would represent a 0.11% to 0.14% increase in baseline mortality. As the population of gannets has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 13,392 apparently occupied nests (or 26,784 breeding adults) (Aitken et al. 2017). On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of 2,170 breeding adults) then the prediction of between one to two breeding adults suffering displacement consequent mortality would represent a 0.07% to 0.09% increase in baseline mortality mortality in the migration-free breeding bio-season.

Non-breeding season

10.4.3.34 The number predicted to be displaced from the array area and a 2 km buffer (applying displacement rates of between 30% and 40%) in the return migration bio-season is between 71 (70.60) and 94 (94.13) individuals and in the post-breeding migration bio-season is 256 (256.33) and 316 (316.32) individuals (there is no migration free winter bio-season). The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.70 and 0.94) individual during the return migration bio-season and between two (2.56) and three (3.16) individuals during the post-breeding migration bio-season. On the basis of 6.23% (**Section 10.4.4.42)** of all the birds in the return migration bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at under one (0.04 to 0.06) breeding adult per annum. On the basis of 4.84% (**Section 10.4.4.42**) of all the birds in the post-breeding migration bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at under one (0.12 to 0.17) breeding adult per annum. This equates to a total consequent mortality from displacement across the entire non-breeding bio-season of less than one (0.17 to 0.22) breeding adult per annum.

10.4.3.35 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the FFC SPA during the non-breeding bio-season, then this represents only a slight increase of 0.01% in baseline mortality to the citation population or the 2017 population of FFC SPA.

Annual Total

10.4.3.36 The potential impact of displacement on gannets from the array area that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of one to two (1.45 to 1.94) adult birds from the FFC SPA in the migration-free breeding bio-season and less than one (0.17 to 0.22) adult bird from the FFC SPA in the non-breeding bio-seasons equates to less than two to two (1.62 to 2.16) breeding adults birds per annum across all bio-seasons for the planned duration of contruction activities. The consequent increase in mortality relative to the baseline mortality is 0.12% to 0.16% to the citation population or 0.07% to 0.10% to the 2017 population of FFC SPA per annum.

10.4.3.37 The conservation objective for the gannet feature of the FFC SPA is to maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts.

10.4.3.38 The addition of up to two possible breeding adult mortalities per annum equates to less than a 0.2% increase in baseline mortality when considering either the citation or the latest 2017 colony count. This level of impact would be indistinguishable from natural fluctuations in the population, especially considering the impacts from construction are both temporally and spatially limited. There is, therefore, no potential for an AEoI to the conservation objectives of the gannet feature of FFC SPA in relation to potential adverse disturbance and displacement effects from the construction phase of Hornsea Four alone and therefore, subject to natural change, gannet would be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – guillemot

10.4.3.39 Guillemot has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.3.40 Based on the above the conservation objective for the FFC SPA the specific target for the guillemot feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 41,607 breeding pairs (83,214 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 121,754 breeding adults based on the most recent 2017 colony count (Aitken et al. 2017).

10.4.3.41 The construction activities within the array area will be undertaken within only three to four work areas of 5 km^2 at any one time across the entire 468 km^2 array area and hence large parts of the array area will not be influenced by offshore construction activities over the approximate 36 month period.

10.4.3.42 In order to assess the potential impact on guillemot, a displacement effect distance was determined to be within the array area and surrounding 2 km. Within that displacement effect area, the percentage of birds displaced was set as half that assessed in O&M phase (25% displacement) during all bio-seasons and within the 2 km buffer. The potential level of mortality consequential from construction displacement was set at precautionary 1% during all bio-seasons.

10.4.3.43 The potential for impact on guillemots from the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max and mean max plus 1 SD foraging distances. Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. Further details of the apportionment process for guillemot to the FFC SPA can be found in **paragraph 10.4.4.57**.

Breeding Season

10.4.3.44 The number of guillemots predicted to be displaced from the array area and a 2 km buffer (applying a displacement rate of 25%) in the breeding bio-season is 2,138 (2138.31) individuals and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 21 (21.38) individuals. On the basis of 56% (**paragraph 10.4.4.57**) of all the birds predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at 12 (11.93) breeding adults.

10.4.3.45 When considering the potential impact of this loss to the FFC SPA (classified guillemot population of 83,214 breeding adults, with an annual background mortality of 5,076 breeding adults), then using this prediction of 12 breeding adults suffering displacement consequent mortality would represent a 0.24% increase in baseline mortality. As the population of guillemots has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 121,754 breeding adults (Aitken et al. 2017). On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of 7,427 breeding adults) then this prediction of 12 breeding adults suffering displacement consequent mortality would represent a 0.16% increase in baseline mortality mortality in the breeding bio-season.

Non-breeding Season

10.4.3.46 The number predicted to be displaced from the array area and a 2 km buffer (applying displacement rate of 25%) in the non-breeding bio-season is 4,265 (4,265.43) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 43 (42.65) individuals during the non-breeding bio-season. On the basis of 13% (**paragraph 10.4.4.57**) of all the birds in the non-breeding bio-season predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at six (5.59) breeding adults per annum.

10.4.3.47 When considering six breeding adults may be subject to displacement consequent mortality that can be attributed to the FFC SPA during the non-breeding bio-season then this represents only a slight increase of 0.11% or 0.08% in baseline mortality to the citation population or the 2017 population of FFC SPA, respectively.

Annual Total

10.4.3.48 The impact of displacement from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of 12 breeding adults from the SPA in the breeding bio-season and six breeding adults in the non-breeding bio-season, which equates to 18 (17.53) breeding adults per annum for the planned duration of contruction activities. The consequent increase in mortality relative to the baseline mortality is 0.35% when considering the citation population or increase of 0.24% when considering the more recent 2017 colony count per annum.

10.4.3.49 Should Natural England's range of displacement rates (applying a range of 15% and 35% displacement with a 1% mortality rate) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area plus 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of between 11 (10.52) and 25 (24.54) breeding adults from the FFC SPA per annum for the planned duration of contruction activities. This equates to a consequent increase in mortality relative to the baseline mortality of between 0.21% and 0.48% when considering the citation population or between 0.14% and 0.33% when considering the more recent 2017 colony count per annum.

10.4.3.50 The addition of between 11 and 25 possible additional breeding adult mortalities per annum (based on Natural England's range of displacement rates) equates to less than a 0.5% increase in baseline mortality when considering either the citation or the latest 2017 colony count. This level of impact would be indistinguishable from natural fluctuations in the population, especially considering the impacts from construction are both temporally and spatially limited. There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of FFC SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – razorbill

10.4.3.51 Razorbill has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.3.52 Based on the above the conservation objective for the FFC SPA the specific target for the razorbill feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 10,570 breeding pairs (21,140 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 40,506 breeding adults based on the most recent 2017 colony count (Aitken et al. 2017).

10.4.3.53 The construction activities within the array area will be undertaken within only three to four works areas of 5 km^2 at any one time across the entire 468 km^2 array area and hence large parts of the array area will not be influenced by offshore construction activities over the approximate 36 month period.

10.4.3.54 In order to assess the potential impact on razorbill a displacement effect distance was determined to be within the array area and surrounding 2 km buffer. Within that displacement effect area, the percentage of birds displaced was set as half that assessed in O&M phase (25% displacement) during all bio-seasons and within the 2 km buffer. The potential level of mortality consequential from construction displacement was set at a precautionary 1% during all bio-seasons.

10.4.3.55 The potential for impact on razorbills from the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the migration-free breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max and mean max plus 1 SD foraging distances. Outside of the migration-free breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the migration-free breeding bio-season the mean max foraging distance and the mean max plus 1 SD foraging distance from Woodward et al. (2019) determine which breeding colonies the birds may be apportioned to and in the non-breeding bio-seasons the information on populations contained in Furness (2015) is applied. Further details of the apportionment process for razorbill to the FFC SPA can be found in **paragraph 10.4.4.92**.

Breeding Season

10.4.3.56 The number predicted to be displaced from the array area and a 2 km buffer (applying a displacement rate of 25%) in the breeding bio-season is 69 (69.04) individuals and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.69) individual. On the basis of 56% (**paragraph 10.4.4.92**) of all the birds predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at less than one (0.39) breeding adult.

10.4.3.57 When considering the potential loss of less than one breeding adult to the FFC SPA (classified razorbill population of 21,140 breeding adults, with an annual background mortality of 2,220 breeding adults), then this prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.02% increase in baseline mortality. As the population of razorbills has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 40,506 breeding adults (Aitken et al. 2017). On this basis if all the birds predicted to be displaced were breeding adult birds from the FFC SPA (with an annual background mortality 4,253 breeding adults) then this prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.01% increase in baseline mortality in the breeding bio-season.

Non-breeding Season

10.4.3.58 The number predicted to be displaced from the array area and a 2 km buffer (applying displacement rate of 25%) in the return migration bio-season is 69 (69.04) individuals, in the post-breeding migration bio-season is 897 (897.47) individuals and in the migration-free winter bio-season is 119 (118.54) individuals. The predicted consequent mortality (applying a mortality rate of 1%) in the return migration bio-season is one (0.69) individual, in the post-breeding migration bio-season is nine (8.97) individuals and in the migration-free winter bio-season is one (1.18) individual. On the basis of 3.38% (**paragraph 10.4.4.100**) of all the birds in the migratory bio-seasons predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.03) breeding adult in the return migration bio-season and less than one (0.30) breeding adult in the post-breeding migration bio-season. On the basis of 2.74% (**paragraph 10.4.4.100**) of all the birds in the migration-free winter bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.03) breeding adult in the migration-free winter bio-season per annum. This equates to a total consequent mortality from displacement across the entire non-breeding bio-season of less than one (0.37) breeding adult per annum.

10.4.3.59 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the FFC SPA during the non-breeding bio-season, then this represents only a slight increase of 0.01% to 0.02% in baseline mortality to the citation population or the 2017 population of FFC SPA, respectively.

Annual Total

10.4.3.60 The impact of displacement from the array area and a 2 km buffer, that would occur throughout the construction phase of Hornsea Four, is a prediction of consequent mortality of less than one breeding adult from the SPA in the breeding bio-season and less than one breeding adult in the non-breeding bio-seasons equates to less than one (0.75) breeding adult per annum for the planned duration of contruction activities. The consequent increase in mortality relative to the baseline mortality is 0.03% when considering the citation population or 0.02% when considering the more recent 2017 colony count across all bio-seasons per annum.

10.4.3.61 Should Natural England's range of displacement mortality rates (applying a range of 15% and 35% displacement with a 1% mortality rate) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area plus 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of between less than one (0.45) to one (1.05) breeding adult from the FFC SPA per annum, for the planned duration of contruction activities. This equates to a consequent increase in mortality relative to the baseline mortality of between 0.02% and 0.05% when considering the citation population or 0.01% and 0.02% when considering the more recent 2017 colony count per annum.

10.4.3.62 The conservation objective for the razorbill feature of the FFC SPA is to maintain the size of the breeding population at a level which is above 10,570 breeding pairs (21,140 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 40,506 breeding adults based on the most recent 2017 colony count, with continued growth likely, based on the colony population trend presented in Aitken et al. (2017).

10.4.3.63 The addition of between less than one up to one possible additional mortality per annum (based on Natural England's range of displacement and mortality rates) equates to less than a 0.1% increase in baseline mortality when considering either the citation or the latest 2017 colony count. This level of impact would be indistinguishable from natural fluctuations in the population, especially considering the impacts from construction are both temporally and spatially limited. There is, therefore, no potential for an AEoI to the conservation objectives of the razorbill feature of FFC SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, razorbill will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – puffin

10.4.3.64 Puffin has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.3.65 Based on the above the conservation objective for the FFC SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 216,730 individuals, whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.3.66 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on puffin as a feature, but more as an important component of the seabird assemblage.

10.4.3.67 The construction activities within the array area will be undertaken within only three to four works areas of 5 km^2 at any one time across the entire 468 km^2 array area and hence large parts of the array area will not be influenced by offshore construction activities over the approximate 36 month period.

10.4.3.68 In order to assess the potential impact on puffin a displacement effect distance was determined to be within the array and 2 km surrounding the array area. Within that displacement effect area, the percentage of birds displaced was set as half that assessed in O&M phase (25% displacement) during all bio-seasons and within the 2 km buffer. The potential level of mortality consequential from construction displacement was set at a precautionary 1% during all bio-seasons.

10.4.3.69 The potential for impact on puffins from the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max and mean max plus 1 SD foraging distances. Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the breeding bio-season the mean max foraging distance and the mean max plus 1 SD foraging distance from Woodward et al. (2019) determine which breeding colonies the birds may be apportioned to and in the non-breeding bio-season the information on populations contained in Furness (2015) is applied. Further details of the apportionment process for puffin to the FFC SPA can be found in **paragraph 10.4.4.120**.

Breeding Season

10.4.3.70 The number of puffins predicted to be displaced from the array area and a 2 km buffer (applying a displacement rate of 25%) in the breeding bio-season is 38 (38.37) individuals and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.38) individual. On the basis of 89% (**paragraph 10.4.4.120**) of all the birds predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.34) breeding adult.

10.4.3.71 When considering the potential impact of less than one breeding adult to the FFC SPA population of 3,759 breeding adults based on the mean of the 2017 & 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with an annual background mortality of 336 breeding adults, then using this prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.10% increase in baseline mortality in the breeding bio-season.

Non-breeding Season

10.4.3.72 The number predicted to be displaced from the array area and a 2 km buffer (applying a displacement rate of 25%) in the non-breeding bio-season is 88 (88.21) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.88) individual during the non-breeding bio-season. On the basis of 0.41% (**paragraph 10.4.4.120**) of all the birds in the non-breeding bio-season predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at less than one (0.00) breeding adults per annum.

10.4.3.73 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the SPA during the non-breeding bio-season then this represents an increase of less than 0.01% to the baseline mortality of the mean of the 2017 / 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**) of the FFC SPA.

Annual Total

10.4.3.74 The potential impact of displacement on puffins from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality which equates to less than one (0.35) breeding adult per annum across all bio-seasons from the FFC SPA for the planned duration of contruction activities. The consequent increase in mortality relative to the baseline mortality of the 2017 / 2018 colony count (OFF-ORN-2.30 **B1.1.1 Evidence Plan**) is 0.10% across all bio-seasons per annum.

10.4.3.75 Should Natural England's range of displacement mortality rates (Applying a range of 15% and 35% displacement with 1% mortality) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area plus 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of less than one (0.21 to 0.48) breeding adult from the FFC SPA for all bio-seasons per annum. The increase in the baseline mortality of between 0.06% and 0.14% per annum when considering the mean of the 2017 / 2018 colony counts.

10.4.3.76 Puffin is a named feature within the seabird assemblage for the FFC SPA. The conservation objective of the seabird assemblage is to maintain an overall seabird assemblage population level of all species at the FFC SPA of 216,730 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.3.77 The possible loss of less than one breeding adult per annum would be indistinguishable from natural fluctuations in the population, especially considering the impacts from construction activities are both temporally and spatially limited. There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage, of which puffin is a named feature of FFC SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, the seabird assemblage will be maintained as a feature in the long term.

<u>Coquet Island SPA – puffin</u>

10.4.3.78 Puffin has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.3.79 Based on the above the conservation objective for the Coquet Island SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 47,662 individuals, whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.3.80 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on puffin as a feature, but more as an important component of the seabird assemblage.

10.4.3.81 Contextual information on the assessment of displacement effects on puffin are provided above (**paragraph 10.4.3.64**) in the account for the FFC SPA and for conciseness are not repeated here.

Breeding Season

10.4.3.82 In the breeding bio-season the number of puffins predicted to be displaced from the array area plus 2 km buffer is 38 (38.37) individuals (using a displacement rate of 25%). Of these individuals, the predicted consequent mortality from being displaced is estimated at less than one (0.38) individual (using a mortality rate of 1%). The Hornsea Four array area is beyond the mean-max foraging distance of 137.1 km to the Coquet Island SPA at 167 km but is within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). On a worst-case basis (which is highly unlikely given the presence of breeding birds from the closer Flamborough and Filey Coast SPA) if all the birds predicted to be displaced were breeding adult birds from the Coquet Island SPA (classified puffin population of 31,686 breeding adults, with an annual background mortality of 2,978 breeding adults), then a prediction of less than one (0.38) breeding adult suffering displacement consequent mortality would represent a 0.01% increase in baseline mortality. This is a worst-case prediction since not all birds occurring in the array area and buffer would be of adult breeding age and not all would come from the Coquet Island SPA.

Non-breeding Season

10.4.3.83 In the non-breeding bio-season the number of puffins predicted to be displaced from the array area plus a 2 km buffer (applying a displacement rate of 25%) is 88 (88.21) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.88) individuals during the non-breeding bio-season. On the basis of 5.32% (**paragraph 10.4.4.146**) of all the birds predicted to be displaced being breeding adult birds from the Coquet Island SPA, then the consequent mortality from being displaced is estimated at less than one (0.05) breeding adult per annum in the non-breeding bio-season.

10.4.3.84 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the Coquet Island SPA during the non-breeding bio-season, then this represents an increase of less than 0.01% in baseline mortality when considering the citation population of 31,686 breeding adults.

Annual Total

10.4.3.85 The annual predicted mortality of puffins attributed to the Coquet Island SPA is less than one (0.43) breeding adults across all bio-seasons per annum. This would represent an increase of 0.01% in baseline mortality when considering the citation population of 31,686 breeding adults.

10.4.3.86 Should Natural England's range of displacement mortality rates (applying a range of 15% and 35% displacement with 1% mortality) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of less than one (0.26 to 0.60) breeding adult consequent mortality from the SPA per annum across all bio-seasons. This would represent an increase of less than 0.01% to 0.02% in baseline mortality when considering the citation population of 31,686 breeding adults.

10.4.3.87 The potential loss of less than one breeding adult, is deemed so low as to be considered no material contribution to the natural baseline mortality rates of Coquet Island SPA, especially considering that construction activities are both temporally and spatially limited and the highly precautionary apportionment in the breeding bio-season. There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage, of which puffin is a named feature of Coquet Island SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, the seabird assemblage will be maintained as a feature in the long term.

Farne Islands SPA – guillemot

10.4.3.88 Guillemot has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the Farne Islands SPA:

- Maintain the population of each of the qualifying features.

10.4.3.89 Based on the above the conservation objective for the Farne Islands SPA the specific target for the guillemot feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 32,875 breeding pairs (65,750 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

10.4.3.90 Contextual information on the assessment of displacement effects on guillemot are provided above in the account on the FFC SPA and for conciseness are not repeated here.

10.4.3.91 This SPA at 198 km from Hornsea Four is outside both the mean max of 73.2 km and mean max plus 1 SD foraging range of 153.7 km (Woodward et al. 2019) for this species when attending a breeding colony and as a result no breeding bio-season assessment is required.

10.4.3.92 During the non-breeding bio-season the number predicted to be displaced from the array area and a 2 km buffer (applying displacement rate of 25%) is 4,265 (4,265.43) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 43 (42.65) individuals. On the basis of 3.73% (**paragraph 10.4.4.155**) of all the birds predicted to be displaced being breeding adult birds from the Farne Islands SPA, then the consequent mortality from being displaced is estimated at two (1.59) breeding adults in the non-breeding bio-season.

10.4.3.93 When considering two breeding adults may be subject to displacement consequent mortality that can be attributed to the Farne Islands SPA during the non-breeding bio-season, then this represents an increase of 0.02% in baseline mortality when considering the citation population of 65,751 breeding adults with a baseline mortality of 4,011 breeding adults per annum.

10.4.3.94 Should Natural England's range of displacement mortality rates (applying a range of 15% and 35% displacement with 1% mortality) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of between less than one (0.95) and two (2.23) breeding adults from the SPA in the non-breeding bio-season. This would represent and increase in baseline mortality of between 0.01% to 0.03%, when considering the citation population.

10.4.3.95 The potential loss of up to two breeding adults (based on Natural England's range of displacement and mortality rates) equates to 0.03% increase in baseline mortality when assessed against the citation population. This level of impact would be indistinguishable from natural fluctuations in the population, especially considering the impacts from construction are both temporally and spatially limited. There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of the Farne Islands SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Farne Islands SPA – puffin

10.4.3.96 Puffin has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.3.97 Based on the above the conservation objective for the Farne Islands SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 163,819 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.3.98 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on puffin as a feature, but more as an important component of the seabird assemblage.

10.4.3.99 Contextual information on the assessment of displacement effects on puffin are provided above in the account on the Farne Islands SPA and for conciseness are not repeated here.

Breeding Season

10.4.3.100 In the breeding bio-season the number of puffins predicted to be displaced from the array area plus 2 km buffer is 38 (38.37) individuals (using a displacement rate of 25%). Of these individuals, the predicted consequent mortality from being displaced is estimated at less than one (0.38) individual (using a mortality rate of 1%). The Hornsea Four array area is beyond the mean max foraging distance of 137.1 km to the Farne Islands SPA at 198 km but is within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). On a worst-case basis (which is highly unlikely given the presence of breeding birds from the closer FFC SPA) if all the birds predicted to be displaced were breeding adult birds from the Farne Islands SPA (classified puffin population of 76,798 breeding adults, with an annual background mortality of 7,219 breeding adults), then a prediction of less than one breeding adult suffering displacement consequent mortality would represent an increase of less than 0.01% in baseline mortality. This is a worst-case prediction since not all birds occurring in the array area and buffer would be of adult breeding age and not all would come from the Farne Islands SPA.

Non-breeding Season

10.4.3.101 In the non-breeding bio-season the number of puffins predicted to be displaced from the array area plus 2 km buffer (applying a displacement rate of 25%) is 88 (88.21) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.88) individuals during the non-breeding bio-season. On the basis of 17.23% (**paragraph 10.4.4.166**) of all the birds predicted to be displaced being breeding adult birds from the Farne Islands SPA, then the consequent mortality from being displaced is estimated at less than one (0.15) breeding adult per annum in the non-breeding bio-season.

10.4.3.102 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the Farne Islands SPA during the non-breeding bio-season, then this represents an increase of less than 0.00% in baseline mortality when considering the citation population of 76,798 breeding adults.

Annual Total

10.4.3.103 The annual predicted mortality of puffins attributed to the Farne Islands SPA is less than one (0.54) breeding adult across all bio-seasons per annum. This would represent an increase of less than 0.01% in baseline mortality when assessed against the citation population of 76,798 breeding adults.

10.4.3.104 Should Natural England's range of displacement mortality rates (applying a range of 15% and 35% displacement with 1% mortality) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of less than one (0.32 to 0.75) breeding adult from the SPA per annum across all bio-seasons. This would represent an increase of 0.01% in baseline mortality when considering the citation population of 76,798 breeding adults.

10.4.3.105 The potential loss of less than one breeding adult, is deemed so low as to be considered no material contribution to the natural baseline mortality rates of the Farne Islands SPA, especially considering that construction activities are both temporally and spatially limited and the highly precautionary apportionment in the breeding bio-season. There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage, of which puffin is a named feature of the Farne Islands SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, the seabird assemblage will be maintained as a feature in the long term.

Northumberland Marine SPA – guillemot

10.4.3.106 Guillemot has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the Northumberland Marine SPA:

- Maintain the population of each of the qualifying features.

10.4.3.107 Based on the above the conservation objective for the Northumberland Marine SPA the specific target for the guillemot feature is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 65,751 individuals, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

10.4.3.108 Although guillemots within the Northumberland Marine SPA are from the Farne Islands SPA, for the purpose of this assessment they have been considered separately for completeness.

10.4.3.109 Contextual information on the assessment of displacement effects on guillemot are provided above in the account on the FFC SPA and for conciseness are not repeated here.

10.4.3.110 This SPA at 187 km from Hornsea Four is outside both the mean max of 73.2 km and mean max plus 1 SD foraging range of 153.7 km (Woodward et al. 2019) for this species when attending a breeding colony and as a result no breeding bio-season assessment is required.

10.4.3.111 During the non-breeding bio-season the number predicted to be displaced from the array area and a 2 km buffer (applying displacement rate of 25%) is 4,265 (4,265.43) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 43 (42.65) individuals. On the basis of 3.73% (**paragraph 10.4.4.155**) of all the birds predicted to be displaced being breeding adult birds from the Northumberland Marine SPA, then the consequent mortality from being displaced is estimated at two (1.59) breeding adults in the non-breeding bio-season.

10.4.3.112 When considering two breeding adults may be subject to displacement consequent mortality that can be attributed to the Northumberland Marine SPA during the non-breeding bio-season, then this represents an increase of 0.02% in baseline mortality when considering the citation population of 65,751 breeding adults with a baseline mortality of 4,011 breeding adults per annum.

10.4.3.113 Should Natural England's range of displacement mortality rates (applying a range of 15% and 35% displacement with 1% mortality) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of between less than one (0.95) and two (2.23) breeding adults from the SPA in the non-breeding bio-season. This would represent and increase in baseline mortality of between 0.01% to 0.03%, when considering the citation population.

10.4.3.114 The potential loss of up to two breeding adults (based on Natural England's range of displacement and mortality rates) equates to 0.03% increase in baseline mortality when assessed against the citation population. This level of impact would be indistinguishable from natural fluctuations in the population, especially considering the impacts from construction are both temporally and spatially limited. There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of the Northumberland Marine SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Northumberland Marine SPA – puffin

10.4.3.115 Puffin has been screened in for the assessment of the construction phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.3.116 Based on the above the conservation objective for the Northumberland Marine SPA the specific target for puffin is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of puffin at a level, which is above 108,484 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.3.117 Although puffins within the Northumberland Marine SPA are from Coquet Island SPA (31,686 breeding adults) and the Farne Islands SPA (76,798 breeding adults), for the purpose of this assessment they have been considered together within the Northumberland Marine SPA for completeness (total 108,484 breeding adults).

10.4.3.118 Contextual information on the assessment of displacement effects on puffin are provided above in the account on the FFC SPA and for conciseness are not repeated here.

Breeding Season

10.4.3.119 In the breeding bio-season the number of puffins predicted to be displaced from the array area plus 2 km buffer is 38 (38.37) individuals (using a displacement rate of 25%). Of these individuals, the predicted consequent mortality from being displaced is estimated at less than one (0.38) individual (using a mortality rate of 1%). The Hornsea Four array area is beyond the mean max foraging distance of 137.1 km to the Northumberland Marine SPA at 187 km but is within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). On a worst-case basis (which is highly unlikely given the presence of breeding birds from the closer FFC SPA) if all the birds predicted to be displaced were breeding adult birds from the Northumberland Marine SPA (classified puffin population of 108,484 breeding adults, with an annual background mortality of 10,197 breeding adults), then a prediction of less than one breeding adult suffering displacement consequent mortality would represent an increase of less than 0.01% in baseline mortality. This is a worst-case prediction since not all birds occurring in the array area and buffer would be of adult breeding age and not all would come from the Northumberland Marine SPA.

Non-breeding Season

10.4.3.120 In the non-breeding bio-season the number of puffins predicted to be displaced from the array area plus 2 km buffer (applying a displacement rate of 25%) is 88 (88.21) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.88) individuals during the non-breeding bio-season. As the two puffin colonies within the Northumberland Marine SPA sit within two separate SPAs these are addressed separately initially in order to estimate the potential levels of displacement mortality. On the basis of 17.23% (**paragraph 10.4.4.166**) of all the birds predicted to be displaced being breeding adult birds from the Farne Islands SPA, then the consequent mortality from being displaced is estimated at less than one (0.15) breeding adult per annum in the non-breeding bio-season. On the basis of 5.32% (**paragraph 10.4.4.146**) of all the birds predicted to be displaced being breeding adult birds from the Coquet Island SPA, then the consequent mortality from being displaced is estimated at less than one (0.05) breeding adult per annum in the non-breeding bio-season. Therefore, the total the consequent mortality from being displaced for the Northumberland Marine SPA is estimated at less than one (0.20) breeding adult per annum in the non-breeding bio-season.

10.4.3.121 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the Northumberland Marine SPA during the non-breeding bio-season, then this represents an increase of less than 0.00% in baseline mortality when considering the citation population of 108,484 breeding adults.

Annual Total

10.4.3.122 The annual predicted mortality of puffins attributed to the Northumberland Marine SPA is less than one (0.58) breeding adult across all bio-seasons per annum. This would represent an increase of less than 0.01% in baseline mortality when assessed against the citation population of 108,484 breeding adults.

10.4.3.123 Should Natural England's range of displacement mortality rates (applying a range of 15% and 35% displacement with 1% mortality) as detailed in **paragraph 10.4.3.9** be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the construction phase of Hornsea Four is a prediction of consequent mortality of less than one (0.35 to 0.82) breeding adult from the SPA per annum across all bio-seasons. This would represent an increase of less than 0.01% to 0.01% in baseline mortality when considering the citation population of 108,484 breeding adults.

10.4.3.124 The potential loss of less than one breeding adult, is deemed so low as to be considered no material contribution to the natural baseline mortality rates of the Northumberland Marine SPA, especially considering that construction activities are both temporally and spatially limited and the highly precautionary apportionment in the breeding bio-season. There is, therefore, no potential for an AEoI to the conservation objectives of the puffin feature of the Northumberland Marine SPA in relation to disturbance and displacement effects in the construction phase from Hornsea Four alone and therefore, subject to natural change, puffin will be maintained as a feature in the long term.

10.4.4 Operation and Maintenance

Disturbance and Displacement

10.4.4.1 The potential for disturbance and displacement to result in an AEoI relates to the following designated sites and the relevant features:

- Greater Wash SPA; red-throated diver and common scoter during the non-breeding bio-season;
- Flamborough and Filey Coast SPA; gannet, guillemot, razorbill and puffin during the breeding and non-breeding bio-seasons;
- Coquet Island SPA; puffin during the breeding and non-breeding bio-seasons;
- Farne Islands SPA; guillemot during the non-breeding bio-season and puffin during the breeding and non-breeding bio-seasons;
- Northumberland Marine SPA; guillemot during the non-breeding bio-season and puffin during the breeding and non-breeding bio-seasons;
- St Abb's Head SPA; guillemot and razorbill during the non-breeding bio-season;
- Forth Islands (UK) SPA; guillemot, razorbill and puffin during the non-breeding bio-season;
- Outer Firth of Forth and St Andrew's Complex pSPA; guillemot and puffin during the non-breeding bio-season;
- Fowlsheugh SPA; guillemot and razorbill during the non-breeding bio-season;
- Buchan Ness to Collieston Coast SPA; guillemot during the non-breeding bio-season;
- Troup, Pennan and Lion's Heads SPA; guillemot and razorbill during the non-breeding bio-season;
- East Caithness Cliffs SPA; guillemot and razorbill during the non-breeding bio-season;
- North Caithness Cliffs SPA; guillemot, razorbill and puffin during the non-breeding bio-season;
- Copinsay SPA; guillemot during the non-breeding bio-season;
- Hoy SPA; guillemot and puffin during the non-breeding bio-season;

- Marwick Head SPA; guillemot during the non-breeding bio-season;
- Rousay SPA; guillemot during the non-breeding bio-season;
- Calf of Eday SPA; guillemot during the non-breeding bio-season;
- West Westray; guillemot and razorbill during the non-breeding bio-season;
- Fair Isle SPA; guillemot, razorbill and puffin during the non-breeding bio-season;
- Sumburgh Head SPA; guillemot during the non-breeding bio-season;
- Noss SPA; guillemot and puffin during the non-breeding bio-season;
- Foula SPA; guillemot, razorbill and puffin during the non-breeding bio-season; and
- Hermaness, Saxa, Vord and Valla Field SPA; guillemot and puffin during the non-breeding bio-season.

10.4.4.2 The presence of WTGs has the potential to directly disturb and displace seabirds that would normally reside within and around the area of sea where Hornsea Four is proposed to be developed. This in effect represents indirect habitat loss, which would potentially reduce the area available to those seabirds to forage, loaf and / or moult that currently occur within and around Hornsea Four and may be susceptible to displacement from such a development. Displacement may contribute to individual birds experiencing fitness consequences, which at an extreme level could lead to the mortality of individuals.

10.4.4.3 Seabird species vary in their response to the presence of operational infrastructure associated with offshore wind farms, such as WTGs and shipping activity related to maintenance activities. Offshore wind farms are a relatively new feature in the marine environment and as a result there is limited evidence as to the effects of disturbance and displacement by operational infrastructure in the long-term.

10.4.4.4 Garthe and Hüppop (2004) developed a scoring system for such disturbance factors, which has been widely applied in offshore wind farm HRAs. Furness and Wade (2012) developed a similar system with disturbance ratings for particular species that was applied alongside scores for habitat flexibility and conservation importance to define an index value that highlights the sensitivity of each species to disturbance and displacement.

10.4.4.5 Natural England and JNCC issued a joint Interim Displacement Guidance Note (Natural England and JNCC 2012), which provides recommendations for presenting information to enable the assessment of displacement effects in relation to offshore wind farm developments. This has been superseded recently by a joint SNCB interim displacement advice note (SNCBs 2017), which provides the latest advice for UK development applications on how to consider, assess and present information and potential consequences of seabird displacement from offshore wind farms. These guidance notes have shaped the assessment provided for each site and their interest features presented below.

10.4.4.6 The detailed methods and results of the displacement assessment are presented in **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis**.

10.4.4.7 Of the species identified, it was agreed in principle, that four species would be the focus for displacement through the EP process (OFF-ORN-2.10 **B1.1.1 Evidence Plan**). These are; gannet, guillemot, razorbill and puffin. For each of these four species an evidence led approach to quantifying the level of displacement led to the following rates of displacement being used at this stage to determine the overall number of birds within the areas defined as most appropriate for each species. Commentary on the remaining two species, red throated diver and common scoter, is provided in **paragraph 10.4.3.16**.

Gannet

10.4.4.8 Gannets show a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004 and Furness & Wade, 2012). A study by Krijgsveld et al. (2011) using radar and visual observations to monitor the post-construction effects of the Offshore Windpark Egmond aan Zee (OWEZ) established that 64% of gannets avoided entering the wind farm (macro-avoidance). The results of the post-consent monitoring surveys for Thanet OWF found that gannet densities reduced within the site in the third year, but the report did not quantify this (Royal HaskoningDHV 2013). For the purpose of this assessment the level of displacement considered during the non-migratory breeding bio-season is between 60% to 70% within the Hornsea Four array area and 2 km buffer. A more recent study by APEM (APEM 2014) provided evidence that during their migration most gannets would avoid flying into areas with operational WTGs (macro-avoidance), with the estimated macro avoidance being 95%. For the purpose of this assessment the level of displacement considered across all bio-seasons is between 60% to 80%, accepted by Natural England as appropriate rates for assessment purposes (OFF-ORN-2.43 **B1.1.1 Evidence Plan**).

10.4.4.9 A mortality rate of 1% was selected for this assessment, based on expert judgement supported by additional evidence that suggests that gannet have a large mean max (315 km) and maximum (709 km) foraging range (Woodward et al. 2019) and feed on a variety of different prey items that provide sufficient alternative foraging opportunities despite the potential loss of habitat within the Hornsea Four array area.

Auk species

10.4.4.10 Auk species (guillemot, razorbill and puffin) show a medium level of sensitivity to ship and helicopter traffic (Garthe and Hüppop 2004; Furness and Wade 2012; Langston 2010; and Bradbury et al. 2014). Studies on auk displacement in response to OWFs have previously been summarised by Dierschke et al. (2016). This review summarised evidence of auk displacement obtained from studies of 20 different European OWF sites that compared changes in seabird abundance between baseline and post-construction. The review concluded that the mean outcome across all OWFs for auks was 'weak displacement' but highly variable. Since the publication of the Dierschke et al. (2016) review, there have been a number of additional OWF sites which have reported displacement effects on auks (APEM 2017; Webb et al. 2017; Vanermen et al. 2019; Peschko et al. 2020; MacArthur Green 2021). Furthermore, previously published datasets from three OWF sites have recently been re-analysed utilising a novel modelling approach, which has resulted in different displacement effects being concluded for some (R-INLA; Zuur 2018; Leopold et al. 2018).

10.4.4.11 A comprehensive review has been undertaken by APEM (2021a) of all post-construction monitoring studies undertaken to date within the North Sea and UK Western Waters as summarised in **Table 12**. The aim of the review was to provide the latest reported displacement rates from OWF sites and to better understand what factors might be influencing the varying degree of displacement reported at different operational OWFs.

The review's objective to provde a more empirical approach (rather than the previous speculative displacement rate range) for auk assessments for this report and to better understand the likely consequence of displacement in terms of consequential mortality. The key findings from this review are summarised below. It is important to note that auk displacement effects vary considerably, within different study sites showing attraction, no significant effect or a displacement effect. The studies included: one OWF with positive displacement effects, eight OWFs with no significant effects or weak displacement effects, three with inferred displacement effects (but not statistically tested) and eight with negative displacement effects. The displacement effects from those studies which provided a defined displacement rate ranged from +112% to -75%.

10.4.4.12 Examination of the analysis methods used for these studies, together with the quality of the datasets gathered, suggests that not all predicted displacement effects are equally robust. Some studies have not utilised the most appropriate statistical modelling methods for the data collected, indeed many sites with predicted high displacement rates have low or very low auk abundance. These studies have high numbers of zero counts, making displacement rate prediction highly problematic given natural spatial and temporal variation in auk abundance and distribution. As such, the displacement effects reported in these studies are most likely unreliable. For example, the independent re-analysis of the data for Prinses Amalia and Egmond aan Zee OWFs, which previously reported significant displacement effects, was not able to detect a significant effect using R-INLA analysis (Zuur 2018). Furthermore, Zuur (2018) considered that previously reported displacement effects at Alpha Ventus, Blighbank, Thorntonbank and Horns Rev OWFs, may be misleading since the high-level of zero-inflation in their datasets precluded their re-analysis using R-INLA. These OWFs constitute the majority of the reported displacement rates for auks of up to 75%, so when considering the findings of Zuur (2018), they should be considered with caution and not presented as strong evidence in support of high displacement effects. It has previously been suggested that high displacement rates are associated with those OWF sites which are small in size and/or with a high-density WTG layout. However, other OWF sites such as Robin Rigg and North Hoyle of similarly small sizes with similar densities of WTGs have shown little or no avoidance effects (Vallejo et al. 2017; and PMSS 2007). Indeed, Prinses Amalia OWF is a relatively high WTG density site and after a re-analysis of these data (Zuur 2018) it was predicted to have had no displacement effect, which would suggest that WTG density may not be a predominant factor influencing displacement rates in auks. Indeed, the data presented in **Table 12** suggest that there is no clear correlation of displacement effects with current WTG density layouts at OWF.

Table 12: Published evidence of auk (guillemot and razorbill) displacement.

Offshore wind farm	Predicted displacement rate	No. years pre-construction data	No. years operational data	Period included in analysis	Array density (turbines/km^2)	Operational array mean peak density (n/km^2)[12]
Beatrice	NSE	1	1	May-Jul	1.56	100/6.0
Thanet	NSE	1	3	Oct-Mar	2.86	11.6/2.6
Westermost Rough	NSE	N/A[5]	N/A[5]	July	1.00	(10.5)
North Hoyle	(+)/<25%[3]	<1[winter]	3	All Months	3.11	8.9/4.8
Robin Rigg	NSE[1]	2[4]	3	All Months	3.16	5.1/4.1
Lincs	NSE	3	3	All Months	2.14	(5.0)
Prinses Amalia	NSE[2]	1.5[6]	3	Sept-Mar	4.30	4.1/1.9
Egmond aan Zee	NSE[2]	1.5[6]	4	Sept-Mar	1.30	4.1/1.9
Helgoland Cluster & Butendiek	63%/44%[11]	14	3	All Months	2.65 1.36 2.01 2.56	n/a
Thornton Bank Phase I, II, II	60%	2-10[10]	6	All Months[9]	2.71	3.0/1.0
Bligh Bank (Belwind)	75%	2-10[10]	4.5	All Months[9]	3.24	2.0/2.5
BARD 1	(-)	2	1	All Months	1.36	2.5/-
Alpha Ventus	75%	N/A[7]	3	All Months	3.05	(<2)[8]
Kentish Flats	NSE	3	2	All Months[9]	3.02	(<1)[8]
Gunfleet Sands	(-)	1	1	Oct-Mar	3.04	<1/-
Horns Rev 1	(-)	N/A[7]	1	Jan-Apr	3.87	(<1)
Horns Rev 2	(-)	2	1	Oct-Apr	2.74	(<1)

NSE; non significant effect. [1]weak displacement effect predicted after re-analysis; [2]displacement effects shown to be statistically non-significant after re-analysis; [3]a positive displacement effect was predicted however a weak (<25%) negative displacement rate was also compatible with the data; [4]surveys not conducted in consecutive years (2001/2 and 2004) and a minimum of six years prior to operation; [5]gradient analysis conducted with data from three surveys conducted in July during second year of operation; [6]pre-construction surveys cover two winter seasons; [7]inside/outside wind farm analysis was conducted; [8]density not provided but estimated at less than two from count data; [9]displacement effects are representative of the winter season only due to low/zero counts during other periods; [10]monthly surveys covering two to 10 years for different months; [11]non-breeding and breeding displacement effects, [12] mean peak density shown at species level for guillemot and razorbill or shown in brackets when given at auk group level. respectively. Sources: Beatrice: MacArthur Green 2021; Thanet: Percival, 2013; Westermost Rough: APEM, 2017; North Hoyle: PMSS, 2007; Robin Rigg: Vallejo et al., 2017, Zuur, 2018; Lincs: Webb et al., 2017; Prinses Amalia: Leopold et al 2013, Zuur 2018; Egmond aan Zee: Leopold et al 2013, Zuur 2018; Helgoland Cluster & Butendiek: Peschko et al., 2020; Thornton Bank: Vanermen et al., 2019; Bligh Bank: Vanermen et al., 2019; BARD 1: Braasch et al., 2015: Alpha Ventus: Welcker and Nehls, 2016; Kentish Flats: Gill et al., 2008; Gunfleet Sands: Percival, 2010; Horns Rev 1: Petersen and Fox 2007; Horns Rev 2: Petersen et al 2014.

10.4.4.13 These data would suggest that OWF sites that have moderate to high auk abundance (e.g. densities of ≥5/km^2), tend to have reported displacement effects that are non-significant or weak as demonstrated from the analysis of data from Robin Rigg, Westernmost Rough, North Hoyle, Lincs and Thanet OWFs. The higher and variable displacement rates demonstrated by some OWF sites seem to be related to low abundance and may to be artefacts of the analysis method being incapable of incorporating low abundances and/or high zero inflation within the dataset. Therefore, displacement effects appear to be related to the importance of the respective area for auks with regard to breeding, migrating and moulting. For example, in an area of high auk density competition for food between birds is greater, and individual birds may become more tolerant of any real or perceived disturbance from an OWF. In locations of low auk density, birds select habitat with sufficient prey, but as competition for food between birds is reduced, they can also select areas where real or perceived disturbance is low. This may in part explain the highly variable displacement effects reported between OWF sites, especially in North Sea waters between the UK and mainland Europe. These data show no evidence that displacement effects are predominantly correlated to WTG density or size of the OWF, as suggested in earlier studies.

10.4.4.14 Study design is critical to the statistical power to detect change but is often not adequate for this purpose (Degraer et al. 2012). The power to detect change from survey data alone is related to the frequency of surveys, their temporal extent and spatial coverage (Maclean et al. 2013). The number of years of data that may be needed to be able to demonstrate statistically significant changes (due to 'natural' year-to-year fluctuations in populations), has been suggested to be more than the three-year monitoring studies often employed (Vanerman et al. 2013). Unless declines are substantial (e.g. in excess of 50%) or survey effort is considerable (e.g. > 80 surveys), the likelihood of being able to detect declines is likely to be low (Maclean et al. 2013).

10.4.4.15 The inability to detect changes in abundance should not be taken to mean that no changes are occurring, particularly since **Table 12** shows the majority of studies have three or fewer years of monitoring data. Therefore, until further monitoring data are collected and analysed at OWF sites, a precautionary approach would be to assign a displacement rate of up to 50% for auks at sites which currently report no significant displacement effects. The higher displacement rates reported from German and Belgium OWFs with low auk abundance and poor displacement rate accuracy (48-78% reported after explorative INLA analysis for Thorntonbank OWF) would not be suitable sites for predicting auk displacement rates for Hornsea Four. This is on the basis of two important considerations, firstly, some of the reported higher displacement rates from sites of low auk abundance are likely to be artefacts of analysis[61]. Secondly, that the Hornsea Four site displays a moderate auk density similar to sites such as Beatrice, Thanet, Westermost Rough and North Hoyle, and a predominant factor in predicting displacement rate appears to be auk density therefore, low auk abundance OWF sites would not be reflective of auk behaviour at Hornsea Four. A displacement rate of 50% for auks would therefore be the most applicable and precautionary for Hornsea Four using this evidence-led approach. This would be on the basis that comparable sites to Hornsea Four should be based primarily on comparable (moderate to high) abundance levels of auks in OWF areas to predict behavioural responses.

[61] An artefact of the analysis is a result of an unsuitable investigative procedure, in this case a statistical test that is not appropriate for the data set in question (Zuur 2018)

10.4.4.16 Therefore, whilst in conclusion there is robust evidence to support an auk displacement rate of up to 50% within the Hornsea Four array area as an upper limit, it is still considered as precautionary as this level of displacement is also applied to the 2 km buffer.

Effects of Displacement on Auk Mortality

10.4.4.17 Current evidence suggests that the response of seabirds to OWFs varies depending on the species and of life stage of the individual birds. Birds that avoid OWFs may do so entirely, including an area considered to be a buffer around an OWF or do so partially. Avoidance of OWFs may be either on a spatial scale or temporally according to levels of competition outside the OWF or prey abundance within the OWF. Habitat loss is ultimately considered to be the consequence of these avoidance behaviours and therefore, a major challenge is understanding how displacement from OWF habitat may impact upon population processes.

10.4.4.18 Displacement effects may act at differing levels, including the individual, colony and population levels and are dependent on key factors:

- The importance of the area to be occupied by the OWF in context to the surrounding area;
- The fraction of the colony/population utilising the area of the OWF;
- The degree (number of birds and distance) of displacement by the OWF; and
- The consequences of habitat loss (in terms of the survival probability and productivity) as a result of the OWF.

10.4.4.19 Mortalities are likely to correlate strongly with the quality of the habitat lost; if key foraging habitat is lost and the remaining habitat is already close to carrying capacity, then the mortality rates of displaced birds may be considerably higher (Busche and Garthe, 2016).

10.4.4.20 The appropriateness of using mortality rates as high as 10% in assessments is unclear, given the lack of evidence, though UK SNCBs regularly advise the use of a range of 1–10% mortality based on expert opinion (Natural England, 2014) for guillemots and other auk species. In contrast, environmental consultants working on behalf of Developers have claimed that 1% or 2% mortality is more appropriate (Norfolk Boreas Limited, 2019; SPR, 2019; Orsted 2018), though these were also almost entirely based on expert judgement. The lack of empirical evidence previously considered led to the 1-10% mortality rate range prediction continuing to be used despite it being a 'best guess' to allow for precaution. This was evident following consultation with seabird experts, such as stated by Allen (2013), in the JNCC expert statement on ornithological issues for East Anglia One OWF. At that time there was currently no data (even anecdotal) with which to support the reliable selection of mortality rates stemming from varying levels of displacement. However, since Natural England's interim advise on auk mortality rates was issued and updated in 2017 (SNCBs 2017) there have been two detailed studies with updates to predict the fate or population consequence of displaced seabirds, including auks, from OWFs (Searle et al., 2014 and 2018, and van Kooten et al., 2019), and anecdotal evidence of implied low additional mortality rates from auk colony stability on Helgoland, where OWFs have been operating in the area since 2014 and auk displacement rates of 44-63% have been reported under the Helgoland OWF cluster and Butendiek (Peschko et al., 2020).

10.4.4.21 Van Kooten et al., (2019) applied an assessment method to estimate full life cycle, North Sea population effects caused by OWF-induced habitat loss. The study included assessment of two auk species, razorbill and guillemot, for the non-breeding season and included all existing and planned North Sea OWFs as presented in van der Wal et al., (2018). The analysis consisted of habitat quality maps based on seabird distribution data and determining the cost of habitat loss using an individual based energy-budget model. Together the potential cost of habitat loss in terms of reduced survival rates of bird redistribution, due to a change in the availability and configuration of the foraging area under OWF scenarios, were calculated. Two mortality rates were tested; the first based on the Individual Based Model (IBM), using an energy budget approach to quantify this effect and the outputs from the Habitat Utilization Maps (HUMs); the second based on a precautionary 10% mortality rate. Displacement rates were set at a realistic maximum of 50% based on Dierschke et al., (2016) or an overly precautionary 100% in order to understand complete displacement. The modelling process assumes individual birds have an amount of energy available at any particular time and have an intake of energy and incur energetic costs over time. Utilising the values in the habitat maps calculates energetic gain or losses of moving to different locations to produce a frequency distribution of survival probabilities.

10.4.4.22 The Van Kooten et al., (2019) study demonstrated that an additional 1% mortality for displaced auks is a more appropriate evidence-based rate that would still be considered precautionary considering the additional monthly mortality rates modelled by the study which translate to an additional non-breeding season mortality rate for displaced auks of 0.1% for a 50% displacement rate and 0.4% for a 100% displacement rate(van Kooten et al., 2018) and that a 10% mortality rate is overly precautionary.

10.4.4.23 Searle et al., (2014) presented what is still considered to be the most comprehensive assessment of the effects of displacement and barrier effects from OWFs on breeding seabirds. The study developed time and energy models of foraging during the chick-rearing period to estimate the population consequences of displacement from proposed OWF developments for key species of seabirds, including guillemot and razorbill, breeding at local SPAs.

10.4.4.24 The Searle et al., (2014) model simulated foraging decisions of individual seabirds under the assumption that they were acting in accordance with optimal foraging theory. Each individual selected a suitable location for feeding during each foraging trip from the colony based on bird density maps and that the foraging behaviour of individual seabirds was driven by prey availability, travel costs, provisioning requirements for offspring, and behaviour of conspecifics. The impacts of the proposed OWFs were assessed by comparing simulated values of adult and chick survival in models that included the OWFs against the baseline simulations. The scenarios run reflected possible assumptions regarding food availability (good, moderate or poor), the spatial distribution of prey (homogeneous or heterogeneous), the percentage of birds affected by barrier and displacement effects. The final simulations assumed moderate food availability, a 1 km buffer around each OWF, and that 60% of birds experienced displacement and barrier effect, which may be considered to be the most similar model to conditions at Hornsea

Four. The results did not show evidence of declines in adult survival of more than 0.5% for razorbills or guillemots.

10.4.4.25 The results of the Searle et al., (2014) model simulations consistently yielded estimated OWF effects on adult survival that corresponded to declines of less than 0.5% for guillemot and razorbill. For guillemot and razorbill estimated additional mortality from individual OWFs ranged from 0.04% to 0.3% and 0.01% to 0.11%, respectively, therefore considerably lower than the current minimum applied of 1% mortality. Searle et al., (2018) further developed a tool that uses a simulation model, which extends the simulation model developed by Searle et al. (2014), to predict the time and energy budgets of breeding seabirds and translates these into projections of adult annual survival and productivity (i.e., chick survival/mortality).

10.4.4.26 In summary, Searle et al., (2014) provides evidence that changes in time and energy budgets, in relation to guillemot and razorbill, as a result of displacement from OWFs has the potential to impact on the body condition, and future survival prospects. Such changes may also reduce breeding success if provisioning rate declines result in offspring starvation, or if the extended time required for foraging results in temporary unattendance of eggs or young, which increases the likelihood of mortality from predation or exposure. OWFs located on favoured foraging habitats that force birds to forage at greater densities in sub-optimal habitats were found to have the highest impact. However, studies using simulation models of time and energy budgets for auks during the breeding and non-breeding season conclude that these displacement effects, even at their highest impacts, are unlikely to exceed an additional 0.5% in mortality and that a 1% additional mortality rate based on available evidence, would offer precaution and encompass even scenarios with the highest impacts on demographics from displacement.

10.4.4.27 Considering the results of simulation models by Searle et al., (2014) and van Kooten et al., (2019) on the impacts of displacement on auk adult survival to be consistently less than 0.5%, it would suggest that additional mortality effects at a colony or population level would be negligible or undetectable under current monitoring conditions. However, an additional mortality level of 10% would likely be detectable after several years of monitoring, especially if continued moderate displacement from an OWF is occurring. Although published studies with empirical evidence to support this are lacking, impacts on demographic effects from OWF displacement can be inferred from colony population trends, where displacement effects on auk distributions have been reported. One such colony is that on Helgoland in the German North Sea in which displacement rates for auks have been predicted to be 44% during the breeding season and 63% during the non-breeding season (Peschko et al., 2020). OWFs of the Helgoland cluster have been in operation since 2014 allowing a substantial time for any correlation between operation of the OWFs and changes in colony demographics if significant additional mortality from displacement is occurring. These data provide supporting evidence that overly precautionary rates of mortality over 1% are not apparent, as the latest breeding population status on Helgoland shows a continued increase for both razorbill and guillemot numbers over the latest five-year period, which has remained unchanged compared to long-term data (Gerlach et al., 2019).

10.4.4.28 The studies considered for this assessment (van Kooten et al., 2019, Searle et al., 2014, Peschko et al., 2020, and Gerlach et al., 2019) together provide the most comprehensive review of potential displacement consequences to auks during the breeding and non-breeding season. They all collectively conclude that any displacement effects, even when considering overly precautionary rates to increase potential impacts, are unlikely to exceed a mortality rate 0.5%. Therefore, they support the use of up to a 1% mortality rate based on the best available evidence offers an appropriate level of precaution that encompasses scenarios considering the highest impacts on demographics from displacement.

Precautionary Nature of Assessment

10.4.4.29 The assessments provided within this RIAA include a number of assumptions that contribute to the predicted impacts and potential effects being considered overly precautionary, including;

- The population within each bio-season being the mean (or weighted mean; see **Volume A5, Annex 5.2: Offshore Ornithology Displacement Analysis**) of the peaks from each survey year. This makes the assumption that such a high population is maintained for each of the months within the bio-season, whilst the actual abundance of each species is likely to be less than this for much of the bio-season;
- The maximum extent of displacement assessed for each species is likely to be greater than actually experienced within the array area and buffer;
- The maximum of 10% mortality of birds displaced during the non-migratory breeding bio-season is highly unlikely, as the species assessed in this RIAA are not solely dependant upon the area within the Hornsea Four array area and buffer for all their foraging needs (**Figure 18** & **Figure 20**);
- That adult birds that are actively breeding will respond to displacement by putting themselves to further stress to the extent of dying rather than ceasing to breed (i.e. abandoning eggs or young) and surviving to breed in a later year; and
- Not all adult birds within the Hornsea Four array area and / or buffer will be from Flamborough and Filey Coast SPA.

10.4.4.30 In addition to the four species for which it was agreed in principle with Natural England as being the focus of the displacement assessment (**paragraph 10.4.4.7**), a further two species were screened in for assessment of potential displacement from operation and maintenance vessels; red-throated diver and common scoter. Both species are features of the Greater Wash SPA and it was agreed with Natural England in principle, through the EP process, as being the only species of focus for displacement from operational and maintenance vessel movements (OFF-ORN-5.9 **B1.1.1 Evidence Plan**). However, as both these species are considered to be at very low risk from such potential activities associated with Hornsea Four, due to the majority of activities occurring in areas with no divers or scoters present, the assessments for both species are presented at an appropriate level.

<u>Greater Wash SPA – red-throated diver</u>

10.4.4.31 Red-throated diver has been screened in for the assessment of the O&M phase to assess the the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the SPA:

- Maintain the population of each of the qualifying features; and

- Maintain the distribution of qualifying features within the site.

10.4.4.32 Red-throated diver has been screened into the assessment of the O&M phase on the basis of its sensitivity to WTG and vessel presence.

10.4.4.33 Red-throated diver were not recorded in the Hornsea Four array area or 4 km buffer, which is 63.4 km from the Greater Wash SPA, so are not considered to be at risk from disturbance and displacement from WTGs and vessel presence in the array area during the operational phase of Hornsea Four. The exact location at which any operational and maintenance vessels would be based is not yet determined, but should they be to the north of the array area (for instance at Filey) vessels would completely avoid the Greater Wash SPA, so no potential effects would be apparent. Should a worst case be considered for the port location, for instance if operational and maintenance vessels be based at a port within the Humber Estuary, then this may require some movement of vessels through the Greater Wash SPA. However, should the Humber Estuary be the port of choice then routes would follow the main shipping channels out of the Humber, which run through lower density areas of red-throated divers in the Greater Wash SPA (Lawson et al, 2016) and the levels of activity associated with Hornsea Four would not be considered to contribute any meaningful difference to current shipping levels considered to be part of the current baseline level (as detailed in **Volume A2, Chapter 7: Shipping and Navigation**), as most would involve small vessels and limited activity within the region.

10.4.4.34 There is also the potential for ad-hoc maintenance of export cables at periods through the operational phase of Hornsea Four that may lead to disturbance and displacement of species within the ECC and differing degrees of buffers surrounding it. However, as no significant adverse impacts or effects are predicted to occur on red-throated divers in the construction phase (**paragraph 10.4.3.13**), then no significant adverse impacts or effects would occur through this very limited, estimated to be one event per annum, and unlikely occurrence within close proxity to the SPA during the operational and maintenance phase of Hornsea Four.

10.4.4.35 It is therefore determined that the small level of vessel activities associated with the operational and maintenance activities for Hornsea Four would not lead to any consequent displacement related mortality, as it would not significantly alter the background vessel activities already present from the Humber Estuary shipping channel into the North Sea. There is, therefore, no potential for an AEoI to the conservation objectives of the red-throated diver feature of Greater Wash SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, red-throated diver will be maintained as a feature in the long term.

Greater Wash SPA – common scoter

10.4.4.36 Common scoter has been screened in for the assessment of the O&M phase to assess the the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the SPA:

- Maintain the population of each of the qualifying features; and
- Maintain the distribution of qualifying features within the site.

10.4.4.37 Common scoter has been screened into the assessment of the O&M phase on the basis of its sensitivity to WTG and vessel presence.

10.4.4.38 Common scoter were not recorded within the Hornsea Four array area (which is 63.4 km from the Greater Wash SPA) or the 4 km buffer on any of the 24 months of aerial survey. This absence of common scoter is because of the depth of the water at this distance from the coast, with deep water (deeper than 10 m) not being favoured by common scoter for foraging.

10.4.4.39 As common scoter were not recorded in the Hornsea Four array area or 4 km buffer they are not considered to be at risk from disturbance and displacement from WTGs and vessel presence in the array area during the operational phase of Hornsea Four. The exact location at which any operational and maintenance vessels would be based is not yet determined, but should they be to the north of the array area (for instance at Filey) vessels would completely avoid the Greater Wash SPA, so no potential effects would be apparent. Should a worst case be considered for the port location, for instance if operational and maintenance vessels be based at a port within the Humber Estuary, then this may require some movement of vessels through the Greater Wash SPA. However, should the Humber Estuary be the port of choice then routes would follow the main shipping channels out of the Humber, which run through very low density areas of common scoter in the Greater Wash SPA (Lawson et al. 2016) and the levels of activity associated with Hornsea Four would not be considered to contribute any meaningful difference to current shipping levels considered to be part of the current baseline level (as detailed in as detailed in **Volume A2, Chapter 7: Shipping and Navigation**), as most would involve small vessels and limited activity within the region.

10.4.4.40 There is also the potential for ad-hoc maintenance of export cables at periods through the operational phase of Hornsea Four that may lead to disturbance and displacement of species within the ECC and differing degrees of buffers surrounding it. However, as no significant adverse impacts or effects are predicted to occur on common scoter in the construction phase (**paragraph 10.4.3.19**), then no significant adverse impacts or effects would occur through this very limited, estimated to be one repair per annum, and unlikely occurrence, within close proximity to the SPA during the operational and maintenance phase of Hornsea Four.

10.4.4.41 It is therefore determined that the small level of vessel activities assoaciated with the operational and maintenance activities for Hornsea Four would not lead to any consequent displacement related mortality, as it would not alter the background vessel activities already present from the Humber Estuary shipping channel into the North Sea. There is, therefore, no potential for an AEoI to the conservation objectives of the common scoter feature of Greater Wash SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, common scoter will be maintained as a feature in the long term with respect to the potential for adverse effects from disturbance and displacement.

Flamborough and Filey Coast SPA – gannet

10.4.4.42 Gannet has been screened into the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.4.43 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts (Aitken et al. 2017).

10.4.4.44 Gannet has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs. In order to assess the potential impact on gannet a displacement effect distance was determined of the array area and a 2km buffer. The percentage of birds displaced and consequential mortality was determined, with the same approach for each bio-season. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the migration-free breeding bio-season, defined as being the months of April to August by Furness (2015), the post-breeding migration bio-season of September to November and the return migration bio-season of December to March (there is no migration free winter bio-season). The percentage of birds displaced was set at 60 to 80% and the consequential mortality was set at 1%. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 10.4.4.8**.

10.4.4.45 Natural England consider displacement and any consequent mortality rates in the assessments of gannet should be made using a range of values. The displacement matrix in Table 13. provides a displacement matrix for the annual total of gannets apportioned to FFC SPA predicted to be at risk of displacement from the Hornsea Four array area plus 2 km buffer when applying any value of displacement or mortality.

10.4.4.46 In the migration-free breeding bio-season the number of gannets estimated to occur in the array area is 791 individuals. Outside of the migration-free breeding bio-season the number of gannets estimated to occur in the array area and a 2 km buffer in the return migration bio-season is 235 individuals and in the post-breeding migration bio-season is 854 individuals. All abundance data in the assessment below is drawn from Table 2 of **Volume A5, Annex 5.2 Offshore Ornithology Displacement Analysis**. The potential for impact on the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the migration-free breeding bio-season may contain a higher proportion of adult birds that can be attributed to a nearby breeding colony SPA than during the non-breeding bio-seasons.

10.4.4.47 For the purpose of this assessment, the proportion of adult gannets present in the array area and 2 km buffer during the migration-free breeding bio-season was considered to be 0.68, as derived from Appendix A: Table 16 of Furness (2015) for the FFC SPA. The data presented in Furness (2015) are considered to provide a more accurate representation of population age structure than site-based data, since only a low number of gannets could be positively aged within the latter. Furness (2015) draws upon a wide number of data sources gathered across multiple years in order to model population age structure, thus reducing the potential for any bias associated with the snapshot nature of site-based surveys.

10.4.4.48 Furthermore, not all adult gannets present in the array area and 2 km buffer will be breeding birds. This is evidenced from adult sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017) in addition to adult non-breeding birds forming 'clubs' (or social gatherings) on separate cliff ledges adjaent to the main breeding colony. A sabbatical rate of 10% for gannet populations was recently agreed by Marine Scotland for inclusion in all three revised Forth and Tay OWF applications (Neart na Gaoithe OWF, Seagreen Alpha and Bravo OWF, and Inch Cape OWF) in relation to the Forth Islands SPA and Firth of Forth and St. Andrews Bay Complex SPA, designated for breeding gannets (Marine Scotland 2017). As such, this value has been applied for use in this assessment of gannets from FFC SPA during the migration-free breeding bio-season.

10.4.4.49 After consideration of the proportion of immature gannets present, together with the sabbatical rate, the overall proportion of adult breeding gannets from FFC SPA present during the migration-free breeding bio-season was determined to be 61.20% following this evidence-led appraoch.

10.4.4.50 Outside the breeding season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel Biologically Defined Minimum Population Scale (BDMPS) population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during return migration and post-breeding migration bio-seasons were estimated to be 6.23% and 4.84%, respectively, which was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the EP process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

Breeding Season

10.4.4.51 The number of gannets predicted to be displaced from the array area and 2 km buffer in the migration-free breeding bio-season is between 474 (474.47) and 633 (632.63) individuals (applying displacement rates of between 60% and 80%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at between five (4.74) and six (6.33) individuals in total. On the basis of 61.20% of all the birds predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at between three (2.90) and four (3.87) breeding adults.

10.4.4.52 When considering the potential impact of this loss to the FFC SPA (classified gannet population of 16,938 breeding adults, with an annual background mortality of 1,372 breeding adults), then using the prediction of three to four breeding adults suffering displacement consequent mortality would represent a 0.21% to 0.28% increase in baseline mortality. As the population of gannets has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 13,392 apparently occupied nests (or 26,784 breeding adults). On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of 2,170 breeding adults) then the prediction of three to four breeding adult birds suffering displacement consequent mortality would represent a 0.13% to 0.18% increase in baseline mortality in the migration-free breeding bio-season.

Non-breeding Season

10.4.4.53 The number predicted to be displaced from the array area (applying displacement rates of between 60% and 80%) in the return migration bio-season is between 141 (141.20) and 188 (188.27) individuals and in the post-breeding migration bio-season is 513 (512.65) and 684 (683.54) individuals (there is no migration free winter bio-season). The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at one (1.41) to two (1.88) individuals during the return migration bio-season and between five (5.13) and seven (6.84) individuals during the post-breeding migration bio-season. On the basis of 6.23% (**paragraph 10.4.4.50**) of all the birds in the return migration bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at under one (0.09 to 0.12) breeding adult per annum. On the basis of 4.84% (**paragraph 10.4.4.50**) of all the birds in the post-breeding migration bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.25 to 0.33) breeding adult per annum. This equates to a total consequent mortality from displacement across the entire non-breeding bio-season of less than one (0.34 to 0.45) breeding adult per annum.

10.4.4.54 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the FFC SPA during the entire non-breeding bio-season, then this represents an increase of 0.001% to 0.02% in baseline mortality of the citation population or the 2017 population of FFC SPA.

Annual Total

10.4.4.55 The impact of displacement from the array area and a 2km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality ranging from three to four breeding adults from the SPA in the migration-free breeding season and less than one breeding adult from the SPA in the non-breeding bio-seasons equates to a prediction of between three (3.24) and four (4.32) breeding adults per annum across all bio-seasons. The prediction of a total consequential additional mortality of between three and four breeding adults per annum represents an increase 0.24% to 0.31% when considering the citation population or an increase of 0.15% to 0.20% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.56 The addition of between three and four possible additional breeding adult mortalities per annum equates 0.2% increase in baseline mortality at most, when considering either the citation or the latest 2017 colony count. This level of impact would be indistinguishable from natural fluctuations in the population. Therefore, the potential for an AEoI to the conservation objectives of the gannet feature of FFC SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone can be ruled out, subject to natural change, gannet will be maintained as a feature in the long term.

Table 13: Annual displacement matrix for breeding adult gannets within the Hornsea Four array area plus 2 km buffer apportioned to the FFC SPA, values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	1	1	2	2	3	3	4	4	5	5
10	1	1	2	2	3	5	11	16	22	27	32	38	43	49	54
20	1	2	3	4	5	11	22	32	43	54	65	76	86	97	108
30	2	3	5	6	8	16	32	49	65	81	97	113	130	146	162
40	2	4	6	9	11	22	43	65	86	108	130	151	173	194	216
50	3	5	8	11	14	27	54	81	108	135	162	189	216	243	270
60	3	6	10	13	16	32	65	97	130	162	194	227	259	292	324
70	4	8	11	15	19	38	76	113	151	189	227	265	302	340	378
80	4	9	13	17	22	43	86	130	173	216	259	302	346	389	432
90	5	10	15	19	24	49	97	146	194	243	292	340	389	437	486
100	5	11	16	22	27	54	108	162	216	270	324	378	432	486	540

Flamborough and Filey Coast SPA – guillemot

10.4.4.57 Guillemot has been screened into the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea Four in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.4.58 Based on the above the conservation objective for the FFC SPA the specific target for the guillemot feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 41,607 breeding pairs (83,214 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 121,754 breeding adults based on the most recent 2017 colony count (Aitken et al. 2017).

10.4.4.59 Guillemot has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance. The Hornsea Four array area is within the mean max foraging distance of 73.2 km to the FFC SPA at 63 km distant and also within the mean max plus 1 SD foraging distance of 150.7 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding bio-seasons. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the breeding bio-season, defined as being the months of March to July by Furness (2015) and the non-breeding bio-season of August to February.

10.4.4.60 In order to assess the potential impact on guillemot a displacement effect distance was determined of the array area and within a buffer out to 2 km. Within that displacement effect area the percentage of birds displaced from the array area was set at 50% during all bio-seasons and within the 2 km buffer. The level of mortality consequential on displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 10.4.4.10**.

10.4.4.61 Natural England consider displacement and any consequent mortality rates in the assessments of guillemot should be made using a range of values. The displacement matrix in **Table 14** provides a displacement matrix for the annual total of guillemots apportioned to FFC SPA predicted to be at risk of displacement from the Hornsea Four array area plus 2 km buffer (OFF-ORN-4.8 **B1.1.1 Evidence Plan**) when applying any value of displacement or mortality. Summary statements applying the lower end (a displacement rate of 30% and a mortality rate of 1%) and extreme upper end (a displacement rate of 70% and a mortality rate of 10%) of Natural England's range of displacement and consequent mortality rates are also considered within this assessment, though Natural England acknowledge that the use of displacement mortality rates from the upper end of the range are not likely (Natural England 2020).

10.4.4.62 The number of guillemots estimated to occur in the array area and a 2 km buffer is 8,553 individuals in the breeding bio-season and 17,062 in the non-breeding bio-season. All abundance data in the assessment below is drawn from Table 2 of **Volume A5, Annex 5.2 Offshore Ornithology Displacement Analysis**. The potential for impact on the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to a nearby breeding colony SPA than during the non-breeding bio-season.

10.4.4.63 For the purpose of this assessment, the proportion of adult guillemots present in the array and 2 km buffer during the breeding bio-season was considered to be 60%, as derived from Appendix A: Table 62 of Furness for FFC SPA. The data presented in Furness (2015) are considered to provide a more accurate representation of population age structure than site-based data, since it was not possible to distinguish adults from immatures in the latter. Furness (2015) draws upon a wide number of data sources gathered across multiple years in order to model population age structure and is therefore considered appropriate for this purpose.

10.4.4.64 Furthermore, not all adult guillemots present in the array area and 2 km will be breeding birds. This is evidenced from adult sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017). A sabbatical rate of 7% for guillemot populations was recently agreed by Marine Scotland for inclusion in all three revised Forth and Tay OWF applications (Neart na Gaoithe OWF, Seagreen Alpha and Bravo OWF, and Inch Cape OWF) in relation to a number of east-coast SPAs designated for breeding guillemots (Marine Scotland 2017). As such, this value has been applied for use in this assessment of guillemots from FFC SPA.

10.4.4.65 After consideration of the proportion of immature guillemots present, together with the sabbatical rate, the overall proportion of adult guillemots from FFC SPA during the breeding bio-season was determined to be 55.80% following this evidence-led appraoch.

10.4.4.66 Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away (e.g. Furness 2015; Dunn et al. 2020), then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is usually based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report, which for guillemot would equate to an apportionment rate of 4.41% for guillemots from the FFC SPA. This method was agreed as applicable for the FFC SPA at EP 11 with Natural England (OFF-ORN-6.1 **B1.1.1 Evidence Plan**). At EP 14 Natural England requested that a bespoke method to apportionment in the non-breeding bio-season to incorporate a higher proportion of guillemots apportioned to the FFC SPA. This was to account for a higher proportion of birds during the post dispersal months of August and September that may be from FFC SPA (OFF-ORN-2.52 **B1.1.1 Evidence Plan**).

10.4.4.67 In order to account for a potentially higher proportion of FFC SPA guillemots during the post dispersal months of the non-breeding bio-season a weighted approach to apportionment has been taken to accommodate Natural England's request. As it is not possible to determine exactly how many guillemots within the Hornsea Four array area and 2 km buffer during the post dispersal months are from the FFC SPA an evidence-led approach was taken. Studies on guillemot dispersal indicate that guillemots can begin leaving the colony as early as the end of June (Camphuysen 2002) and from July to September have been recorded over 300 km from the nearest attributable colony (Campphuysen 2002; Harris et al. 2015; Dunn et al. 2020). This means that within the months of August and September guillemots from colonies in Scotland could have dispersed as far south as the Hornsea Four array area. Based on these studies of guillemot dispersal, an evidence-led expert judgement has been made and an apportionment value of 75% of all guillemots being from the FFC SPA has been applied to account for this colony being the closest to the Hornsea Four array area. This expert judgement also acknowledges that guillemots from colonies further north migrate in substantial numbers into the Southern North Sea, including the waters within and surrounding the Hornsea Four array area, during the months of August and September (Dunn et al. 2020).

10.4.4.68 Not all guillemots within the post dispersal months attributed to the FFC SPA will be adult birds. Consideration has been given to the number of adults likely to be within the Hornsea Four array area, estimated to be 60% as derived from Appendix A: Table 62 of Furness for FFC SPA as detailed in **paragraph 10.4.4.63**. During the post dispersal months of August and September it is highly likely that this value will be lower than calculated in the breeding bio-season due to the influx of first year fledglings and likelihood that adult females will have begun migrating to their wintering foraging areas. To account for this likely greater proportion of juveniles than the rest of year, the proportion of adult birds was reduced to 50% of guillemots recorded.

10.4.4.69 Furthermore, not all adult guillemots present in the post dispersal months will be breeding adults. As detailed in paragraph 10.4.4.64, a sabbatical rate of 7% has been applied to account for guillemots free roaming the North Sea taking a break from breeding. When considering the proportion of individuals attributable to the FFC SPA, proportion of adults and proportion of sabbaticals, this equates to an overall apportionment in the post dispersal months to the FFC SPA of 35% with a weighting factor of two to account for the number of component months.

10.4.4.70 For the remaining five months the proportion of breeding adults was calculated as the standard 4.41% based on the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015) with a weighting factor of five to account for the number of component months.

10.4.4.71 The overall apportionment to the FFC SPA in the non-breeding bio-season for the full seven months (August to February) was calculated as 13% using the weighted approach as summarised in the equation below.

$$Entire\ non\ breeding\ apportionment\ (Aug\ to\ Feb) = \frac{((PDr \times t_{PD}) + (NB \times t_{NB}))}{(t_{PD} + t_{NB})}$$

Where:
PD = Calculated apportionment in the post-dispersal months (35%)
NB = Calculated apportionment in the remaining non-breeding bio-season months (4.41%)
tPD = number of post-dispersal months (2)
tNB = number of remaining non-breeding bio-season months (5)

Breeding Season

10.4.4.72 The number of guillemots predicted to be displaced from the array area and a 2 km buffer in the breeding bio-season is 4,277 (4,276.61) individuals (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 43 (42.77) individuals. On the basis of 55.80% of all the birds predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at 24 (23.86) breeding adults.

10.4.4.73 When considering the potential impact of this loss to the FFC SPA (classified guillemot population of 83,214 breeding adults, with an annual background mortality of 5,076 breeding adults), then using this prediction of 24 breeding adults suffering displacement consequent mortality would represent a 0.47% increase in baseline mortality. As the population of guillemots has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 121,754 breeding adults. On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of 7,427 breeding adults) then the prediction of 24 adult birds suffering displacement consequent mortality would represent a 0.32% increase in baseline mortality in the breeding bio-season.

10.4.4.74 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement is a prediction of consequent mortality of between 14 (14.32) and 334 (334.09) breeding adult birds from the SPA in the breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.28% and 6.58% when considering the citation population or between 0.19% and 4.50% when considering the recent 2017 colony count in the breeding bio-season per annum. As Natural England's upper range presents over a 1% increase in the baseline mortality rate, further consideration has been taken into account below.

Non-breeding Season

10.4.4.75 The number predicted to be displaced from the array area and a 2 km buffer (applying displacement rates of 50%) in the non-breeding bio-season is 8,531 (8,530.87) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 85 (85.31) individuals during the non-breeding bio-season. On the basis of 13% of all the birds in the non-breeding bio-season predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at 11 (11.19) breeding adults per annum.

10.4.4.76 When considering 11 breeding adults may be subject to displacement consequent mortality that can be attributed to the SPA during the non-breeding bio-season then this represents only a slight increase of 0.22% or 0.15% in baseline mortality to the citation population or the 2017 population of FFC SPA, resepctively.

10.4.4.77 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement is a prediction of consequent mortality of between seven (66.71) and 157 (156.64) breeding adult birds from the SPA in the non-breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.13% and 3.09% when considering the citation population or between 0.09% and 2.11% when considering the recent 2017 colony count in the non-breeding bio-season per annum.

Annual Total

10.4.4.78 The impact of displacement on guillemots from within the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of 24 breeding adults in the breeding bio-season and 11 breeding adults in the non-breeding bio-season equates to 35 (35.05) breeding adults across all bio-seasons per annum. The prediction of a total consequential additional mortality of 35 breeding adults per annum represents an increase 0.69% when considering the citation population or an increase of 0.47% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.79 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement is a prediction of consequent mortality of between 21 (21.03) and 491 (490.73) breeding adult birds from the SPA across all bio-seasons. This predicted additional mortality would represent an increase in baseline mortality of between 0.41% and 9.67% when considering the citation population or between 0.28% and 6.61% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.80 Although the use of 70% displacement and 10% mortality is considered extremely unlikely, as previously stated, a precautionary approach has been taken for Hornsea Four alone and further consideration in the form of Population Viability Analysis (PVA) has been carried out considering a wide range of displacement and mortality rates as requested by Natural England (OFF-ORN-2.50 **B1.1.1 Evidence Plan**). Further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**. The results of the PVA are summarised in **Table 15** below for impacts from displacement alone apportioned to the FFC SPA.

Table 14: Annual displacement matrix for breeding adult guillemots within the Hornsea Four array area plus 2 km buffer apportioned to the FFC SPA, values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

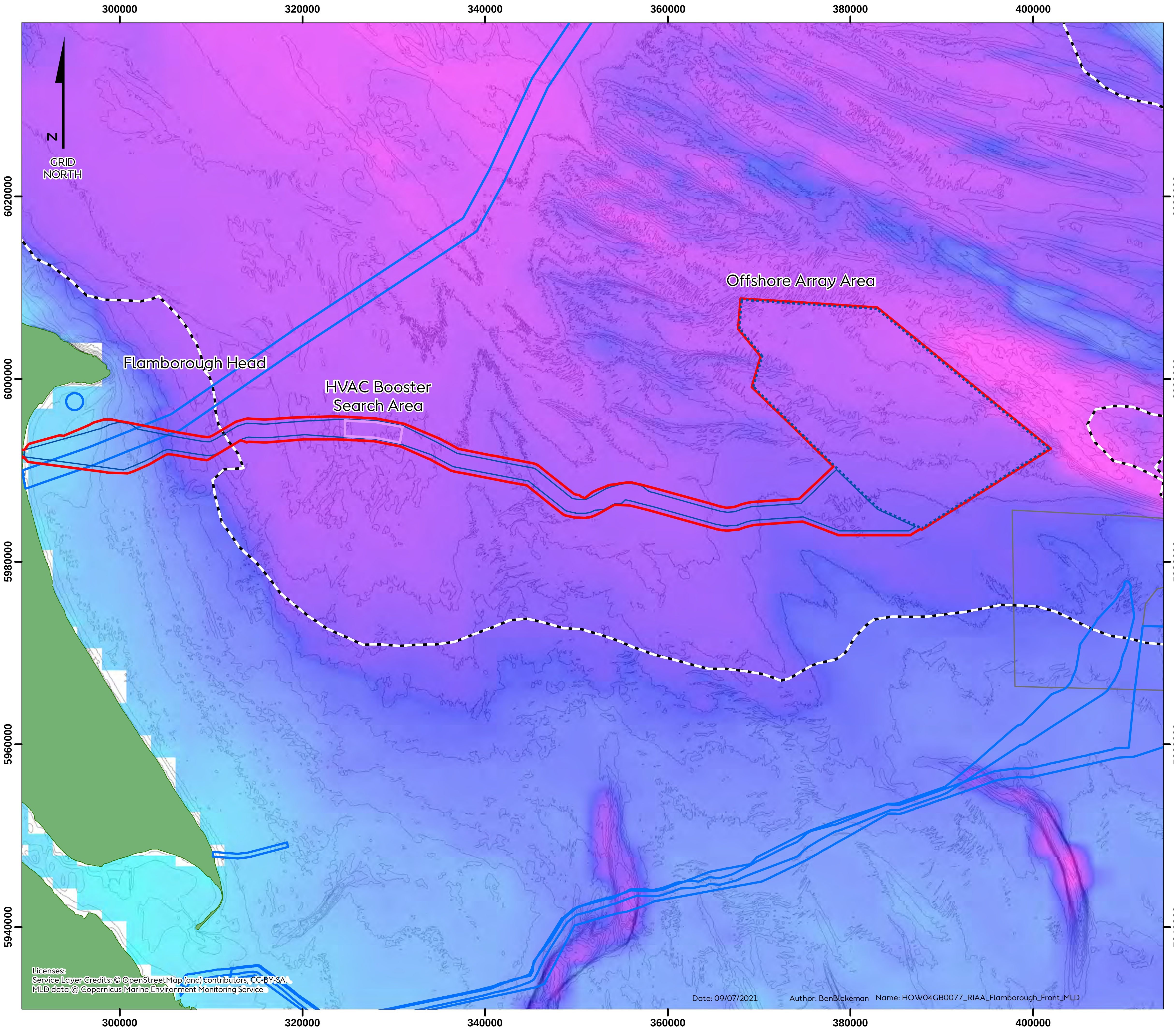
Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	1	2	3	4	7	14	21	28	35	42	49	56	63	70
10	7	14	21	28	35	70	140	210	280	351	421	491	561	631	701
20	14	28	42	56	70	140	280	421	561	701	841	981	1,122	1,262	1,402
30	21	42	63	84	105	210	421	631	841	1,052	1,262	1,472	1,683	1,893	2,103
40	28	56	84	112	140	280	561	841	1,122	1,402	1,683	1,963	2,243	2,524	2,804
50	35	70	105	140	175	351	701	1,052	1,402	1,753	2,103	2,454	2,804	3,155	3,505
60	42	84	126	168	210	421	841	1,262	1,683	2,103	2,524	2,944	3,365	3,786	4,206
70	49	98	147	196	245	491	981	1,472	1,963	2,454	2,944	3,435	3,926	4,417	4,907
80	56	112	168	224	280	561	1,122	1,683	2,243	2,804	3,365	3,926	4,487	5,048	5,608
90	63	126	189	252	315	631	1,262	1,893	2,524	3,155	3,786	4,417	5,048	5,678	6,309
100	70	140	210	280	351	701	1,402	2,103	2,804	3,505	4,206	4,907	5,608	6,309	7,010

Table 15: Guillemot PVA results for impacts apportioned to the FFC SPA.

Scenario Description	Increase in Adult mortality	Density independent counterfactual of growth rate (after 35 years)	Reduction in growth rate (%)
Hornsea Four Alone 30% Displacement, 1% Mortality	21	1.000	0.02
Hornsea Four Alone 50% Displacement, 1% Mortality	35	1.000	0.03
Hornsea Four Alone 60% Displacement, 1% Mortality	42	1.000	0.04
Hornsea Four Alone 70% Displacement, 1% Mortality	49	1.000	0.05
Hornsea Four Alone 30% Displacement, 2% Mortality	42	1.000	0.0
Hornsea Four Alone 50% Displacement, 2% Mortality	70	0.999	0.06
Hornsea Four Alone 70% Displacement, 2% Mortality	98	0.999	0.09
Hornsea Four Alone 30% Displacement, 5% Mortality	105	0.999	0.10
Hornsea Four Alone 50% Displacement, 5% Mortality	175	0.998	0.16
Hornsea Four Alone 70% Displacement, 5% Mortality	245	0.998	0.23
Hornsea Four Alone 30% Displacement, 10% Mortality	210	0.998	0.19
Hornsea Four Alone 50% Displacement, 10% Mortality	351	0.997	0.32
Hornsea Four Alone 70% Displacement, 10% Mortality	491	0.995	0.45

10.4.4.81 The guillemot colony at FFC SPA has increased annually by between 3.23% and 4.05% over the last 30 to 50 years, respectively (**Table 47**) (Lloyd et al. 2020), with only a slight reduction in the productivity of the colony in 2017 (the monitoring plan (Aiteken et al. 2017) suggest this reduction was caused by prospecting gannets displacing guillemots from nest sites and carrion crow predation), suggesting that the colony is stable and in favourable condition (see **Appendix A** of **Appendix H**). At present, it is noted that the guillemot annual growth for the FFC SPA colony over the next 35 years is unknown, but that there is no indication that this favourable status is changing or the rate of growth slowing.

10.4.4.82 Although evidence suggests that for auk species a displacement rate of 50% with 1% mortality is suitably precautionary for the basis of assessments (**paragraph 10.4.4.10**), at EP 14 Natural England requested that in order to be satisfied that the upper ranges of displacement and mortality can be dismissed for Hornsea Four, further investigation into the importance of the Flamborough Front for auk species and potential connectivity between the Flamborough Front and Hornsea Four would be required (OFF-ORN-2.52 **B1.1.1 Evidence Plan**). The Flamborough Front is described as an area of sea characterised by a distinct temperature gradient between the waters north and south of the Flamborough headland (further description and detail of the Flamborough Front can be found in **Volume A5, Annex 1.1: Marine Processes Technical Report**). This front results in increased nutrient rich waters during summer and to a lesser extent in Autumn months, which creates ideal foraging habitat for a number of seabird species. The Flamborough Front can be defined within a shifting band of water to differing distances from an indicative line (**Figure 15**) through the North Sea (English Nature, 2000). The final Hornsea Four array area completely avoids the areas considered to constitute the band of water that forms the Flamborough Front, which is a considerable distance to the south, clearly showing there is no direct overlap or connectivity between the Flamborough Front and the Hornsea Four array area. This avoidance is a result of the DAA, from which Orsted undertook a review of the original AfL in order to take forward an array area that reduced the risk to auks from potential disturbance and displacement. As any connectivity to the Flamborough Front has been eliminated due to the DAA, The Hornsea Four array area therefore does not reside in an area of high importance to guillemots during the post dispersal period, meaning the higher range of displacement and mortality can be dismissed as overly precautionary.



Hornsea Four

Figure 15

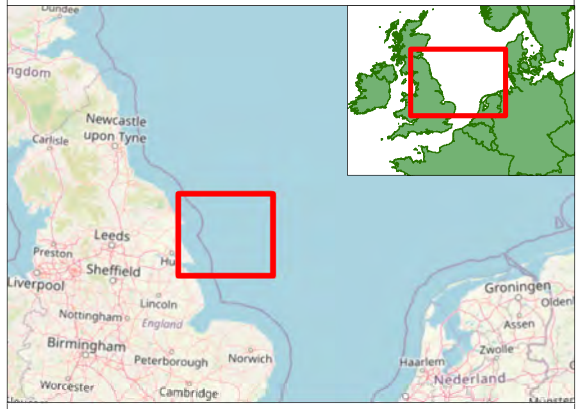
Location of Flamborough Front, based on variation in MLD for July 2018

- Order Limits
- Array Area
- Offshore Export Cable Corridor
- HVAC Booster Station Works Area
- Existing Licence Areas for Export Cables and Disposal Sites
- 5m Contour
- Location of Front - July 2018

Mixed Layer Depth (m below sea surface)

High : 70

Low : 3



Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:400,000

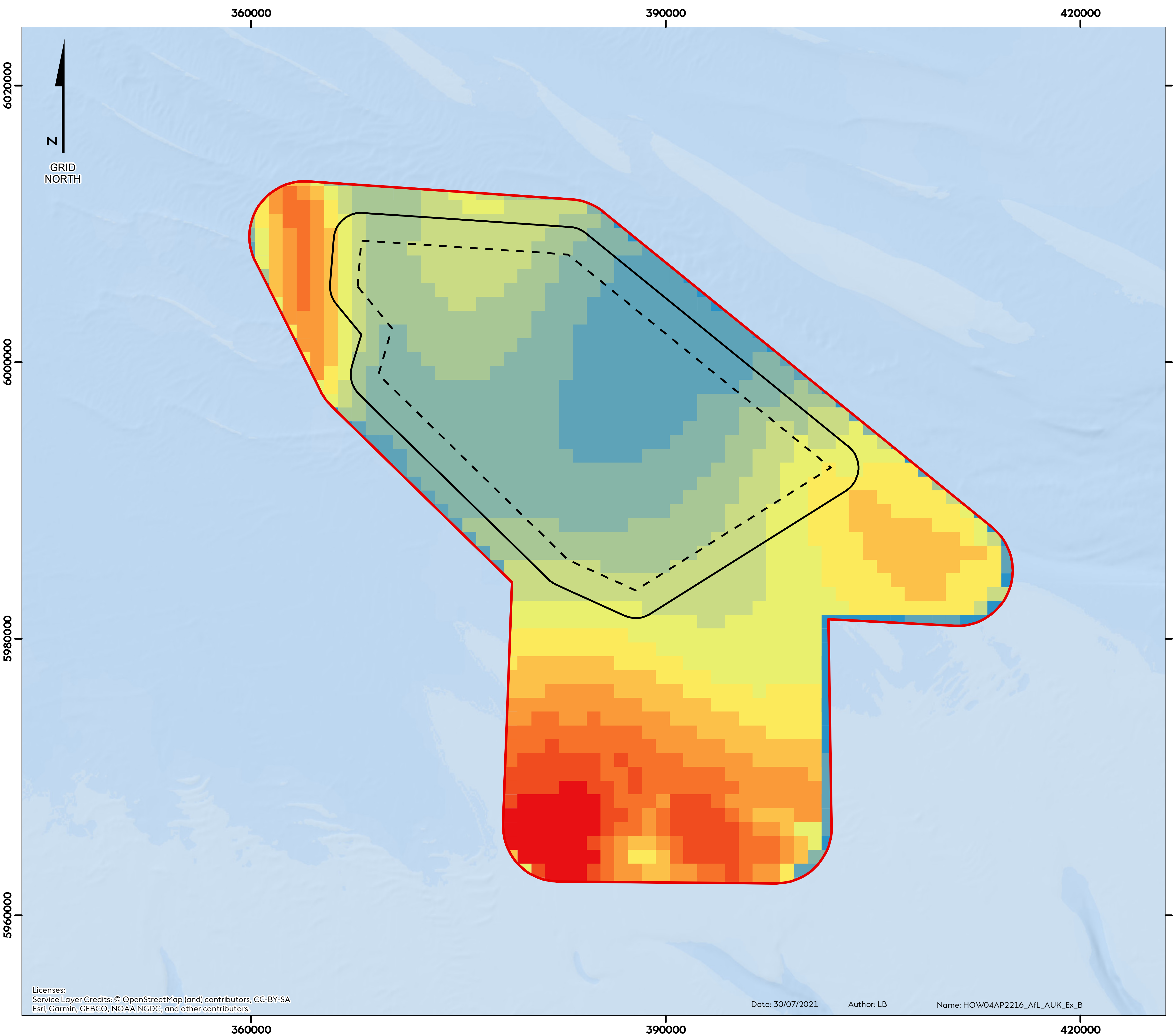
0 10 20 Kilometres

0 5 10 Nautical Miles

REV	REMARK	DATE
....	First Issue	07/06/2019
A	Updated following PEIR consultation, for DCO	09/07/2021

Flamborough Front variation in MLD
Document no: HOW04GB0077
Created by: BPHB
Checked by: BC
Approved by: LK

10.4.4.83 Through the DAA the Hornsea Four array area not only completely avoids the Flamborough Front (**Figure 15**), but also the areas within the original AFL with higher densities of auks (**Figure 16)**. As clearly presented in **Figure 16**, through the Applicant's DAA the areas of relatively high density to the south of the Hornsea Four array area (likely caused by the close proximity to the Flamborough Front), north west and south east of the AFL are now excluded from the final Hornsea Four array area. Therefore, it can be concluded that Hornsea Four has excluded the areas of relatively high density from the final array area and in turn, the areas within the AFL likely to be of greater importance to guillemots, meaning the higher range of displacement and mortality can be dismissed as overly precautionary.



Hornsea Four

Figure 16

Predicted Density of All Auks for the Extended Breeding Bio-Season for the Entire AfL

Array Area

Array Area plus 2 km Buffer

AfL Plus 4 km Buffer

Predicted Auk Density (birds / km²)

- 0.00 - 5.11
- 5.12 - 10.08
- 10.09 - 13.14
- 13.15 - 16.37
- 16.38 - 20.06
- 20.07 - 24.49
- 24.50 - 29.18
- 29.19 - 34.73
- 34.74 - 41.28
- 41.29 - 48.68
- 48.69 - 58.52
- 58.53 - 73.91

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:264,838

0 5 10 Kilometres

0 2 4 Nautical Miles

REV	REMARK	DATE
	First Issue	30/07/2021

Predicted Density of All Auks for the Extended Breeding Bio-season for the Entire AfL
Document no: HOW04AP2216
Created by: LB
Checked by: MB
Approved by: SS

Ørsted

10.4.4.84 Consideration has also been given to the key foraging areas for guillemot during the breeding bio-season in order to further evidence that Hornsea Four does not reside within an area of importance to guillemots during the breeding bio-season.

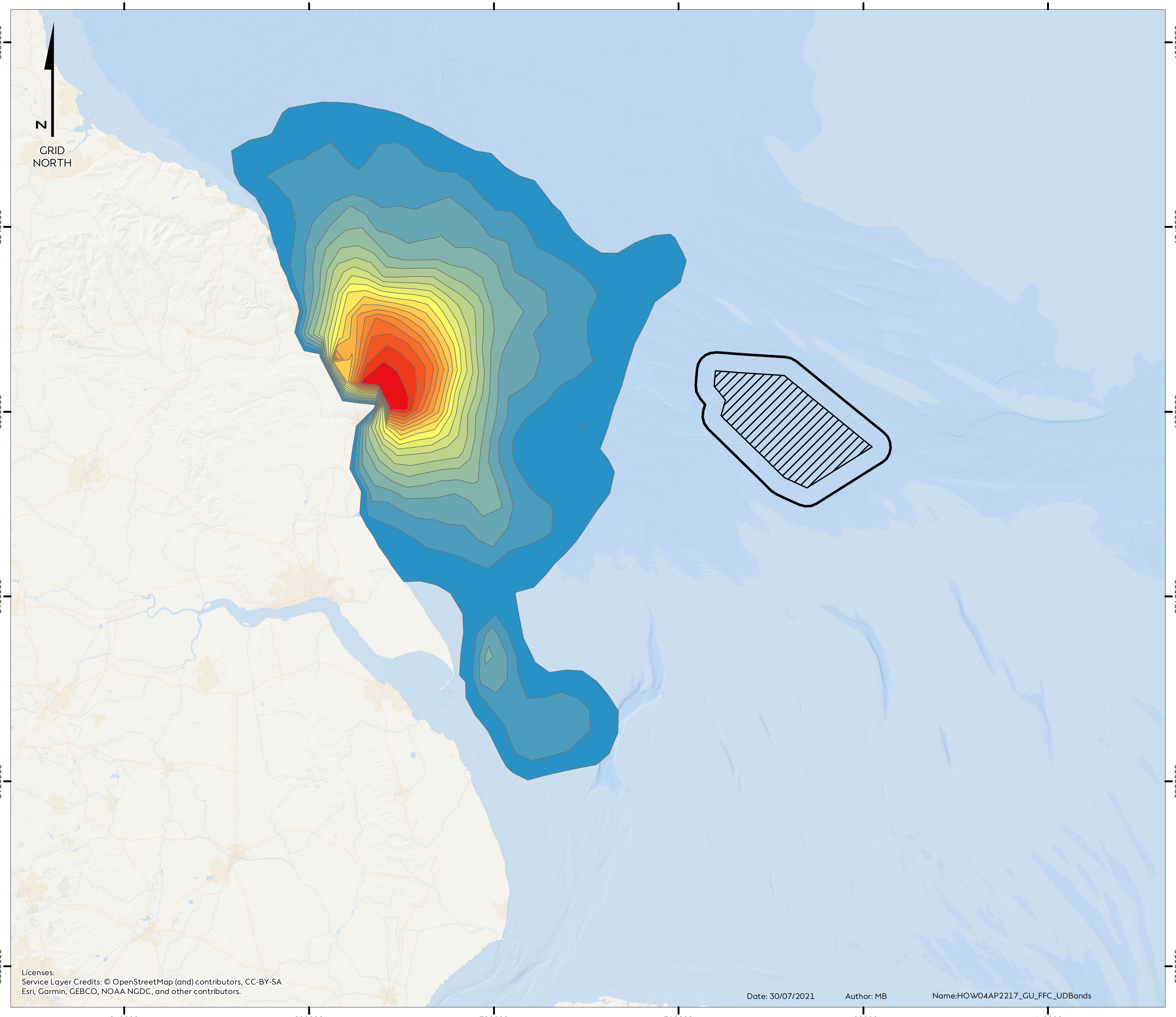
10.4.4.85 During 2010 to 2015, the RSPB and partners undertook a series of large-scale tracking studies of guillemots across the UK during the breeding season in order to map their UK wide, at-sea distributions (of which the FFC SPA was one of colonies tracked). These data were subject to analysis by Wakefield et al. (2017) in order to map guillemot distribution and their core foraging range, the result of this analysis is presented in **Figure 17**. Core foraging range was defined as the area of sea up to the 50% Utilisation Distribution (UD) band (Cleasby et al. 2018). The Hornsea Four array area and 4 km buffer were not located within any of the UD bands as shown in **Figure 17**, suggesting that the Hornsea Four array area and 2 km buffer does not lie within either the core foraging range or any other area of sea important to those guillemots tracked from the FFC SPA.

10.4.4.86 Further analysis of these tracking data was undertaken by Cleasby et al. (2018) using hotspot mapping techniques in order to identify important areas of high seabird density at sea. Maximum curvature and Getis-Ord analyses were used to generate SPA-level and UK-level hotspots as presented in **Figure 18** below. Regardless of the hotspot mapping technique utilised, the Hornsea Four array area and 4 km buffer were found to be significantly outside the areas of sea suggested to be of importance to guillemots foraging during the breeding bio-season. Based on the modelling depicted in **Figure 17** and **Figure 18** it is clear that Hornsea Four will not displace guillemots from important foraging areas during the breeding bio-season meaning the higher range of displacement and mortality can be dismissed as overly precautionary.

10.4.4.87 In summary the Applicant's DAA to reduce potential disturbance and displacement of guillemots from the Hornsea Four array area has resulted in the following:

- The Hornsea Four array area does not have any direct overlap or connectivity to the Flamborough Front, an area of known importance to guillemots during their flightless post-breeding dispersal period (**Figure 15**);
- The Hornsea Four array area excludes the areas of higher relative guillemot density (and therefore areas of importance) during the extended breeding season (March to September) as depicted in **Figure 16**; and
- The Hornsea Four array area is not located within the known foraging areas of guillemots during the breeding bio-season, meaning the Hornsea Four array area is not a highly important area for guillemots foraging during the breeding bio-season (**Figure 17** and **Figure 18**).

10.4.4.88 The above evidence clearly shows that the Hornsea Four array area is not an area of sea of high importance to guillemots during the breeding and subsequent post-breeding dispersal period, the time periods where guillemots are most sensitive to disturbance and displacement effects. This means that using Natural England's upper ranges of displacement and mortality (over 50% displacement and over 1% mortality) for assessment can be considered overly precautionary and unsuitable for the basis of disturbance and displacement effects from Hornsea Four.



Hornsea Four

Figure 17
Guillemot FFC SPA Utilisation Distributions in 5% Bands

DCO Array Area

DCO Array Area Plus 4 km Buffer

Guillemot UD Bands

- 5%
- 10%
- 15%
- 20%
- 25%
- 30%
- 35%
- 40%
- 45%
- 50%
- 55%
- 60%
- 65%
- 70%
- 75%
- 80%
- 85%
- 90%
- 95%

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:800,000

0 10 20 Kilometres

0 5 10 Nautical Miles

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Guillemot FFC SPA Utilisation Distributions in 5% Bands
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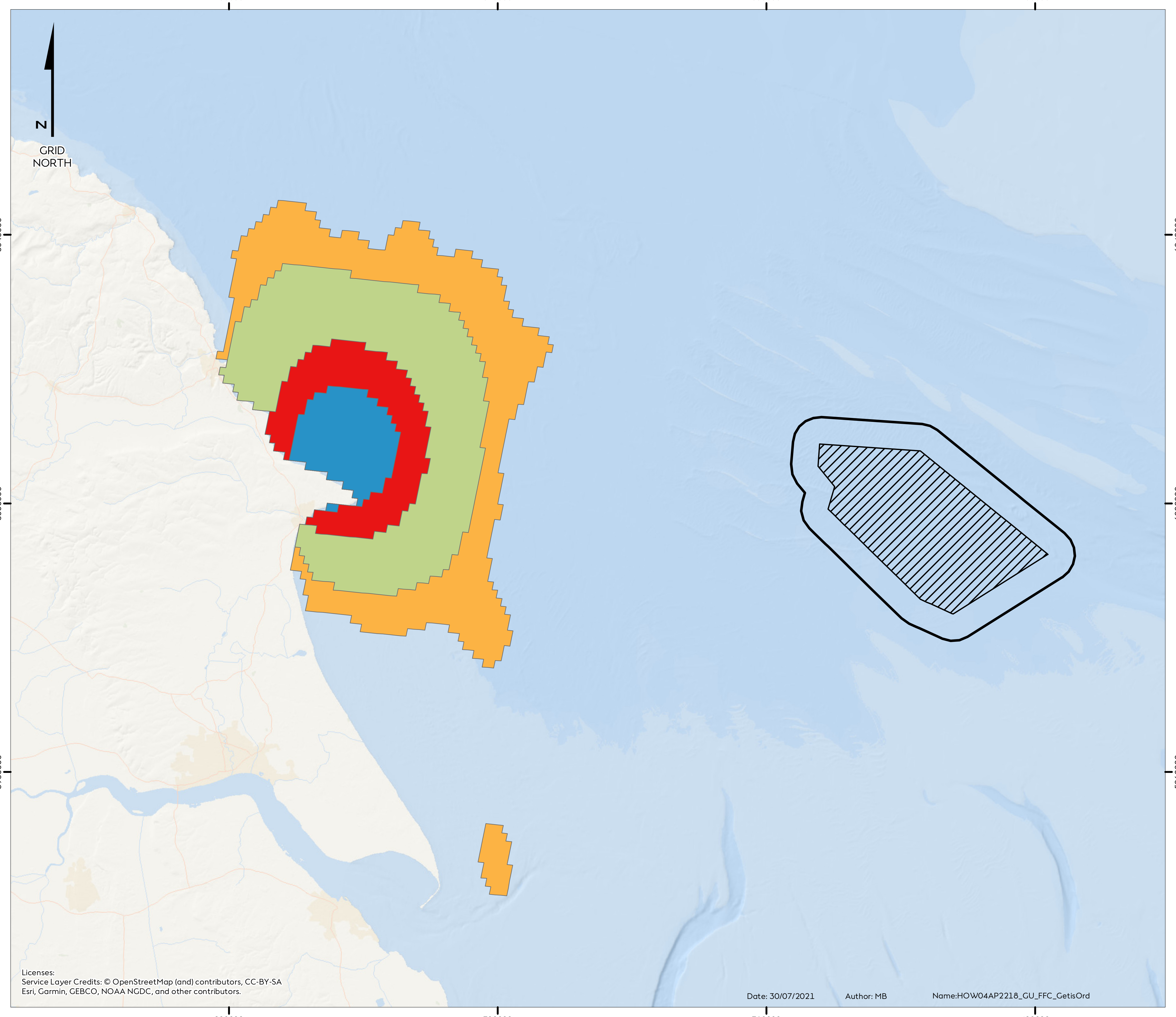

Hornsea Four

Figure 18

Guillemot FFC SPA Maximum Curviture and Getis-Ord Hotspots

- DCO Array Area
- DCO Array Area Plus 4 km Buffer
- Maximum Curvature
- Statistically Significant Getis-Ord hotspot - d = 9km
- Top 1% Getis-Ord hotspot - d = 9km
- Top 5% Getis-Ord hotspot - d = 9km

Coordinate system: ETRS 1989 UTM Zone 31N
Scale@A3: 1:550,000

0 10 20 Kilometres

0 5 10 Nautical Miles

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Guillemot FFC SPA Maximum Curviture and Getis-Ord Hotspots
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10.4.4.89 Given that the Hornsea Four array area avoids those areas of highest guillemot densities and abundances, based on both the RSPB tracking results and the site-based surveys, the evidence demonstrates that the Hornsea Four array area is not within an area of sea of high importance to guillemots. Therefore, the higher displacement and mortality ranges suggested by Natural England can be regarded as overly precautionary as concluded in **paragraph 10.4.4.88**.

10.4.4.90 Over the past 50 years the guillemot colony has grown at an average rate of over 3% annually (**Table 47**). Natural England have previously stated that they believe a maximum reduction in the growth rate of up to 0.4% would not cause an AEoI of the guillemot feature of the FFC SPA (Natural England, 2021b). When considering the current size of the population is significantly larger than that of the citation population and the average growth rate of over 3% per annum, it would be reasonable to assume that the colony would be able to tolerate a greater reduction of 0.4% in the population growth rate long before an adverse effect would be reached.

10.4.4.91 The results of the PVA for scenarios up to 50% Displacement and a 10% mortality rate, which equates to a tenfold increase in predicted mortalities when compared to the realistic predicted mortality form 50% displacement and 1% mortality, would not exceed a reduction in growth rate of over 0.4%; therefore, even when considering this extremely precautionary approach to assessing the impacts (with rates of 50% displacement and a 10% mortality) the target for the guillemot feature of the FFC SPA to maintain the size of the breeding population at a level which is above 41,607 breeding pairs (83,214 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent would still be met for the FFC SPA over the operational lifespan of Hornsea. There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of FFC SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – razorbill

10.4.4.92 Razorbill has been screened into the Hornsea Four O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.4.93 Based on the above the conservation objective for the FFC SPA the specific target for the razorbill feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 10,570 breeding pairs (21,140 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 40,506 breeding adults based on the most recent 2017 colony count (Aitken et al. 2017).

10.4.4.94 Razorbill has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance. The Hornsea Four array area is within the mean max foraging distance of 88.7 km to the FFC SPA at 63 km distant and also within the mean max plus 1 SD foraging distance of 164.6 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding seasons. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the return migration bio-season defined as the months of January to March, the migration-free breeding bio-season defined as being the months of April to July, the post-breeding migration bio-season defined as the months of August to October and the migration-free winter bio-season defined as the months of November and December by Furness (2015).In order to assess the potential impact on razorbill a displacement effect distance was determined of the array area and within a buffer out to 2 km. Within that displacement effect area the percentage of birds displaced from the array area was set at 50% during all bio-seasons and within the 2 km buffer. The level of mortality consequential on displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 10.4.4.10**.

10.4.4.95 Natural England consider displacement and any consequent mortality rates in the assessments of razorbill should be made using a range of values. The displacement matrix in **Table 16** provides a displacement matrix for the annual total of razorbills apportioned to FFC SPA predicted to be at risk of displacement from the Hornsea Four array area plus 2 km buffer (OFF-ORN-4.8 **B1.1.1 Evidence Plan**) when applying any value of displacement or mortality. Summary statements applying the lower end (a displacement rate of 30% and a mortality rate of 1%) and extreme upper end (a displacement rate of 70% and a mortality rate of 10%) of Natural England's range of displacement and consequent mortality rates are also considered within this assessment, though Natural England acknowledge that the use of displacement mortality rates from the upper end of the range are not likely (Natural England 2020).

10.4.4.96 The number of razorbills estimated to occur in the array area and a 2 km buffer is 371 during the return migration bio-season, 276 individuals in the migration-free breeding bio-season, 3,590 during the post-breeding migration bio-season and 474 in the winter bio-season. All abundance data in the assessment below is drawn from Table 2 of **Volume A5, Annex 5.2 Offshore Ornithology Displacement Analysis**. The potential for impact on the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding season may contain a higher proportion of adult birds that can be attributed to a nearby breeding colony SPA than during the non-breeding bio-seasons.

10.4.4.97 For the purpose of this assessment the proportion of adult razorbills present in the array area and 2 km buffer during the breeding bio-season was considered to be 0.60, as derived from Appendix A: Table 64 of Furness for FFC SPA. The data presented in Furness (2015) are considered to provide a more accurate representation of population age structure than site-based data, since it was not possible to distinguish adults from immatures in the latter. Furness (2015) draws upon a wide number of data sources gathered across multiple years in order to model population age structure and is therefore considered appropriate for this purpose.

10.4.4.98 Furthermore, not all adult razorbills present in the array area and 2 km buffer will be breeding birds. This is evidenced from adult sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017). A sabbatical rate of 7% for razorbill populations was recently agreed by Marine Scotland for inclusion in all three revised Forth and Tay OWF applications (Neart na Gaoithe OWF, Seagreen Alpha and Bravo OWF, and Inch Cape OWF) in relation to a number of east-coast SPAs designated for breeding razorbills (Marine Scotland 2017). As such, thisvalue has been applied for use in this assessment of razorbills from FFC SPA.

10.4.4.99 After consideration of the proportion of immature razorbills present, together with the sabbatical rate, the overall proportion of adult breeding razorbills from FFC SPA present during the breeding bio-season was determined to be 55.80% following this evidence-led approach.

10.4.4.100 Outside the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. The UK North Sea population in the migratory bio-seasons is 591,874 individuals, whilst it is 218,622 in the winter bio-season. One hundred percent of the breeding birds from the FFC SPA remain in the UK North Sea in the non-breeding bio-seasons, which is a population of 21,140 breeding individuals (from the SPA citation) or 20,002 breeding individuals when considering the colony count data used to underpin the UK North Sea population (Furness 2015). Therefore, there would be 20,002 breeding individuals remaining in the UK North Sea (based on 100% Furness (2015) population). Accordingly, the proportion of birds in the UK North Sea that can be attributed to the SPA is 3.38% in the migratory bio-seasons and 2.74% in the winter bio-season, when considering the apportionment of populations within the UK North Sea population according to Furness (2015). Following this approach, the proportion of the BDMPS populations from FFC SPA during migratory bio-season of 3.38% and during the winter bio-season of 2.74% was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the EP process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

Breeding Season

10.4.4.101 The number of razorbills predicted to be displaced from the array area and a 2 km buffer in the migration-free breeding bio-season is 138 (138.08) individuals (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at one (1.38) individual. On the basis of 55.80% of all the birds predicted to be displaced being breeding adult birds from the FFC SPA then the consequent mortality from being displaced is estimated at less than one (0.77) breeding adult.

10.4.4.102 When considering the potential impact of this loss to the FFC SPA (classified razorbill population of 21,140 breeding adults, with an annual background mortality of 2,220 breeding adults), then the prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.03% increase in baseline mortality in the migration-free breeding bio-season. As the population of razorbills has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was 40,506 breeding adults. On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of 4,253 breeding adults) then the prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.02% increase in baseline mortality in the breeding bio-season.

10.4.4.103 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment, then the impact of displacement is a prediction of consequent mortality of between less than one (0.46) and 11 (10.79) breeding adult birds from the SPA in the migration-free breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.02% and 0.49% when considering the citation population or between 0.01% and 0.25% when considering the recent 2017 colony count in the breeding bio-season per annum.

Non-breeding Season

10.4.4.104 The number predicted to be displaced from the array area and a 2 km buffer (applying displacement rates of 50%) in the return migration bio-season is 186 (185.50) individuals, in the post-breeding migration bio-season is 1,795 (1,794.94) individuals and in the migration free winter bio-season is 237 (237.07) individuals. The predicted consequent mortality (applying a mortality rate of 1%) in the return migration bio-season is two (1.86) individuals, in the post-breeding migration bio-season is 18 (17.95) individuals and in the migration free winter bio-season is two (2.37) individuals. On the basis of 3.38% (**paragraph 10.4.4.100**) of all the birds in the migratory bio-seasons predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.06) breeding adult in the return migration bio-season and less than one (0.61) breeding adult in the post-breeding migration bio-season. On the basis of 2.74% (**paragraph 10.4.4.100**) of all the birds in the migration-free winter bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.07) breeding adult in the migration-free winter bio-season per annum. This equates to a total consequent mortality from displacement across the entire non-breeding bio-season of less than one (0.73) breeding adult per annum.

10.4.4.105 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the FFC SPA during the non-breeding bio-seasons, then this represents an increase of 0.03% in baseline mortality of the citation population or an increase of 0.02% in baseline mortality of the 2017 population of FFC SPA.

10.4.4.106 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment, then the impact of displacement is a prediction of consequent mortality of between less than one (0.44) and 10 (10.28) breeding adult birds from the SPA across the entire non-breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.02% and 0.46% when considering the citation population or between 0.01% and 0.24% when considering the recent 2017 colony count in the non-breeding bio-season per annum.

Annual Total

10.4.4.107 The impact of displacement on razorbills from within the array area and 2 km buffer, that would occur throughout the operational life of Hornsea Four, is a prediction of consequent mortality of less than one breeding adult from the SPA in the breeding season and less than one breeding adult in the non-breeding season, equating to less than two (1.50) breeding adults across all bio-seasons per annum. The prediction of a total consequential additional mortality of less than two breeding adults per annum represents an increase 0.07% when considering the citation population or an increase of 0.04% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.108 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement is a prediction of consequent mortality of between less than one (0.90) and 21 (21.07) breeding adult birds from the SPA across all bio-seasons per annum. This predicted additional mortality would represent an increase in baseline mortality of between 0.04% and 0.95% when considering the citation population or between 0.02% and 0.50% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.109 Although the use of 70% displacement and 10% mortality is considered extremely unlikely and does not exceed a 1% increase in mortality, as previously stated, a precautionary approach has been taken for Hornsea Four alone and further consideration in the form of Population Viability Analysis (PVA) has been carried out considering a wide range of displacement and mortality rates as requested by Natural England (OFF-ORN-2.50 **B1.1.1 Evidence Plan**). Further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**. The results of the PVA are summarised in **Table 17** below for impacts from displacement alone apportioned to the FFC SPA.

Table 16: Annual displacement matrix for breeding adult razorbills within the Hornsea Four array area plus 2 km buffer apportioned to the FFC SPA, values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	0	1	1	1	2	2	2	2	3	3
10	0	1	1	1	2	3	6	9	12	15	18	21	24	27	30
20	1	1	2	2	3	6	12	18	24	30	36	42	48	54	60
30	1	2	3	4	5	9	18	27	36	45	54	63	72	81	90
40	1	2	4	5	6	12	24	36	48	60	72	84	96	108	120
50	2	3	5	6	8	15	30	45	60	75	90	105	120	135	150
60	2	4	5	7	9	18	36	54	72	90	108	126	144	163	181
70	2	4	6	8	11	21	42	63	84	105	126	147	169	190	211
80	2	5	7	10	12	24	48	72	96	120	144	169	193	217	241
90	3	5	8	11	14	27	54	81	108	135	163	190	217	244	271
100	3	6	9	12	15	30	60	90	120	150	181	211	241	271	301

Table 17: Razorbill PVA results for impacts apportioned to the FFC SPA.

Scenario Description	Increase in Adult mortality	Density independent counterfactual of growth rate (after 35 years)	Reduction in growth rate (%)
Hornsea Four Alone 30% Displacement, 1% Mortality	0.90	1.000	0.00
Hornsea Four Alone 50% Displacement, 1% Mortality	1.50	1.000	0.00
Hornsea Four Alone 60% Displacement, 1% Mortality	1.81	1.000	0.00
Hornsea Four Alone 70% Displacement, 1% Mortality	2.11	1.000	0.01
Hornsea Four Alone 30% Displacement, 2% Mortality	1.81	1.000	0.01
Hornsea Four Alone 50% Displacement, 2% Mortality	3.01	1.000	0.01
Hornsea Four Alone 70% Displacement, 2% Mortality	4.21	1.000	0.01
Hornsea Four Alone 30% Displacement, 5% Mortality	4.51	1.000	0.01
Hornsea Four Alone 50% Displacement, 5% Mortality	7.52	1.000	0.02
Hornsea Four Alone 70% Displacement, 5% Mortality	10.53	1.000	0.03
Hornsea Four Alone 30% Displacement, 10% Mortality	9.03	1.000	0.03
Hornsea Four Alone 50% Displacement, 10% Mortality	15.05	1.000	0.04
Hornsea Four Alone 70% Displacement, 10% Mortality	21.07	0.999	0.06

10.4.4.110 The razorbill colony at FFC SPA has increased annually by on average just under 6% annually over the last 50 years (Table 51) (Lloyd et al. 2020), with further increase in the average annual growth rate to over 7% annually in the last 20 years. At present, it is noted that the razorbill annual growth for the FFC SPA colony over the next 35 years is unknown, but that there is no indication that this favourable status is changing or the rate of growth slowing.

10.4.4.111 Although evidence suggests that for auk species a displacement rate of 50% with 1% mortality is suitably precautionary for assessment (paragraph 10.4.4.10), due to Hornsea Four being closer to the FFC SPA than other OWFs in the North Sea, further evidence was requested to define the importance of the Hornsea Four array area in relation to auks from the FFC SPA to rule out Natural England's higher displacement range (OFF-ORN-2.52 B1.1.1 Evidence Plan).

10.4.4.112 The Flamborough Front (See Volume A5, Annex 1.1: Marine Processes Technical Report for detailed description) is an important foraging area to razorbills during the post-breeding migration bio-season whilst they undergo their post-breeding moult. As presented in Figure 15 The final Hornsea Four array area completely avoids the areas considered to constitute the band of water that forms the Flamborough Front, which is a considerable distance to the south, clearly showing there is no direct overlap or connectivity between the Flamborough Front and the Hornsea Four array area. This avoidance is a result of the DAA, from which Orsted undertook a review of the original AfL in order to take forward an array area that reduced the risk to auks from potential disturbance and displacement. As any connectivity to the Flamborough Front has been eliminated due to the DAA, The Hornsea Four array area therefore does not reside in an area of high importance to razorbills during the post-breeding migration bio-season, meaning the higher range of displacement and mortality can be dismissed as overly precautionary.

10.4.4.113 As clearly setout in **paragraph 10.4.4.82** though the DAA the areas of relatively high abundance within the wider Hornsea AFL are now excluded from the final Hornsea Four array area. Therefore, it can be concluded that Hornsea Four has excluded the areas of relatively high density from the final array area and in turn, the areas within the AFL likely to be of greater importance to razorbills. This means that using Natural England's upper ranges of displacement and mortality (over 50% displacement and over 1% mortality) for assessment can be considered overly precautionary and unsuitable for the basis of disturbance and displacement effects from Hornsea Four.

10.4.4.114 Consideration has also been given to the key foraging areas for guillemot during the breeding bio-season in order to further evidence that Hornsea Four does not reside within an area of importance to razorbills during the breeding bio-season. During 2010 to 2015, the RSPB and partners undertook a series of large-scale tracking studies of razorbills across the UK during the breeding season in order to map their UK wide, at-sea distributions (of which the FFC SPA was one of colonies tracked). These data were subject to analysis by Wakefield et al. (2017) in order to map razorbill distribution and their core foraging range, the result of this analysis is presented in **Figure 19**. Core foraging range was defined as the area of sea up to the 50% Utilisation Distribution (UD) band (Cleasby et al. 2018). The Hornsea Four array area and 4 km buffer were not located within any of the UD bands as shown in **Figure 19**, suggesting that the Hornsea Four array area and 4 km buffer does not lie within either the core foraging range or any other area of sea important to those razorbills tracked from the FFC SPA.

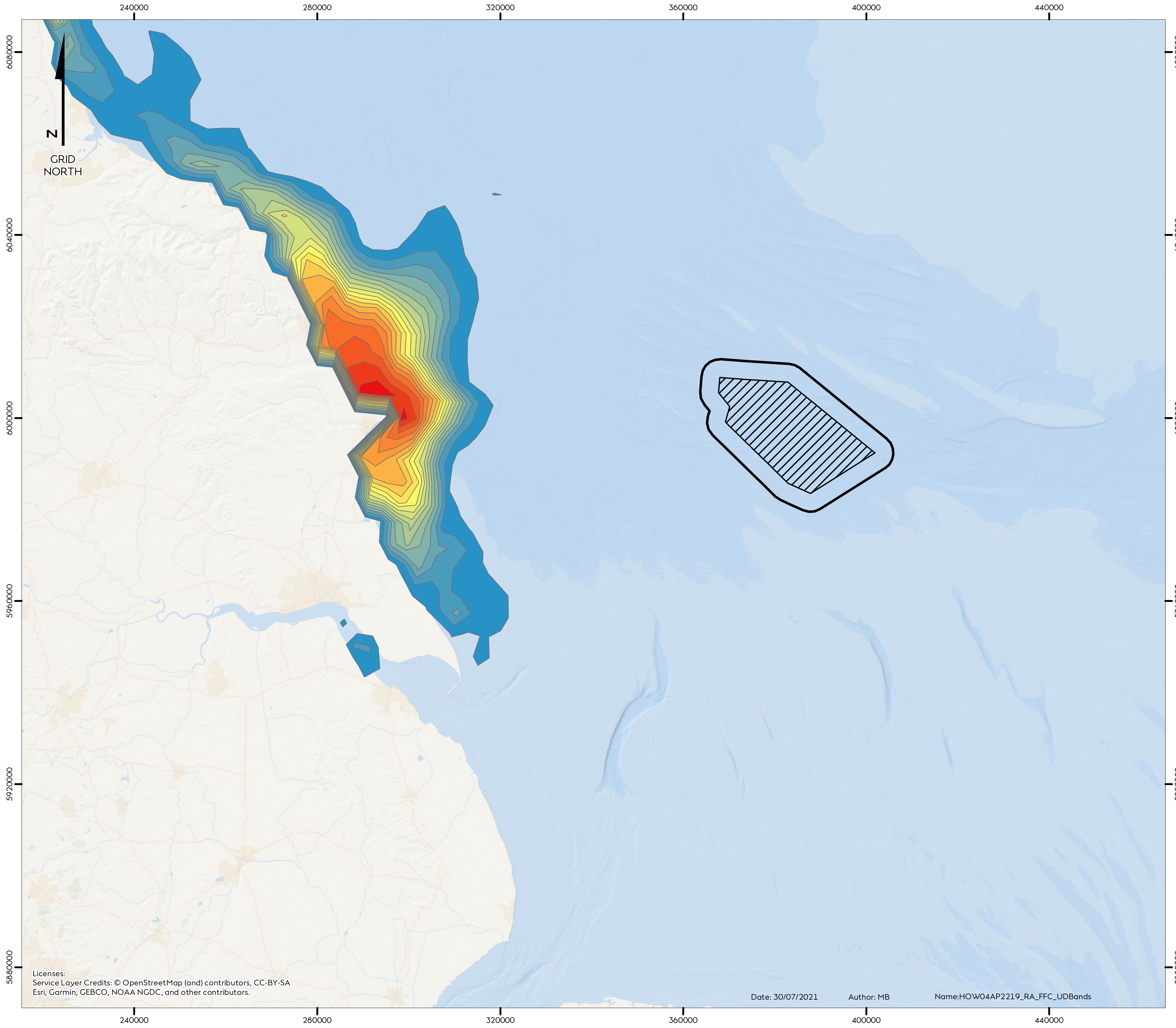
10.4.4.115 Further analysis of these tracking data was undertaken by Cleasby et al. (2018) using hotspot mapping techniques in order to identify important areas of high seabird density at sea. Maximum curvature and Getis-Ord analyses were used to generate SPA-level and UK-level hotspots as presented in **Figure 20** below. Regardless of the hotspot mapping technique utilised, the Hornsea Four array area and 4 km buffer were found to be outside the areas of sea suggested to be of importance to those razorbills tracked from the FFC SPA. Based on the modelling depicted in **Figure 19** and **Figure 20** it is clear that Hornsea Four will not displace razorbills from an area of importance during the migration-free breeding bio-season, therefore Natural England's upper displacement and mortality range can be dismissed.

10.4.4.116 In summary the Applicant's DAA to reduce potential disturbance and displacement of razorbills from the Hornsea Four array area has resulted in the following:

- The Hornsea Four array area does not have any direct overlap or connectivity to the Flamborough Front, an area of known importance to razorbills during their flightless post-breeding dispersal period (**Figure 15**);
- The Hornsea Four array area excludes the areas of higher relative razorbill density (and therefore areas of importance) during the extended breeding season (March to September) as depicted in **Figure 16**; and
- The Hornsea Four array area is not located within the known foraging areas of razorbills during the breeding season, meaning the Hornsea Four array area is not a

highly important area for razorbills foraging during the breeding season (**Figure 19** and **Figure 20**).

10.4.4.117 The above evidence clearly shows that the Hornsea Four array area is not an area of sea of high importance to razorbills during the breeding and subsequent post-breeding migration bio-season, the time periods where razorbills are most sensitive to disturbance and displacement effects. This means that using Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality) for assessment can be considered overly precautionary and unsuitable for the basis of disturbance and displacement effects from Hornsea Four.



Hornsea Four

Figure 19

Razorbill FFC SPA Utilisation Distributions in 5% Bands

DCO Array Area

DCO Array Area Plus 4 km Buffer

Razorbill UD Bands

5%
10%
15%
20%
25%
30%
35%
40%
45%
50%
55%
60%
65%
70%
75%
80%
85%
90%
95%

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:800,000

0 10 20 Kilometres

0 5 10 Nautical Miles

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Razorbill FFC SPA Utilisation Distributions in 5% Bands
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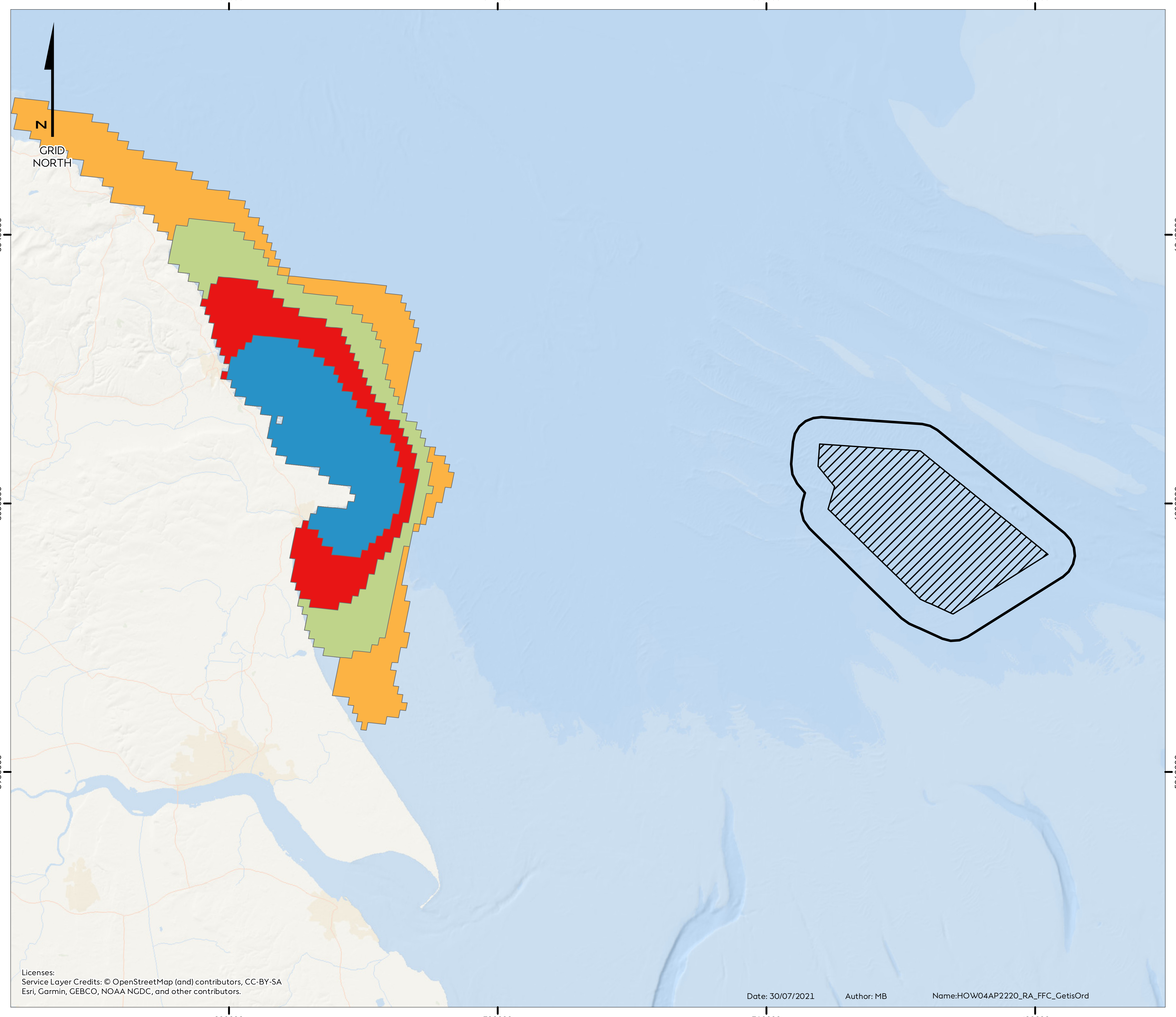
Hornsea Four

Figure 20

Razorbill FFC SPA Maximum Curviture and Getis-Ord Hotspots



- DCO Array Area
- DCO Array Area Plus 4 km Buffer
- Maximum Curvature
- Statistically Significant Getis-Ord hotspot - d = 7km
- Top 1% Getis-Ord hotspot - d = 7km
- Top 5% Getis-Ord hotspot - d = 7km

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:550,000

0 10 20 Kilometres

0 5 10 Nautical Miles

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Razorbill FFC SPA Maximum Curviture and Getis-Ord Hotspots

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10.4.4.118 Given that the Hornsea Four array area avoids those areas of highest auk density, based on both the RSPB tracking results and the site-based surveys, the evidence demonstrates that the Hornsea Four array area is not within an area of sea of high importance to razorbills. Therefore, the higher displacement and mortality ranges suggested by Natural England can be regarded as overly precautionary.

10.4.4.119 Natural England have previously stated that a maximum reduction in the growth rate of 0.5% would not cause an AEoI of the razorbill feature of the FFC SPA (Natural England, 2021b), although when considering the actual annual growth rate over the past 50 years has been just under 6% annually it's highly plausible that a higher reduction in growth rate would still not lead to a reduction in the population or, therefore, an AEoI. The results of the PVA for scenarios up to 70% Displacement and a 10% mortality rate, which equates to a fourteenfold increase in predicted mortalities when compared to the realistic predicted mortality form 50% displacement and 1% mortality, would not exceed a reduction in growth rate of over 0.5%, therefore, even when considering this extremely overly precautionary approach to assessing the in-combination impacts (even when considering up to an overly precuationary 70% Displacement and a 10% mortality rate) the target for the razorbill feature of the FFC SPA to maintain the size of the breeding population at a level which is above 10,570 breeding pairs (21,140 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent would still be met for the FFC SPA over the operational lifespan of Hornsea Four. There is, therefore, no potential for an AEoI to the conservation objectives of the razorbill feature of FFC SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – puffin

10.4.4.120 Puffin has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.4.121 Based on the above the conservation objective for the FFC SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 216,730 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.122 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on puffin as a feature, but more as an important component of the seabird assemblage.

10.4.4.123 Puffin has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance. The Hornsea Four array area is within the mean max foraging distance of 137.1 km to the FFC SPA at 63 km distant and also within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding bio-season. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the breeding bio-season, defined as being the months of April to July by Furness (2015) and the non-breeding bio-season of August to March.

10.4.4.124 In order to assess the potential impact on puffin a displacement effect distance was determined of the array area and within a buffer out to 2 km. Within that displacement effect area, the percentage of birds displaced from the array area was set at 50% during all bio-seasons and within the 2 km buffer. The level of mortality consequential on displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 10.4.4.10**.

10.4.4.125 Natural England consider displacement and any consequent mortality rates in the assessments of puffin should be made using a range of values. The displacement matrix in **Table 18** provides a displacement matrix for the annual total of puffins apportioned to FFC SPA predicted to be at risk of displacement from the Hornsea Four array area plus 2 km buffer (OFF-ORN-4.8 **B1.1.1 Evidence Plan**) when applying any value of displacement or mortality. Summary statements applying the lower end (a displacement rate of 30% and a mortality rate of 1%) and extreme upper end (a displacement rate of 70% and a mortality rate of 10%) of Natural England's range of displacement and consequent mortality rates are also considered within this assessment, though Natural England acknowledge that the use of displacement mortality rates from the upper end of the range are not likely (Natural England 2020).

10.4.4.126 The number of puffins estimated to occur in the array area and a 2 km buffer is 153 individuals in the breeding bio-season and 353 in the non-breeding bio-season. All abundance data in the assessment below is drawn from Table 2 of **Volume A5, Annex 5.2 Offshore Ornithology Displacement Analysis**. The potential for impact on the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding season may contain a higher proportion of adult birds that can be attributed to a nearby breeding colony SPA than during the non-breeding bio-season.

10.4.4.127 For the purpose of this assessment, the proportion of adult puffins present in the array and 2 km buffer during the breeding bio-season was considered to be 0.96, as derived from Appendix A: Table 68 of Furness for FFC SPA. The data presented in Furness (2015) are considered to provide a more accurate representation of population age structure than site-based data, since it was not possible to distinguish adults from immatures in the latter. Furness (2015) draws upon a wide number of data sources gathered across multiple years in order to model population age structure and is therefore considered appropriate for this purpose.

10.4.4.128 Furthermore, not all adult puffins present in the array area and 2 km buffer will be breeding birds. This is evidenced from adult sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017). A sabbatical rate of 7% for puffin populations was recently agreed by Marine Scotland for inclusion in all three revised Forth and Tay OWF applications (Neart na Gaoithe OWF, Seagreen Alpha and Bravo OWF, and Inch Cape OWF) in relation to a number of east-coast SPAs designated for breeding puffins (Marine Scotland 2017). As such, this value has been applied for use in this assessment of puffins from FFC SPA.

10.4.4.129 After consideration of the proportion of immature puffins present, together with the sabbatical rate, the overall proportion of adult breeding puffins from FFC SPA was determined to be 89.28% following this evidence-led approach.

10.4.4.130 Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. The UK North Sea population during the non-breeding bio-season is 231,957 individuals. Fifty percent of the breeding birds from the FFC SPA remain in the UK North Sea in the non-breeding season, which is a population of 3,759 individuals based on the mean of the 2017 & 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**) or 1,916 breeding individuals when considering the colony count data used to underpin the UK North Sea population (Furness 2015). Therefore, there would be 958 breeding adults remaining in the UK North Sea (based on 50% Furness (2015) population). Accordingly, the proportion of birds in the UK North Sea that can be attributed to the SPA is 0.41% when considering the apportionment of populations within the UK North Sea population according to Furness (2015). Following this approach, the proportion of the BDMPS populations from FFC SPA during non-breeding bio-season of 0.41% was agreed as appropriate for other auk species by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the EP process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

Breeding Season

10.4.4.131 The number of puffins predicted to be displaced from the array area and a 2 km buffer in the breeding bio-season is 77 (76.74) individuals (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than one (0.77) individual. On the basis of 89.28% of all the birds predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.69) breeding adult.

10.4.4.132 When considering the potential impact of the loss of less than one breeding adult to the FFC SPA of 3,759 breeding adults based on the mean of the 2017 / 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with an annual background mortality of this number of adult birds being 336 breeding adults, then using this prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.20% increase in baseline mortality during the breeding bio-season per annum.

10.4.4.133 Should Natural England's range of displacement mortality rates (applying a range of 30% and 70% displacement and 1% to 10% mortality) be considered alongside the evidence-led apportionment, then the potential impact of this loss to the FFC SPA based on the mean of the 2017 and 2018 colony counts, then using the lower end of the range (applying rates of 30% displacement and 1% mortality) a prediction of less than one (0.41) breeding adult suffering displacement consequent mortality would represent a 0.12% increase in baseline mortality. When considering the potential impact of this loss to the most recent FFC SPA population using the upper end of the range (applying rates of 70% displacement and 10% mortality) then this prediction of 10 (9.59) breeding adults suffering displacement consequent mortality would represent a 2.85% increase in baseline mortality.

Non-breeding Season

10.4.4.134 The number predicted to be displaced from the array area and a 2 km buffer (applying displacement rates of 50%) in the non-breeding bio-season is 176 (176.42) individuals. The predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than two (1.76) individuals during the non-breeding bio-season. On the basis of 0.41% of all the birds in the non-breeding bio-season predicted to be displaced being breeding adult birds from the FFC SPA, then the consequent mortality from being displaced is estimated at less than one (0.01) breeding adult per annum in the non-breeding bio-season.

10.4.4.135 When considering less than one breeding adult may be subject to displacement consequent mortality that can be attributed to the SPA during the non-breeding bio-season, then this represents less than a 0.01% increase in baseline mortality to the mean of the 2017 / 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**) of the FFC SPA.

10.4.4.136 Should Natural England's range of displacement mortality rates (applying a range of 30% and 70% displacement and 1% to 10% mortality) be considered alongside the evidence-led apportionment, then the potential impact of this loss to the FFC SPA based on the mean of the 2017 and 2018 colony counts, then using the lower end of the range (applying rates of 30% displacement and 1% mortality) predicts no discernible change in the baseline mortality rate. When considering the potential impact of this loss to the most recent FFC SPA population using the upper end of the range (applying rates of 70% displacement and 10% mortality) then the prediction of less than one (0.10) breeding adult suffering displacement consequent mortality would represent a 0.03% increase in baseline mortality.

Annual Total

10.4.4.137 The impact of displacement on puffin from within the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of less than one (0.69) breeding adult across all bio-seasons per annum. This equates to an increase in the baseline mortality of the 2017 / 2018 colony count (OFF-ORN-2.30 **B1.1.1 Evidence Plan**) of 0.21% across all bio-seasons per annum.

10.4.4.138 Although the use of Natural England's range of 30% to 70% displacement and 1% to 10% mortality is considered extremely unlikely, as previously stated, should this range of displacement mortality rates (applying a range of 30% and 70% displacement and 1% to 10% mortality) be considered alongside the evidence-led apportionment, then the impact of displacement from the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of between less than one (0.42) and 10 (9.69) breeding adults across all bio-seasons per annum. This potential level of impact is predicted to increase in the baseline mortality of the 2017 / 2018 colony count (OFF-ORN-2.30 **B1.1.1 Evidence Plan**) by between 0.12% and 2.88% across all bio-seasons per annum. However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10**, **10.4.4.82** and **10.4.4.111** levels of 70% displacement combined with 10% mortality are acknowledged to be overly precautionary and unsuitable for assessment. This conclusion matches the advice Natural England have given on the matter of auk displacement to other offshore wind developers, based on the evidence suggesting the project areas do not reside in areas of sea desirable for auks to forage (Natural England, 2020, 2021b). Therefore, considering the loss of such a small number of breeding adults to a population this level of effect would not affect the achievement of the conservation objectives for the SPA and as a result would not have an adverse effect on the integrity of the SPA.

10.4.4.139 There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage, of which puffin is a named component, of FFC SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four and therefore, subject to natural change, puffin will be maintained as a feature in the long term.

Table 18: Annual displacement matrix for breeding adult puffins within the Hornsea Four array area plus 2 km buffer apportioned to the FFC SPA, values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1
10	0	0	0	1	1	1	3	4	6	7	8	10	11	12	14
20	0	1	1	1	1	3	6	8	11	14	17	19	22	25	28
30	0	1	1	2	2	4	8	12	17	21	25	29	33	37	42
40	1	1	2	2	3	6	11	17	22	28	33	39	44	50	55
50	1	1	2	3	3	7	14	21	28	35	42	48	55	62	69
60	1	2	2	3	4	8	17	25	33	42	50	58	66	75	83
70	1	2	3	4	5	10	19	29	39	48	58	68	78	87	97
80	1	2	3	4	6	11	22	33	44	55	66	78	89	100	111
90	1	2	4	5	6	12	25	37	50	62	75	87	100	112	125
100	1	3	4	6	7	14	28	42	55	69	83	97	111	125	138

Coquet Island SPA – puffin

10.4.4.140 Puffin has been screened in for the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.4.141 Based on the above the conservation objective for the Coquet Island SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 47,662 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.142 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on puffin as a feature, but more as an important component of the seabird assemblage.

10.4.4.143 Puffin has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area and 2 km buffer during maintenance.

10.4.4.144 Coquet Island SPA, at 200.9 km from the Hornsea Four array area, is outside the mean max foraging distance of 137.1 km but is within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). However, at this level of distance it's highly improbable that breeding adults from this SPA would regularly forage out to the distance required to reach the Hornsea Four array area. Furthermore, following the breeding bio-season attribution to establish potential impacts on puffin from the Flamborough and Filey Coast SPA 100% of breeding adult mortalities (OFF-ORN-6.11 **B1.1.1 Evidence Plan**), in this instance 10 breeding adults, were attributed on a worst-case basis (using Natural England's recommended displacement rate of 70% and 10% mortality) to that site. Considering the distance from the array area to Coquet Island SPA it is highly unlikely that any further refinement of the apportionment of mortality attributed to the FFC SPA would add up to a single breeding individual which could be attributed to Coquet Island SPA. Therefore, on this basis there is no potential for an AEoI during the breeding bio-season for the puffin feature of the Coquet Island SPA, and assessment of impacts attributed to Coquet Island SPA focuses only on the non-breeding season.

10.4.4.145 In order to assess the potential impact on puffin a displacement effect distance was determined of the array area and within a buffer out to 2 km. Following an evidence-led approach the number of puffins estimated to be displaced (applying a 50% displacement rate) from the array area and 2 km buffer in the non-breeding bio-season is 176 (176.42) individuals. For the total number of individuals across the non-breeding bio-season the predicted consequent mortality from being displaced (applying a 1% mortality rate) is estimated for puffin at two (1.76) individuals. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **Volume A2, Chapter 5: Offshore & Intertidal Ornithology**, Section 5.11.

10.4.4.146 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to Coquet Island SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out, which is 24,688 breeding adults for Coquet Island SPA. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some colonies, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the non-breeding bio-season is 231,957 individuals for puffin. Furness estimated that 50% of puffins from Coquet Island SPA remain in the UK North Sea and English Channel during the non-breeding bio-season, which means 12,344 breeding adults remain representing 5.32% of the non-breeding population.

10.4.4.147 When considering 5.32% of puffins during the non-breeding bio-season are from the Coquet Island SPA then this value is applied to the estimated displacement mortality rate from Hornsea Four array area and 2 km buffer. Therefore, the estimated displacement mortality rate for puffins from Coquet Island associated with Hornsea Four is 5.32% of two individuals, which is under a single (0.09) breeding adult per annum. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rates Coquet Island SPA, which would be 2,978 breeding adults per annum of the citation population of 31,686 breeding adults. Based on this mortality rate the increase in baseline mortality would be well under 0.01% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for the Coquet Island SPA and as a result Hornsea Four will not have an adverse effect on the integrity of the puffin feature of this SPA.

10.4.4.148 Should Natural England's range of displacement mortality rates (Applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of less than one (0.06) to one (1.31) breeding adult from the SPA in the non-breeding bio-season. The predicted increase in baseline mortality would be a maximum of 0.04% in the non-breeding bio-season per annum. This will not affect the achievement of the conservation objectives for the SPA and as a result will not have an adverse effect on the integrity of the SPA.

10.4.4.149 There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage of Coquet Island SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone on puffin and therefore, subject to natural change, puffin will be maintained as a feature of the seabird assemblage in the long term.

Farne Islands SPA – guillemot

10.4.4.150 Guillemot has been screened in for the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the Farne Islands SPA:

- Maintain the population of each of the qualifying features.

10.4.4.151 Based on the above the conservation objective for the Farne Islands SPA the specific target for the guillemot feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 32,875 breeding pairs (65,750 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

10.4.4.152 Guillemot has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance.

10.4.4.153 The Farne Islands SPA, at a distance of 225.2 km from the Hornsea Four array area, is outside both the mean max of 73.2 km and mean max plus 1 SD foraging range of 153.7 km (Woodward et al. 2019) for this species when attending a breeding colony and as a result no breeding bio-season assessment is required.

10.4.4.154 In order to assess the potential impact on guillemot a displacement effect distance was determined of the array area and within a buffer out to 2 km. Following an evidence-led approach the number of guillemots estimated to be displaced (applying a 50% displacement rate) from the array area and 2 km buffer in the non-breeding bio-season is 8,531 (8,530.87) individuals. The predicted consequent mortality from being displaced (applying a 1% mortality rate) is estimated at 85 (85.31) individuals. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **Volume A2, Chapter 5: Offshore & Intertidal Ornithology**, Section 5.11.

10.4.4.155 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to theFarne Islands SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out, which is 67,064 breeding adults for the Farne Islands SPA. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some colonies, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the non-breeding bio-season is 1,617,306 individuals for guillemot. Furness estimated that 90% of guillemots from the Farne Islands SPA remain in the UK North Sea and English Channel during the non-breeding bio-season, which means 60,358 breeding adults remain representing 3.73% of the non-breeding population.

10.4.4.156 When considering 3.73% of guillemots during the non-breeding bio-season are from the Farne Islands SPA, then this value is applied to the estimated displacement mortality rate from Hornsea Four array area and 2 km buffer. Therefore, the estimated displacement mortality rate for guillemot from the Farne Islands associated with Hornsea Four is 3.73% of 85 individuals, equating to three (3.18) breeding adults per annum. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rates of guillemots from the Farne Islands SPA, which would be 4,011 breeding adults per annum of the citation population of 65,751 breeding adults. Based on this mortality rate the increase in baseline mortality would be 0.08% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for the Farne Islands SPA and as a result Hornsea Four will not have an adverse effect on the integrity of the guillemot feature of this SPA.

10.4.4.157 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of between two (1.91) and 45 (44.55) breeding adults from the SPA in the non-breeding bio-season. This equates to a predicted increase in baseline mortality of between 0.05% and 1.11% in the non-breeding bio-season per annum. However, levels of 70% displacement combined with 10% mortality are acknowledged by Natural England to be highly unlikely in this instance (Natural England, 2020). Therefore, the impact from displacement from Hornsea Four during its operational life will not affect the achievement of the conservation objectives for the SPA and as a result will not have an adverse effect on the integrity of the SPA.

10.4.4.158 There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of the Farne Islands SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Farne Islands SPA – puffin

10.4.4.159 Puffin has been screened in for the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

10.4.4.160 Based on the above the conservation objective for the Farne Islands SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 163,819 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.161 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on puffin as a feature, but more as an important component of the seabird assemblage.

10.4.4.162 Puffin has been screened into the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance.

10.4.4.163 The Farne Islands SPA, at a distance of 225.2 km from the Hornsea Four array area, is outside the mean max foraging distance of 137.1 km but is within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). However, at this level of distance it is highly improbable that breeding adults from the SPA would regularly forage out to the distance required to reach the Hornsea Four array area (mean max plus 1 SD). Furthermore, following the breeding bio-season attribution to establish impacts on puffin from the Flamborough and Filey Coast SPA of 100% breeding adult mortalities (OFF-ORN-6.11 **B1.1.1 Evidence Plan**), in this instance 10 breeding adults, were attributed on a worst-case basis (using Natural England's recommended displacement rate of 70% and 10% mortality) to that site. Considering the distance to the Farne Islands SPA, it is highly unlikely that any further refinement of the apportionment of mortality attributed to the FFC SPA would add up to a single individual which could be attributed to the Farne Islands SPA. Therefore, on this basis there is no potential for an AEoI during the breeding bio-season for the puffin feature of the Farne Islands SPA, and assessment of impacts attributed to the Farne Islands SPA focuses only on the non-breeding bio-season.

10.4.4.164 In order to assess the potential impact on puffin a displacement effect distance was determined of the array area and within a buffer out to 2 km. Following an evidence-led approach the number of puffins estimated to be displaced (applying a 50% displacement rate) from the array area and 2 km buffer in the non-breeding bio-season is 176 (176.42) individuals.

10.4.4.165 For the total number of individuals across the non-breeding bio-seasons the predicted consequent mortality from being displaced (applying a 50% displacement with 1% mortality rate) is estimated for puffin at two (1.76) individuals. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **Volume A2, Chapter 5: Offshore & Intertidal Ornithology**, Section 5.11.

10.4.4.166 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to Farne Islands SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out, which is 79,924 breeding adults for the Farne Islands SPA. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some colonies, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the non-breeding bio-season is 231,957 individuals for puffin. Furness estimated that 50% of puffins from the Farne Islands SPA remain in the UK North Sea and English Channel during the non-breeding bio-season, which means 39,962 breeding adults remain representing 17.23% of the non-breeding population.

10.4.4.167 When considering 17.23% of puffins during the non-breeding bio-season are from the Farne Islands SPA then this value is applied to the estimated displacement mortality rate from Hornsea Four array area and 2 km buffer. Therefore, the estimated displacement mortality rate for puffins from the Farne Islands SPA associated with Hornsea Four is 17.23% of two individuals, which equates to under a single (0.30) breeding adult per annum. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rate at the Farne Islands SPA, which would be 7,219 breeding adults per annum of the citation population of 76,798 breeding adults. Based on this mortality rate the increase in baseline mortality would be under 0.01% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for the Farne Islands SPA and as a result Hornsea Four will not have an adverse effect on the integrity of the puffin feature of this SPA.

10.4.4.168 Should Natural England's range of displacement mortality rates (Applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of between less than one (0.18) and four (4.26) breeding adults from the SPA in the non-breeding bio-season. The increase in baseline mortality of well under 0.01% and 0.06% in the non-breeding bio-season per annum, will not affect the achievement of the conservation objectives for the SPA and as a result will not have an adverse effect on the integrity of the SPA. However, based on the evidence put forward for guillemots in **paragraph 10.4.4.10** and **10.4.4.82** levels of 70% displacement combined with 10% mortality are acknowledged to be overly precautionary and unsuitable for assessment. This conclusion matches the advice Natural England have given on the matter of auk displacement to other offshore wind developers based on the evidence suggesting the project areas do not reside in areas of sea desirable for auks to forage (Natural England, 2020, 2021b).

10.4.4.169 There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage of the Farne Islands SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone on puffin and therefore, subject to natural change, puffin will be maintained as a feature of the seabird assemblage in the long term.

Northumberland Marine SPA – guillemot

10.4.4.170 Guillemot has been screened in for the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the Northumberland Marine SPA:

- Maintain the population of each of the qualifying features.

10.4.4.171 Based on the above the conservation objective for the Farne Islands SPA the specific target for the guillemot feature is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 65,750 individuals, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

10.4.4.172 Although guillemots within the Northumberland Marine SPA are from the Farne Islands SPA, for the purpose of this assessment they have been considered separately for completeness.

10.4.4.173 Guillemot has been screened in for the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance.

10.4.4.174 The Northumberland Marine SPA, at a distance of 187 km from the Hornsea Four array area, is outside both the mean max of 73.2 km and mean max plus 1 SD foraging range of 153.7 km (Woodward et al. 2019) for this species when attending a breeding colony and as a result no breeding bio-season assessment is required.

10.4.4.175 In order to assess the potential impact on guillemot a displacement effect distance was determined of the array area and within a buffer out to 2 km. Following an evidence-led approach the number of guillemots estimated to be displaced (applying a 50% displacement rate) from the array area and 2 km buffer in the non-breeding bio-season is 8,531 (8,530.87) individuals. The predicted consequent mortality from being displaced (applying a 1% mortality rate) is estimated at 85 (85.31) individuals. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **Volume A2, Chapter 5: Offshore & Intertidal Ornithology,** Section 5.11.

10.4.4.176 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to the Northumberland Marine SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out, which is 67,064 breeding adults for the Farne Islands SPA, which is used in this instance as that colony constitutes the birds within the citation for the Northumberland Marine SPA. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some colonies, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the non-breeding bio-season is 1,617,306 individuals for guillemot. Furness estimated that 90% of guillemots from the Farne Islands SPA remain in the UK North Sea and English Channel during the non-breeding bio-season, which means 60,358 breeding adults remain representing 3.73% of the non-breeding population.

10.4.4.177 When considering 3.73% of guillemots during the non-breeding bio-season are from the Northumberland Marine SPA, then this value is applied to the estimated displacement mortality rate from Hornsea Four array area and 2 km buffer. Therefore, the estimated displacement mortality rate for guillemot from the Northumberland Marine SPA associated with Hornsea Four is 3.73% of 85 individuals, equating to three (3.18) breeding adults per annum. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rates of guillemots from the Northumberland Marine SPA, which would be 4,011 breeding adults per annum of the citation population of 65,751 breeding adults. Based on this mortality rate the increase in baseline mortality would be 0.08% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for the Northumberland Marine SPA and as a result Hornsea Four will not have an adverse effect on the integrity of the guillemot feature of this SPA.

10.4.4.178 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of between two (1.91) and 45 (44.55) breeding adults from the SPA in the non-breeding bio-season. This equates to a predicted increase in baseline mortality of between 0.05% and 1.11% in the non-breeding bio-season per annum. However, levels of 70% displacement combined with 10% mortality are acknowledged by Natural England to be highly unlikely in this instance (Natural England, 2020). Therefore, the impact from displacement from Hornsea Four during its operational life will not affect the achievement of the conservation objectives for the SPA and as a result will not have an adverse effect on the integrity of the SPA.

10.4.4.179 There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of the Northumberland Marine SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Northumberland Marine SPA – puffin

10.4.4.180 Puffin has been screened in for the assessment of the O&M phase to assess the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the Northumberland Marine SPA:

- Maintain the population of each of the qualifying features.

10.4.4.181 Based on the above the conservation objective for the Northumberland Marine SPA the specific target for puffin is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of puffin at a level, which is above 108,484 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.182 Although puffins within the Northumberland Marine SPA are from Coquet Island SPA (31,686 breeding adults) and the Farne Islands SPA (76,798 breeding adults), for the purpose of this assessment they have been considered together within the Northumberland Marine SPA for completeness (total 108,484 breeding adults).

10.4.4.183 Puffin has been screened into the assessment of the O&M phase on the basis of its sensitivity to the presence of the WTGs and the activities which will take place within the array area during maintenance.

10.4.4.184 The Northumberland Marine SPA, at a distance of 187 km from the Hornsea Four array area, is outside the mean max foraging distance of 137.1 km but is within the mean max plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). However, at this level of distance it is highly improbable that breeding adults from the SPA would regularly forage out to the distance required to reach the Hornsea Four array area (mean max plus 1 SD). Furthermore, following the breeding bio-season attribution to establish impacts on puffin from the FFC SPA of 100% breeding adult mortalities (OFF-ORN-6.11 **B1.1.1 Evidence Plan**), in this instance 10 breeding adults, were attributed on a worst-case basis (using Natural England's recommended displacement rate of 70% and 10% mortality) to that site. Considering the distance to the Northumberland Marine SPA, it is highly unlikely that any further refinement of the apportionment of mortality attributed to the FFC SPA would add up to a single individual which could be attributed to the Northumberland Marine SPA. Therefore, on this basis there is no potential for an AEoI during the breeding bio-season for the puffin feature of the Northumberland Marine SPA, and assessment of impacts attributed to the Northumberland Marine SPA focuses only on the non-breeding bio-season.

10.4.4.185 In order to assess the potential impact on puffin a displacement effect distance was determined of the array area and within a buffer out to 2 km. Following an evidence-led approach the number of puffins estimated to be displaced (applying a 50% displacement rate) from the array area and 2 km buffer in the non-breeding bio-season is 176 (176.42) individuals.

10.4.4.186 For the total number of individuals across the non-breeding bio-seasons the predicted consequent mortality from being displaced (applying a 50% displacement with 1% mortality rate) is estimated for puffin at two (1.76) individuals. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **Volume A2, Chapter 5: Offshore & Intertidal Ornithology**, Section 5.11.

10.4.4.187 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to Northumberland Marine SPA (located at the Farne Islands and Coquest Island SPA) has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out, which is 79,924 breeding adults for the Farne Islands SPA and 24,688 breeding adults for Coquet Island SPA. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some colonies, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the non-breeding bio-season is 231,957 individuals for puffin. Furness estimated that 50% of puffins from the Farne Islands SPA and Coquet Island SPA remain in the UK North Sea and English Channel during the non-breeding bio-season, which means 39,962 and 12,344 breeding adults remain representing 17.23% and 5.32% of the non-breeding population, respectively. Therefore, the total number of breeding adults from the Northumberland Marine SPA remaining in the UK North Sea and English Channel is estimated at 52,306, representing 22.55% of the non-breeding population.

10.4.4.188 When considering 22.55% of puffins during the non-breeding bio-season are from the Northumberland Marine SPA then this value is applied to the estimated displacement mortality rate from Hornsea Four array area and 2 km buffer. Therefore, the estimated displacement mortality rate for puffins from the Northumberland Marine SPA associated with Hornsea Four is 22.55% of two individuals, which equates to under a single (0.40) breeding adult per annum. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rate at the Northumberland Marine SPA, which would be 10,197 breeding adults per annum of the citation population of 108,484 breeding adults. Based on this mortality rate the increase in baseline mortality would be under 0.01% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for the Northumberland Marine SPA and as a result Hornsea Four will not have an adverse effect on the integrity of the puffin feature of this SPA.

10.4.4.189 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the impact of displacement from the array area and a 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of between less than one (0.24) and less that six (5.57) breeding adults from the SPA in the non-breeding bio-season. This equates to a predicted increase in baseline mortality of well under 0.01% to 0.05% in the non-breeding bio-season per annum. However, levels of 70% displacement combined with 10% mortality are acknowledged by Natural England to be highly unlikely in this instance (Natural England, 2020), this is further supported by the evidence presented in **paragraphs 10.4.4.10** and **10.4.4.82**. Therefore, the impact from displacement from Hornsea Four during its operational life will not affect the achievement of the conservation objectives for the SPA and as a result will not have an adverse effect on the integrity of the SPA.

10.4.4.190 There is, therefore, no potential for an AEoI to the conservation objectives of the puffin feature of the Northumberland Marine SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone on puffin and therefore, subject to natural change, puffin will be maintained as a feature in the long term.

Scottish SPAs – non-breeding and migratory auk species

10.4.4.191 Guillemot, razorbill and puffin from Scottish SPAs have been screened in for the assessment of the O&M phase to assess the the impacts from disturbance and displacement from Hornsea Four alone in relation to the following conservation objectives for the species, as a qualifying feature or component of the seabird assemblage of the SPA:

- Maintain the population of the species as a viable component of the site in the long-term.

10.4.4.192 A number of SPAs within Scottish waters were screened in for this assessment to cosider the potential for mortality resultant from disturbance and displacement to result in an AEoI with respect to these SPA's auk species features (guillemot, razobill and puffin). These are;

- St Abb's SPA (guillemot & razorbill);

- Forth Islands (UK) SPA (guillemot, razorbill & puffin);
- Outer Firth of Forth and St Andrew's Complex pSPA (guillemot & puffin);
- Fowlsheugh SPA (guillemot & razorbill);
- Buchan Ness to Collieston Coast SPA (guillemot);
- Troup, Pennan and Lion's Heads SPA (guillemot & razorbill);
- East Caithness Cliffs SPA (guillemot & razorbill);
- North Caithness Cliffs SPA (guillemot, razorbill & puffin);
- Copinsay SPA (guillemot);
- Hoy SPA (guillemot & puffin);
- Marwick Head SPA (guillemot);
- Rousay SPA (guillemot);
- Calf of Eday SPA (guillemot);
- West Westray SPA (guillemot & razorbill);
- Fair Isle SPA (guillemot, razorbill & puffin);
- Sumburgh Head SPA (guillemot);
- Noss SPA (guillemot & puffin);
- Foula SPA (guillemot, razorbill & puffin); and
- Hermaness, Saxa Vord and Valla Field SPA (guillemot & puffin).

10.4.4.193 In order to provide a more concise review of all such sites, and in response to Section 42 Consultation Responses from the RSPB and Natural England (**Table 1**), the methods for considering auk species potentially susceptable to disturbance and displacement from more distant designated sites in Scottish waters are considered in this section together.

10.4.4.194 The potential for impact on Scottish SPA auk features varies by season and accordingly this assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max (plus 1 SD) foraging range according to Woodward et al. (2019). Outside the breeding bio-season, when the population within UK North Sea and English Channel waters contains a mix of birds from UK breeding colonies and breeding colonies from further afield, then a much lower percentages of birds can be attributed to any particular breeding colony SPA population. In the breeding bio-season the mean max (plus 1 SD) foraging distance from Woodward et al. (2019) can be used to determine which breeding colonies the birds may be apportioned to and in the non-breeding season the information on populations contained in Furness (2015) is considered most approrpaite to be applied.

10.4.4.195 The Hornsea Four array area is beyond the mean max foraging distance (plus 1 SD) for guillemot of 73.2 km (plus 80.5 km), razorbill of 88.7 km (plus 75.9 km) and puffin of 137.1 km (plus 128.3 km) to any of these Scottish SPAs screened in (Woodward et al. 2019). Accordingly, the three auks species are only assessed for the non-breeding bio-season for each of the Scottish SPAs screened in.

10.4.4.196 In the non-breeding bio-seasons the number of guillemot, razorbill and puffin estimated to occur in the array area and 2 km buffer in have been estimated from site-specific data (**Volume A5, Annex 5.1: Offshore and Intertidal Ornithology Baseline Characterisation Report**). For guilemot and puffin the abundance estimates for the non-breeding bio-season were calculated to be 17,062 and 353 individuals, respectively. For razorbill the abundance estimates were 371 individuals for the return migration bio-season, 3,590 individuals for in the post-breeding migration bio-season and 474 individuals for in the migration-free winter bio-season.

10.4.4.197 For the total number of individuals across the non-breeding bio-seasons the predicted consequent mortality from being displaced (applying a 50% displacement, with 1% mortality rate) is estimated for guillemot at 85 individuals and for puffin at two individuals. For razorbill it is estimated to be 18 individuals in the post-breeding migration bio-season, two individuals in the migration-free winter bio-season and two individuals in the return migration bio-season.

10.4.4.198 In the non-breeding bio-seasons these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to each Scottish SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the non-breeding bio-season is 1,617,306 individuals for guillemot and 231,975 for puffin. The UK North Sea and English Channel population for razorbill during the migration-free winter bio-seasons is 218,622 individuals and during the migratory bio-seasons is 591,874 individuals.

10.4.4.199 According to Furness (2015) differing percentages of each species from each Scottish SPA remain in the UK North Sea and English Channel in their consistuent non-breeding bio-seasons, which are presented in **Table 19** to **Table 22**. Accordingly, the proportion of birds in the UK North Sea and English Channel that can be attributed to each each Scottish SPA is the remaining population as a proportion of the entire population for each auk species during this period, for which each Scottish SPA is presented as a percentage for each auk species. On that basis the number of individuals for each auk species that may potentially suffer displacement consequent mortality can be attributed to each Scottish SPA (**Table 19** to **Table 22**). Following this attribution of mortality rates for each auk species to specific Scottish SPAs a further calculation of what this represents as a percentage increase relative to baseline mortality is also considered.

Table 19: Apportionment of potential guillemot displacement and mortality values from Hornsea Four to Scottish SPAs during the non-breeding bio-season in the UK North Sea and English Channel.

Scottish SPA	Adult population of the SPA remaining in UK North Sea & English Channel (Furness 2015)	SPA population as a percentage of the North Sea and English Channel (%)	Proportioned displacement mortality based on 50% Disp 1% Mort for each SPA (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the non-breeding bio-season (%)
St Abb's SPA	39,785	2.46	2.10	31,750	0.08
Forth Islands (UK) SPA	26,413	1.63	1.39	32,000	0.11
Outer Firth of Forth and St Andrew's Complex pSPA*	25,311	1.57	1.34	28,123	0.07
Fowlsheugh SPA	48,160	2.98	2.54	56,450	0.08
Buchan Ness to Collieston Coast SPA	20,685	1.28	1.09	17,280	0.07
Troup, Pennan and Lion's Heads SPA	15,313	0.95	0.81	44,600	0.10
East Caithness Cliffs SPA	149,100	9.22	7.86	106,700	0.03
North Caithness Cliffs SPA	65,800	4.07	3.47	38,300	0.12
Copinsay SPA	7,850	0.49	0.41	29,450	0.15
Hoy SPA	8,820	0.55	0.47	13,400	0.02
Marwick Head SPA	15,536	0.96	0.82	37,700	0.06
Rousay SPA	8,680	0.54	0.46	10,600	0.04
Calf of Eday SPA	8,820	0.55	0.47	12,645	0.07

Scottish SPA	Adult population of the SPA remaining in UK North Sea & English Channel (Furness 2015)	SPA population as a percentage of the North Sea and English Channel (%)	Proportioned displacement mortality based on 50% Disp 1% Mort for each SPA (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the non-breeding bio-season (%)
West Westray SPA	47,460	2.93	2.50	42,150	0.06
Fair Isle SPA	18,292	1.13	0.96	32,300	0.10
Sumburgh Head SPA	6,667	0.41	0.35	16,000	0.05
Noss SPA	20,696	1.28	1.09	38,970	0.04
Foula SPA	23,261	1.44	1.23	37,500	0.05
Hermaness, Saxa Vord and Valla Field SPA	6,468	0.40	0.34	25,000	0.05

Table Note: *Outer Firth of Forth and St Andrew's Complex pSPA not included in Furness 2015 so citation population of 28,123 individuals used instead with 90% of adults remaining in the North Sea and English Channel.

10.4.4.200 The estimated displacement mortality rates in **Table 19** for guillemot are so low as to be considered no material contribution to the natural baseline mortality rates at each colony.

10.4.4.201 The impact of displacement from the array area and buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality ranging from under one to approximately eight breeding adults for these Scottish SPAs in the non-breeding bio-season. Based on these mortality rates the increase in mortality relative to baseline mortality is well under 0.2% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for any of these SPAs and as a result Hornsea Four will not have an adverse effect on the integrity of the guillemot feature of any of these Scottish SPAs.

10.4.4.202 There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of any Scottish SPAs in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, guillemot will be maintained as a feature in the long-term.

Table 20 Apportionment of potential razorbill displacement and mortality values from Hornsea Four to Scottish SPAs during the migratory bio-seasons in the UK North Sea and English Channel.

Scottish SPA	Adult population of the SPA remaining in UK North Sea & English Channel (Furness 2015)	SPA population as a percentage of the North Sea and English Channel (%)	Proportioned displacement mortality based on 50% Disp 1% Mort for each SPA during the return migration bio-season (breeding adults per annum)	Proportioned displacement mortality based on 50% Disp 1% Mort for each SPA during post-breeding migration bio-season (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during migratory bio-season (%)
St Abb's SPA	2,438	0.41	0.01	0.07	2,180	0.04
Forth Islands (UK) SPA	29,348	0.89	0.02	0.16	2,800	0.06
Fowlsheugh SPA	5,250	1.19	0.02	0.17	5,800	0.03
Troup, Pennan and Lion's Heads SPA	3,486	0.59	0.02	0.21	4,800	0.04
East Caithness Cliffs SPA	25,000	4.22	0.01	0.11	15,800	0.02
North Caithness Cliffs SPA	3,230	0.55	0.08	0.76	4,000	0.05
West Westray SPA	1,045	0.18	0.01	0.10	1,946	0.03
Fair Isle SPA	1,738	0.29	0.00	0.03	3,400	0.02
Foula SPA	712	1.12	0.01	0.05	6,200	0.02

Table 21: Apportionment of potential razorbill displacement and mortality values from Hornsea Four to Scottish SPAs during the migration-free winter bio-season in the UK North Sea and English Channel.

Scottish SPA	Adult population of the SPA remaining in UK North Sea & English Channel (Furness 2015)	SPA population as a percentage of North Sea English Channel (%)	Proportioned displacement mortality rate based on 50% Disp 1% Mort for each SPA during the migration-free bio-season (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the migration-free winter bio-season (%)
St Abb's SPA	731	0.33	0.01	2,180	0.00
Forth Islands (UK) SPA	1,575	0.72	0.02	2,800	0.01
Fowlsheugh SPA	2,114	0.97	0.02	5,800	0.00
Troup, Pennan and Lion's Heads SPA	1,046	0.48	0.02	4,800	0.00
East Caithness Cliffs SPA	7,500	3.43	0.01	15,800	0.00
North Caithness Cliffs SPA	1,020	0.47	0.08	4,000	0.00
West Westray SPA	330	0.15	0.01	1,946	0.00
Fair Isle SPA	549	0.25	0.00	3,400	0.00
Foula SPA	225	0.10	0.01	6,200	0.00

10.4.4.203 The estimated displacement mortality rates in **Table 20** and **Table 21** for razorbill are all well under one breeding adult for the majority of the Scottish SPAs assessed, even when combining potential impacts over the entire non-breeding bio-season. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rates at each colony.

10.4.4.204 The impact of displacement from the array area and 2 km buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of under one breeding adult for these Scottish SPAs in the non-breeding seasons. Based on mortality rates of under one breeding adult for each SPAs this would represent an increase in mortality relative to baseline mortality of well under 0.1% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for any of these SPAs and as a result Hornsea Four will not have an adverse effect on the integrity of the razorbill feature of any of these Scottish SPAs.

10.4.4.205 There is, therefore, no potential for an AEoI to the conservation objectives of the razorbill feature of any Scottish SPAs in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, razorbill will be maintained as a feature in the long term.

Table 22: Apportionment of potential puffin displacement and mortality values from Hornsea Four to Scottish SPAs during the non-breeding bio-season in the UK North Sea and English Channel.

Scottish SPA	Proportioned breeding adult population of SPA remaining in UK North Sea & English Channel	SPA population as a percentage of North Sea English Channel (%)	Proportioned displacement mortality rate based on 50% Disp 1% Mort for each SPA (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the non-breeding bio-season (%)
Forth Islands (UK) SPA	62,231	26.83	0.47	28,000	0.02
Outer Firth of Forth and St Andrew's Complex pSPA*	30,543	13.17	0.23	61,086	0.00
North Caithness Cliffs SPA	293	0.13	0.00	4,160	0.00
Hoy SPA	1,050	0.45	0.01	7,000	0.00
Fair Isle SPA	3,212	1.38	0.02	26,000	0.00
Noss SPA	241	0.10	0.00	2,348	0.00
Foula SPA	6,750	2.91	0.05	96,000	0.00
Hermaness, Saxa Vord and Valla Field SPA	7,098	3.06	0.05	110,000	0.00

Table Note: *Outer Firth of Forth and St Andrew's Complex pSPA not included in Furness 2015 so citation population of 61,086 individuals used instead with 50% of adults remaining in the North Sea and English Channel

10.4.4.206 The estimated displacement mortality rates in **Table 22** for puffin are all well under one breeding adult for any of these Scottish SPA during the non-breeding bio-season. This level of impact is deemed so low as to be considered no material contribution to the natural baseline mortality rates at each colony.

10.4.4.207 The impact of displacement from the array area and buffer that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality of under one breeding adult for these Scottish SPAs in the non-breeding bio-season. Based on these mortality rates the increase in mortality relative to baseline mortality is well under 0.1% in the non-breeding bio-season, which will not affect the achievement of the conservation objectives for any of these SPAs and as a result Hornsea Four will not have an adverse effect on the integrity of the puffin feature of any Scottish SPAs.

10.4.4.208 There is, therefore, no potential for an AEoI to the conservation objectives of the puffin feature of any of these Scottish SPAs in relation to disturbance and displacement effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, puffin will be maintained as a feature in the long term.

Collision Risk

10.4.4.209 The potential for mortality resultant from collision risk to result in an AEoI relates to the following designated sites and the relevant features:

- Greater Wash SPA; little gull during the non-breeding bio-season (migratory);
- Flamborough and Filey Coast SPA; gannet, kittiwake and herring gull during the breeding and non-breeding bio-seasons;
- Humber Estuary SPA; waterbirds and hen harrier during the non-breeding bio-season (migratory);
- Humber Estuary Ramsar; waterbirds and hen harrier during the non-breeding bio-season (migratory);
- Hornsea Mere SPA; Gadwall during the non-breeding bio-season (migratory);
- Northumbria Coast SPA; Arctic tern during the non-breeding bio-season (migratory);
- Teesmouth and Cleveland Coast SPA; Sandwich tern and common tern during the non-breeding bio-season (migratory);
- Coquet Island SPA; kittiwake, common tern, Arctic tern, roseate tern and Sandwich tern during the non-breeding bio-season (migratory);
- Farne Islands SPA; kittiwake during the non-breeding bio-season and common tern, Arctic tern and Sandwich tern during the non-breeding bio-season (migratory);
- Northumberland Marine SPA; kittiwake during the non-breeding bio-season;
- St Abb's Head SPA; kittiwake during the non-breeding bio-season (migratory);
- Forth Islands (UK) SPA; gannet and kittiwake during the non-breeding bio-season and common tern, Arctic tern and Sandwich tern during the non-breeding bio-season (migratory);
- Outer Firth of Forth and St Andrew's Complex pSPA; gannet and kittiwake during the non-breeding bio-season;
- Fowlsheugh SPA; kittiwake during the non-breeding bio-season;
- Buchan Ness to Collieston Coast SPA; kittiwake during the non-breeding bio-season;
- Troup, Pennan and Lion's Heads SPA; kittiwake during the non-breeding bio-season;
- East Caithness Cliffs SPA; kittiwake during the non-breeding bio-season;
- North Caithness Cliffs SPA; kittiwake during the non-breeding bio-season;

- Copinsay SPA; kittiwake during the non-breeding bio-season;
- Hoy SPA; Arctic skua, great skua, kittiwake during the non-breeding bio-season;
- Marwick Head SPA; kittiwake during the non-breeding bio-season;
- Rousay SPA; kittiwake during the non-breeding bio-season and Arctic skua and Arctic tern during the non-breeding bio-season (migratory);
- Calf of Eday SPA; kittiwake and great black-backed gull during the non-breeding bio-season;
- West Westray SPA; kittiwake during the non-breeding bio-season and Arctic skua and Arctic tern during the non-breeding bio-season (migratory);
- Fair Isle SPA; gannet and kittiwake during the non-breeding bio-season and Arctic skua, great skua and Arctic tern during the non-breeding bio-season (migratory);
- Sumburgh Head SPA; kittiwake during the non-breeding bio-season and Arctic tern during the non-breeding bio-season (migratory);
- Noss SPA; gannet and kittiwake during the non-breeding bio-season and great skua during the non-breeding bio-season (migratory);
- Foula SPA; kittiwake during the non-breeding bio-season and Arctic skua, great skua and Arctic tern during the non-breeding bio-season (migratory);
- Fetlar SPA; Arctic skua, great skua and Arctic tern during the non-breeding bio-season (migratory); and
- Hermaness, Saxa, Vord and Valla Field SPA; gannet and kittiwake during the non-breeding bio-season and great skua during the non-breeding bio-season (migratory).

10.4.4.210 There is a potential collision risk to birds which fly through the Hornsea Four array area whilst foraging for food, commuting between breeding sites and foraging areas, or when on migration. The risk to birds arises from colliding with the WTG rotors and associated infrastructure resulting in injury or fatality.

10.4.4.211 Collision Risk Modelling (CRM) has been used to estimate the potential risk to birds associated with the proposed development. The approach to CRM is presented in **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling** and provides the methods, data input and results of the CRM. Modelling has been carried out using the Stochastic Collision Risk Model (sCRM) deterministically (OFF-ORN-2.26 **B1.1.1 Evidence Plan**), developed by Marine Scotland Science (McGregor, 2018) applied through the 'Shinyapp' interface using the density of flying birds measured by 24 months of aerial survey to produce predictions of mortality for particular species across set time periods (biological seasons) and on an annual basis. This most recent version of the Band (2012) CRM has been designed specifically to address uncertainty in developments and other key input parameters as progressed initially by Masden (2015) for application to the assessment of collision risk to seabirds from offshore wind farm developments.

10.4.4.212 The sCRM accounts for a number of different species-specific behavioural aspects of birds being assessed, including the height at which birds fly, their ability to avoid moving or static structures and how active they are diurnally and nocturnally, respectively. Details of these considerations are also provided **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**.

10.4.4.213 Hornsea Four has taken significant measures to reduce the potential impacts from collision to seabirds through:

- Co138, raising the minimum swept height commitment (the distance between sea level and the lower turbine tip or air gap); and
- Co87, a reduction in the size of the proposed developable area, from that presented at Scoping to that forming the EIA, informed by an analysis of risk to seabirds. This was based on assessing the distribution of core species (those recorded in the highest densities) throughout the original AfL that may be at risk from collision (gannet and kittiwake). Through the identification of seabird hotspot areas, a process of refining the Hornsea Four array area was completed and a revised developable area (presented in the PEIR) was selected that avoids the areas of highest densities for these two species deemed most at risk from collision.

10.4.4.214 There were a number of areas of uncertainty with respect to the parameters input into the sCRM ahead of this final assessment, due to this modelling approach not having previously been subject to use within a DCO Application for an OWF. Through the EP process, APEM conducted rigorous testing of the newly updated Donovan (2018) sCRM alongside Natural England and the RSPB, with guidance from the development team responsible for maintaining the sCRM via the online platform used to access the model. Natural England requested that the sCRM should be run deterministically to provide comparable results to the Band (2012) CRM carried out in other OWF assessments. The results of these tests provided evidence that the Donovan (2018) sCRM could be run deterministically to reach results that were comparable to that from Band (2012) CRM outputs to within under 0.01% in most instances. Following further consultation on these results it was agreed with the EP Technical Panel (OFF-ORN-2.38 **B1.1.1 Evidence Plan**) that the use of the Donovan (2018) sCRM is suitable to determine collision risk to seabirds deterministically for Hornsea Four and other OWF assessments.

10.4.4.215 The assessment of collision risk follows an evidence led approach making use of a mixture of site-specific data collected from within the Hornsea Four array area and the most recent literature on seabirds and their behaviour in relation to OWFs (**Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**).

10.4.4.216 Within this report the Shiny app outputs / results for three different Band Options are presented (Band Options 1, 2 and 3), which are described below. However, it is acknowledged that as Natural England and the RSPB are not in agreement with the use of Band Option 1 then the results from Band Option 2 and 3 form the basis of assessing the risk to seabirds from collision for Hornsea Four.

Band Option 1

10.4.4.217 The Basic Band model applies a uniform distribution of bird flights between the lowest and the highest levels of the rotors. The percentage of bird flights passing between the lowest and the highest levels of the rotors (i.e. the proportion of birds at potential collision height (PCH) is determined from the observations of bird flight heights made from the boat-based site-specific surveys. This Band Option was considered for all bird species for collision risk, where site-specific data were available, but only used in the assessments if data for use in Band Option 2 were not available.

Band Option 2

10.4.4.218 The Basic Band model applies a uniform distribution of bird flights between the lowest and the highest levels of the rotors. The PCH was determined from the results of the SOSS-02 project (Cook et al. 2012) that analysed the flight height measurements taken from boat surveys conducted around the UK. The project was updated following Johnston et al. (2014), and the revised published spreadsheet is used to determine the 'generic' percentage of flights at PCH for each species based on the proposed project's wind turbine parameters. This Band Option has been relied upon as the model to carry through to the assessment of collision risk for kittiwake, gannet and migratory birds collision risk assessments.

Band Option 3

10.4.4.219 The Extended Band model accounts for the skewed vertical distribution of bird flight heights between the lowest and the highest levels of the rotors. Most seabird species are observed flying more frequently at the lower level of the rotor swept height, which presents lower risk of collision (i.e. closer to the sea surface) than at heights equivalent to the rotor hub height where collision risk is greater or at the upper levels. By understanding the variation of bird flight through the rotor swept area the Extended Band model considers and applies the different probabilities of being struck by the moving rotor blades through the rotor swept area vertically. The Extended Band model, using Band Option 3, relies on the data spreadsheet that accompanies Johnston et al., (2014), which is the result of a statistical analysis of many offshore surveys across multiple study sites. These data are fed into the model in order to allow for the flight distribution to be calculated based upon the wind farm parameters of the proposed project. This Band Option has been modelled for all three large gull species, as per Statutory Body advice (JNCC et al. 2014) to carry through to the assessment of collision risk for large gull species.

Precautionary nature of CRM

10.4.4.220 It must be noted that a number of elements of additional precaution were included in the input parameters applied in the sCRM for this assessment, including considering a range of nocturnal activity factors and lower avoidance rates than that currently predicted from the latest scientific evidence. The nature of such precaution is evidenced through the findings of the Bird Collision Avoidance Study funded by ORJIP (Offshore Renewables Joint Industry Programme), which undertook a study to understand seabird behaviour at sea around OWFs. The ORJIP project studied birds around Thanet OWF for a two year period (between 2014 and 2016) recording over 12,000 bird movements throughout the day and night. The findings of this study (Skov et al. 2018) presented updated rates for both nocturnal activity rates and avoidance rates from an empirical data source, which it recommended for future incorporation in CRM. It also reported that only six birds (all gull species) collided with WTGs from over 12,000 birds recorded during the two year period, providing evidence of the precautionary nature of collision risk modelling for all species of seabirds.

10.4.4.221 A further review of the data from the ORJIP project was undertaken by Bowgen and Cook (2018), which analysed all the data collected across the two year period to understand more about seabird behaviour and provide evidence to support updates to the previous avoidance rates from Cook et al. (2014). The findings from this study were that for gannet and kittiwake, higher avoidance rates were more appropriate of 99.5% and 99.0%, respectively. It concluded that even when applying these higher rates of avoidance they considered that precaution remained within the estimated number of collision mortality rates.

10.4.4.222 Another recent study on gannets by APEM Ltd during the migratory period (APEM 2014) found that overall avoidance of WTGs was certainly higher than the SNCBs recommended use of 98.9%. This study found that all gannets avoided the WTGs within the study area, which provided evidence that gannets may actually have an avoidance rate as high as 100% during migratory periods at least. However, the concluding recommendation from APEM's research suggested that if it was not appropriate to use a 100% avoidance rate then a rate of 99.5% for the autumn migration would still offer suitable precaution in collision estimates. This indicates that when estimating gannet collision mortality rates the use of an avoidance rate of 98.9% is understood to overestimate the risk to this species, as noted by Cook et al. (2014), who acknowledged that precaution remained within the avoidance rates put forward for gannets and gull species.

10.4.4.223 Despite the above supporting evidence, the use of such higher avoidance rates and lower nocturnal activity rates were not included within the CRM for Hornsea Four alone or in-combination. The final range of nocturnal activity rates were agreed with Natural England through the EP process (OFF-ORN-2.34 **B1.1.1 Evidence Plan**), making use of the more precautionary range-based approach. The use of more precautionary avoidance rates are also applied in this assessment, based on the joint SNCBs advisory note (JNCC et al. 2014) on Cook et al. (2014), which suggests the use of 98.9% for gannet, 98.9% for kittiwake and 99.5% for large gull species. The full details of the approach to CRM for Hornsea Four is provided in **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**.

10.4.4.224 Therefore, it is considered that the CRM input parameters used in the assessment of collision risk to seabirds for Hornsea Four and those from other projects at the cumulative level incorporate a high degree of precaution.

Greater Wash SPA - little gull

10.4.4.225 Little gull has been screened into the assessment of the O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the SPA:

- Maintain the population of each of the qualifying features.

10.4.4.226 Little gull has been screened into the assessment of the O&M phase on a precautionary basis as a result of the proximity of the Greater Wash SPA and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. It has been screened in for the migratory non-breeding bio-seasons.

10.4.4.227 The 24 months of aerial survey recorded little gull flying across the array area on two occasions. In October 2016, with an estimated abundance of 50 birds, and in July 2017 with an estimated abundance of 40 birds (further details are given in **Volume A5, Annex**

5.1: Offshore and Intertidal Ornithology Baseline Characterisation Report). Cook et al. (2012) determined that 5.5% of little gull flights would be at PCH.

10.4.4.228 The number of little gulls that migrate via the North Sea has not been assessed by Furness (2015) or Musgrove et al. (2013); the standard sources used for population estimates. A population estimate for little gull using the UK waters of the North Sea has been prepared from a review of the literature and available databases relating to north-west Europe. This has considered both breeding populations from which the number of non-breeding individuals can be derived and non-breeding individuals recorded using particular sites or on migration along the coast. A copy of the literature review can be found in Appendix C of **Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**. The findings of the literature review proposed an estimate of the autumn migration BDMPS for use in assessments of offshore wind farms (OWFs) occurring in English waters of the North Sea as 30,500 individuals (with a range of between 23,500 and 37,500 individuals). This population estimate was agreed as being appropriate for use in this assessment with Natural England and the RSPB (OFF-ORN-1.17 **B1.1.1 Evidence Plan**), when considered as both the single population alongside the range.

10.4.4.229 Another assessment of little gull migration undertaken by WWT and MacArthur Green (2013) concluded that the majority of UK little gull migrate within 20 km from the UK coastline based on observations from coastal watches and offshore surveys.

10.4.4.230 The resultant apportionment of the migratory population considered that 6,148 little gulls may potentially fly over the Hornsea Four array area during their autumn migration. Subsequent collision risk modelling for little gull provided an estimate of under one individual likely to be subject to mortality per annum. Given the limited risk of collision to this species of under one individual and the SPA population of 1,255 individuals, there is no risk to the population and therefore Hornsea Four will not affect the achievement of the conservation objectives for the SPA or have an adverse effect on the integrity of the SPA.

10.4.4.231 There is, therefore, no potential for an AEoI to the conservation objectives of the little gull feature of the Greater Wash SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, little gull will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – gannet

10.4.4.232 Gannet has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.4.233 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level, which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts (Aitken et al. 2017).

10.4.4.234 Gannet has been screened into the assessment of the O&M phase based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. It has been screened in for both the breeding and the non-breeding bio-seasons. The Hornsea Four array area is within the mean max foraging distance of 315.2 km to the FFC SPA at 63 km distant, and also within the mean max plus 1 SD foraging distance of 509.4 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding bio-seasons. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the migration-free breeding bio-season, defined as being the months of April to August by Furness (2015), the post-breeding migration bio-season of September to November and the return migration bio-season of December to March.

10.4.4.235 The potential for impact on the SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four changes through the seasons with birds breeding at sites remote from the north-east coast of England either passing through the area on spring and autumn migration or arriving in the area to spend the winter. For the purpose of this assessment due to the low number of gannets positively identified down to age categories in comparison to the total number of gannets recorded within the site-specific surveys, the proportion of adult gannets likely to have been recorded within the surveys is derived from the FFC SPA juvenile / adult percentage split in the return migration bio-season presented in Furness (2015) of 68%.

10.4.4.236 Further apportionment of the adult birds is required to determine the risk to birds from the FFC SPA during the breeding and non-breeding bio-seasons, as not all adult birds are breeding birds. This is evidenced from adult sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017) or adult non-breeding birds forming 'clubs' (or social gatherings) on separate cliffs ledges. The sabbatical rate for gannet populations was recently agreed by Marine Scotland for the Seagreen 1 OWF Appropriate Assessment as including at least 10% of adult birds in the population, so this minimum value has been applied for use in this assessment of gannets from FFC SPA.

10.4.4.237 During the migration-free breeding bio-season, when birds are limited in the distance and number of days over which they can forage by the need to return regularly to the nest site, it can be expected that the area in and around Hornsea Four will contain a high proportion of adult birds that can be attributed to the FFC SPA. The evidence gained from tracking adult gannets during the breeding season across a series of colonies is that gannets show 'space partitioning', that is adjacent colonies do not have overlapping foraging areas in the breeding season (Wakefield et al. 2013). The consequence of this is that following consideration of non-breeding adults, 100% of the adult birds in and around the Hornsea Four array area and those predicted to suffer from collision related mortality are attributable to the Flamborough and Filey Coast SPA. Therefore, accounting for non-breeding adults and sabbaticals the overall proportion of breeding adults subject to collision mortality from FFC SPA is 61.2%.

10.4.4.238 Outside the migration-free breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during return migration and post-breeding migration bio-seasons were estimated to be 6.23% and 4.84%, respectively, which was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the EP process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

10.4.4.239 All mortality predictions are drawn from the relevant species sections of **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**.

Breeding Season

10.4.4.240 The predicted collision resultant mortality from the operation of Hornsea Four in the migration-free breeding bio-season is 20 (20.15) individuals. On the basis of 61.2% of all the birds predicted to being breeding adult birds from the Flamborough and Filey Coast SPA then the consequent collision mortality is estimated at eight (8.18) breeding adults.

10.4.4.241 When considering the potential impact of this loss to the FFC SPA (classified gannet population of 16,938 breeding adults, with an annual background mortality of being 1,372 breeding adults), then using this prediction of eight breeding adults suffering collision consequent mortality would represent a 0.60% increase in baseline mortality. As the population of gannets has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 13,392 apparently occupied nests (or 26,784 breeding adults). On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of this number of adult birds being 2,170 breeding adults), then the prediction of eight breeding adults suffering displacement consequent mortality would represent a 0.38% increase in baseline mortality.

Non-breeding Season

10.4.4.242 The predicted collision resultant mortality as a result of the operation of Hornsea Four in the return migration bio-season is two (1.84) individuals and in the post-breeding migration bio-season is five (4.94) individuals (there is no migration free winter bio-season). On the basis of 6.23% in the return migration bio-season and 4.84% in the post-breeding bio-season of all the birds being breeding adult birds from the FFC SPA then the consequent collision mortality is estimated at under one (0.11) breeding adult during the return migration bio-season, under one breeding (0.24) adult during the post-migration bio-season and therefore under one (0.35) breeding adult during the entire non-breeding season.

10.4.4.243 When considering under one breeding adult may be subject to collision consequent mortality that can be attributed to the SPA during the entire non-breeding season, then this represents only a slight increase of 0.03% and 0.02% in baseline mortality when considering the citation population or more recent 2017 colony count of FFC SPA, respectively.

Annual Total

10.4.4.244 The potential impact of collision related mortality, that would occur throughout the operational life of Hornsea Four is predicted at eight breeding adults in the migration-free breeding bio-season and less than one breeding adult in the non-breeding bio-seasons, this equates to nine (8.53) breeding adults in total per annum across all bio-seasons. The prediction of a total consequential mortality of nine breeding adults per annum represents an increase of 0.62% to existing mortality when considering the citation population or an increase of 0.39% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.245 The conservation objective for the gannet feature of the FFC SPA is to maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts.

10.4.4.246 The addition of nine possible additional breeding adult mortalities per annum equates to less than a 1% increase in baseline mortality, when considering either the citation or the latest 2017 colony count. This level of impact would be indistinguishable from natural fluctuations in the baseline mortality rate of 2,170 breeding adults from this population per annum. Therefore, the potential for an AEoI to the conservation objectives of the gannet feature of the FFC SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone can be ruled out, subject to natural change, gannet will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – kittiwake

10.4.4.247 Kittiwake has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Restore the population of each of the qualifying features.

10.4.4.248 Based on the above the conservation objective for the FFC SPA the specific target for the kittiwake feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Restore the size of the breeding population at a level, which is above 83,700 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

10.4.4.249 *Kittiwake* has been screened in for the assessment of the O&M phase based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. The Hornsea Four array area is within the mean max foraging distance of 156.1 km to the FFC SPA at 63 km distant and also within the mean max plus 1 SD foraging distance of 300.6 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding bio-seasons.

The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the migration-free breeding bio-season, defined as being the months of May to July by Furness (2015), the post-breeding migration bio-season of August to December the return migration bio-season of January to April.

10.4.4.250 The potential for impact on the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four changes through the seasons with birds breeding at sites remote from the north-east coast of England either passing through the area on spring and autumn migration or arriving in the area to spend the winter. For the purpose of this assessment the proportion of adult kittiwakes likely to have been recorded within the surveys is derived from the FFC SPA juvenile / adult percentage split in the return migration bio-season presented in Furness (2015) of 69%. This method for adult apportionment was selected over the use of site specific age ratios, as it is not possible to split adult kittiwakes from juvenile 2nd winter birds onwards (Horswill and Robinson (2015) state that the majority of kittiwakes breed for the first time at age four) either in digital imagery or in the field.

10.4.4.251 Further apportionment of the adult birds is required to determine the risk to birds from the FFC SPA during the breeding and non-breeding seasons, as not all adult birds are breeding birds. This is evidenced from adult sabbatical birds free roaming the North Sea whilst taking a break from breeding activities (Marine Scotland 2017). The sabbatical rate for kittiwake populations was recently agreed by Marine Scotland for the Seagreen 1 OWF Appropriate Assessment as including at least 10% of adult birds in the population, so this minimum value has been applied for use in this assessment of kittiwakes from FFC SPA.

10.4.4.252 During the migration-free breeding bio-season, when birds are limited in the distance and number of days over which they can forage by the need to return regularly to the nest site, it can be expected that the area in and around Hornsea Four will contain a high proportion of adult birds that can be attributed to the FFC SPA. The emerging evidence that is coming from studies tracking adult kittiwakes during the breeding bio-season at colonies on the north-east coast of England (Robertson et al. 2014; Aitken et al. 2017; Wakefield et al. 2017), including at the FFC SPA, is that foraging kittiwakes from major colonies do not have overlapping foraging areas in the breeding bio-season and that those in and around the Hornsea Four array area originate from the FFC SPA and smaller colonies along the coast to the north within the mean maximum and maximum foraging range.

10.4.4.253 Due to there being several other kittiwake colonies within foraging range of Hornsea Four, in order to attribute the correct proportion of adult breeding birds to different colonies appropriately the method used to determine any adult's bird origin followed the SNH (2018) apportionment methodology. The SNH (2018) apportionment methodology is based on considering a species' foraging range in addition to three colony-specific weighting factors; colony size (in individuals); distance to colony from the development sites; and sea area (the real extent of the open sea within foraging range of the relevant species). The methods and supporting datasets utilsied in the SNH (2018) apportionment methodology for kittiwake for this assessment are provided in **Appendix H**. The resulting outcome of the apportionment methodology provides the supporting evidence that 93.68% of breeding adults within the Hornsea Four array area may be from FFC SPA. Therefore, accounting for non-breeding adults, sabbaticals and the split of breeding birds between different colonies the overall proportion of breeding adults subject to collision mortality from FFC SPA is 58.17%.

10.4.4.254 Outside of the migration-free breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during return migration and post-breeding migration bio-seasons were estimated to be 7.19% and 5.44%, respectively, which was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the EP process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

10.4.4.255 All mortality predictions are drawn from the relevant species sections of **Volume A5, Annex 5.3: Offshore Ornithology Collision Risk Modelling**.

Breeding Season

10.4.4.256 The predicted collision resultant mortality from the operation of Hornsea Four in the breeding bio-season is 30 (29.79) individuals. On the basis of 58.17% of all the birds predicted to be breeding adult birds from the FFC SPA then the consequent collision mortality is estimated at 17 (17.33) breeding adults.

10.4.4.257 When considering the potential impact of this loss to the Flamborough and Filey Coast SPA (the original citation specifies a kittiwake population of 83,700 breeding pairs or 167,400 breeding adults in 1987, with an annual background mortality of 24,440 breeding adults), then using this prediction of 17 breeding adults suffering collision consequent mortality would represent a 0.07% increase in baseline mortality. However, as the population of kittiwakes has changed since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 51,535 apparently occupied nests (or 103,070 breeding adults). On this basis if all the adult birds predicted to suffer from collision mortality were breeding adult birds from the FFC SPA (with an annual background mortality of this number of adult birds being 15,048 breeding individuals), then this prediction of 17 breeding adults suffering collision consequent mortality would represent a 0.12% increase in baseline mortality per annum during the migration-free breeding bio-season.

Non-breeding Season

10.4.4.258 The predicted collision resultant mortality as a result of the operation of Hornsea Four in the return migration bio-season is 25 (25.05) individuals and in the post-breeding migration bio-season is 38 (38.43) individuals (there is no migration free winter bio-season). On the basis of 7.19% in the return migration bio-season and 5.44% in the post-breeding bio-season of all the birds being breeding adult birds from the FFC SPA then the consequent collision mortality is estimated at two (1.80) breeding adults during the return migration bio-season and two (2.09) breeding adults during the post-migration bio-season, equating to four (3.89) breeding adults during the entire non-breeding bio-season.

10.4.4.259 When considering four breeding adults may be subject to collision consequent mortality that can be attributed to the SPA during the entire non-breeding bio-season, then this represents only a slight increase of 0.02% in baseline mortality to the citation population of FFC SPA. When considering the same level of impact attributed to the more recent 2017 colony count of the SPA, then the increase in baseline mortality is predicted to be under 0.03% per annum across the non-breeding bio-season.

Annual Total

10.4.4.260 The potential impact of collision related mortality that would occur throughout the operational life of Hornsea Four is estimated at 17 breeding adults in the migration-free breeding bio-season and four breeding adults in the non-breeding bio-season, equating to 21 (21.22) breeding adult birds in total per annum across all bio-seasons. The prediction of a total consequential mortality of 21 breeding adults per annum represents an increase 0.09% when considering the citation population or an increase of 0.14% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.261 Although the annual predicted mortality for kittiwake is well under a 1% increase in the baseline mortality rate, a precautionary approach has been taken for Hornsea Four alone and further consideration in the form of Population Viability Analysis (PVA) has been carried out for a number of different scenarios. Further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H** below summarises the kittiwake PVA results for impacts from collision risk alone apportioned to the FFC SPA.

Table 23: Kittiwake PVA results for impacts apportioned to the FFC SPA.

Scenario Description	Increase in Adult mortality	Density independent counterfactual of Growth Rate (after 35 years)	Reduction in Growth Rate (%)
Evidence-led input parameters, Cook et al. (2014) Avoidance Rates, BO2, Mean density estimates	21	1.000	0.03
Evidence-led input parameters, Cook et al. (2014) Avoidance Rates, BO2, Max density estimates	42	0.999	0.05
Evidence-led input parameters, Cook et al. (2014) Avoidance Rates, BO2, Min density estimates	9	1.000	0.01
Evidence-led input parameters, Bowgen & Cook (2018) BO2 Avoidance Rate, Mean density estimates	19	1.000	0.02
Evidence-led input parameters, Bowgen & Cook (2018) BO3 Avoidance Rate, Mean density estimates	5	1.000	0.01

10.4.4.262 As presented in **Table 23**, even when considering the over-precationary annual collision risk estimate of 42 breeding adults based on the most precautionary input parameters the reduction in growth rate is still well under 0.1% per annum.

10.4.4.263 As described in further detail in **paragraph 11.4.3.169** there is a great deal of contention regarding the FFC SPA kittiwake population size over the last 50 years, with the colony counts reporting fluctuation in population size of between +170% to -50%, causing a great deal of dispute between seabird experts on the accuracy of such counts (Coulson 2011, 2017; McArthur Green 2015).

10.4.4.264 If such dramatic population changes did indeed occur, then this would have to be linked to changes from other elements such as changes in available food resources, such as the biomass of sandeels, which are the main food source of kittiwakes and the lack thereof known to cause significant impacts on kittiwake populations (Coulson 2017; Carroll et al. 2017; Frederiksen et al. 2004; Wanless et al. 2007).

10.4.4.265 It is also noted that the productivity rates recorded during the period of decline reported, between 1987 and 2000, do not correlate with such a dramatic population decline. The average productivity during this period is recorded as a relatively high mean value of 1.06 young fledged per pair, which should have caused the population to remain stable or increase, but not cause such a severe decline (Coulson 2011; 2017). Therefore, either there were other unknown elements at work on the colony or the data on colony counts are less accurate than reported.

10.4.4.266 Despite the relationship between sandeels and kittiwakes being evident and for productivity rates to have remained at positive levels, these are not considered to be the reasons for such a potentially dramatic increase and decrease to the FFC SPA kittiwake colony between 1979 and 1986, the circumstances for which may never be known. However, as kittiwake are one of the most numerous gull species in the world (JNCC 2020) and known to colonise and desert suitable nesting colonies in other locations in short periods of time it is not beyond the realms of science that should these data (between 1979 and 1986) be accepted as accurate that such an incident could not occur once more in the future again.

10.4.4.267 Following more regular monitoring at the colony since 2000, the average colony growth rate is calculated as being 0.39% per annum, with further increase in growth rate of 2.14% per annum between 2008 to 2017. When considering the reductions in growth rates presented in **Table 23** against the latest annual colony rates, the colony would still be predicted to grow each year, and therefore Hornsea Four alone would not cause an impact which would impede the colonies restorative conservation objective. This statement can be backed up by the rulings of the SoS in relation to kittiwake collision impacts associated with the FFC SPA of up to 21 breeding adults for Norfolk Vanguard prior to Norfolk Vangaurd's quashed consent application (application being quashed was not related to ornithological matters). The SoS concluded in the HRA for Norfolk Vanguard that '*Both Natural England and the RSPB agreed that there would not be an AEoI from the Project alone for kittiwake of the FFC SPA. In view if the predicted number of collisions from the Project alone (up to 21 adults from FFC SPA) the Secretary of State has concluded that collision mortalities from the Project alone, will not have an adverse effect on the kittiwake feature of the FFC SPA'* BEIS 2020a). This statement can also be further backed up by the recent rulings of the SoS in relation to kittiwake collision impacts associated with the FFC SPA of up to 73 breeding adults for Hornsea Project Three. The SoS concluded in the HRA for Hornsea Project Three that *'The Secretary of State is satisfied that the potential increased kittiwake collision mortality as a result of the Project alone (up to 73 adults from FFC SPA) would not represent an adverse effect upon the integrity of the Flamborough and Filey Coast SPA'* (BEIS 2020b).

10.4.4.268 The potential loss of 21 breeding adults due to collision consequential mortality from the operation of Hornsea Four equates to less than a 0.2% increase in baseline mortality, when considering either the original citation population or the latest 2017 colony count. Recent OWF Development Applications with similar or slightly higher levels of collision risk impacts to kittiwakes from FFC SPA have been agreed by Natural England and the RSPB as not being the cause of an AEoI for the project alone and received consent from the SoS who also summarised no AEoI as a result of such impact levels (BEIS, 2020a and 2020b). Therefore, based on the evidence above and with respect to similar consenting decisions Hornsea Four alone can be ruled out as a cause of an AEoI of the kittiwake feature of the FFC SPA SPA in relation to collision mortality effects in the O&M phase. This level of impact would be indistinguishable from natural fluctuations in the baseline mortality rate of 15,048 breeding adults per annum from this population. Therefore, subject to natural change, the kittiwake population at the FFC SPA will continue to be restored to the size at the point of designation whilst avoiding deterioration from its current level and be maintained as a feature in the long-term.

Flamborough and Filey Coast SPA – herring gull

10.4.4.269 Herring gull has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the populations of each of the qualifying features.

10.4.4.270 Based on the above the conservation objective for the FFC SPA the specific target for the seabird assemblage is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 216,730 individuals, whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.271 Although herring gull is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on herring gull as a feature, but more as an important component of the seabird assemblage.

10.4.4.272 Herring gull has been screened into the assessment of the O&M phase on a precautionary basis as a result of the proximity of the FFC SPA and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. It has been screened in for both the breeding and the non-breeding bio-seasons.

10.4.4.273 The potential for impact on the SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max (plus 1 SD) foraging range of 58.8 ± 26.8 km according to Woodward et al (2019). Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the non-breeding bio-season, for which this species is assessed, the information on populations contained in Furness (2015) is applied.

Breeding Season

10.4.4.274 Following an evidence-led approach to collision risk the number of herring gulls estimated to be subject to mortality from Hornsea Four during the breeding bio-season is less than a single (0.52) individual.

10.4.4.275 Apportionment of the single mortality to herring gull as a consequence of collision was considered in order to determine the potential risk to FFC SPA. This process included considered that as breeding birds are limited by the distance which they can forage during the breeding bio-season by the need to return regularly to the nest site to attend eggs or feed chicks. It also considered the mean max (plus 1 SD) foraging for herring gull and determined that the FFC SPA is the only colony contained within that distance from Hornsea Four. Additional consideration was provided to the known age ratio of herring gulls from the FFC SPA in the UK North Sea and English Channel being 51.12% derived from adult / juvenile proportions in the non-breeding bio-season presented in Furness (2015). Therefore, the consequence of this process determined that all of the breeding adult herring gulls in and around the Hornsea Four array area and those predicted to suffer from collision related mortality are, on a worst-case basis, attributed to the Flamborough and Filey Coast SPA. Despite this, due to the collision mortality estimates during the breeding bio-season being less than a single bird the number of herring gulls at risk of collision mortality that can be attributed to the FFC SPA is well under one breeding adult per annum.

Non-breeding Season

10.4.4.276 Following an evidence-led approach the number of herring gulls estimated to be subject to collision risk mortality from Hornsea Four during the non-breeding bio-season is less than a single (0.27) breeding adult per annum.

10.4.4.277 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to each colony has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea population estimates. The UK North Sea population during the non-breeding bio-season is 466,511 individuals. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during the non-breeding bio-season is 0.43%.

10.4.4.278 On this basis that during the non-breeding season less than a single (0.27) individual is predicted to be at risk of collision mortality when this is apportioned out to the various SPAs within the North Sea, the increase in baseline mortality attributed to the FFC SPA from collision would be indistinguishable from natural change.

Annual Total

10.4.4.279 The possible loss of less than one breeding adult per annum would be indistinguishable from natural fluctuations in the population or when considering relative to the baseline mortality rate. There is, therefore, no potential for an AEoI to the conservation objectives of the seabird assemblage feature, of which herring gull is a named component, of the FFC SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, herring gull will be maintained as a feature of the seabird assemblage in the long term.

Humber Estuary SPA and Ramsar – waterbirds & hen harrier

10.4.4.280 Waterbirds and hen harrier from the Humber Estuary SPA and Ramsar have been screened in for the assessment of the O&M phase to assess the the impacts from collision whilst migrating from Hornsea Four alone in relation to the following conservation objectives for the species, as a qualifying feature or component of the seabird assemblage of the SPA:

- Maintain or restore the population of each of the qualifying features.

10.4.4.281 The migrant waterbird populations of the Humber Estuary SPA and Ramsar are considered in this assessment together and have been screened into the assessment of the O&M phase on a precautionary basis as a result of the potential for a proportion of their twice yearly migratory flights across the North Sea (to spend the non-breeding bio-season at the site) to pass across the array area and at a height that places them at risk of collision with the turning blades of the WTGs. The waterbird species concerned are white-fronted goose, dark-bellied brent goose, shelduck, wigeon, teal, goldeneye, oystercatcher, avocet, ringed plover, grey plover, golden plover, lapwing, knot, sanderling, turnstone, dunlin, redshank, black-tailed godwit, bar-tailed godwit, curlew, whimbrel and ruff. They have been screened in for the migratory non-breeding bio-seasons and include designated features as well as named species in the waterbird assemblage feature (clarified in **Table 24**). In addition to the waterbird features of the Humber Estuary SPA and Ramsar, non-breeding hen harrier was also screened in for consideration of potential collision risk.

10.4.4.282 The 24 months of aerial survey did not record any of these migratory waterbirds. An assessment of all potential migrant birds was undertaken (see Appendix I of **Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Report**) which identified the above species on the basis of them having potential flight paths over Hornsea Four to and from the Humber Estuary SPA. The resultant modelling through Migropath, which modelled the Humber Estuary SPA migratory population for each species across their North Sea migratory paths, provided estimates for the number of each species potentially flying over the Hornsea Four array area during the spring and autumn (**Table 24**).

10.4.4.283 Subsequent collision risk modelling for each species provided an estimate for the potential number of individuals likely to be subject to mortality per annum. The estimated annual risk from collision mortality for migrant waterbirds ranged from zero individuals for several species to 1.11 individuals for knot (**Table 24**) associated with the Humber Estuary SPA. In all cases, the number of collisions is expected to lead to no detectable increase in mortality when compared to the natural baseline mortality.

10.4.4.284 Given the limited risk of collision to these waterbird species and hen harrier of between zero and 1.11 individuals per annum and the SPA non-breeding populations consisting predominantly of large numbers of birds (the non-breeding assemblage population is 153,934 individuals), there is no risk of an adverse effect on the designated features, named assemblages features or assemblage features themselves and hence a prediction that Hornsea Four will not affect the achievement of the conservation objectives for the SPA or Ramsar and as a result will not have an adverse effect on the integrity of the SPA or Ramsar.

Table 24: Estimated number of birds from the Humber Estuary SPA and Ramsar potentially flying over Hornsea Four array area during spring and autumn migration and consequent annual collision mortality rates.

Species	Humber Estuary SPA and Ramsar Citation Population	Number of birds from the Humber Estary SPA passing through the Hornsea Four array area during spring migration (per annum)	Number of birds from the Humber Estary SPA passing through the Hornsea Four array area during autumn migration (per annum)	Humber Estuary SPA collision mortality (per annum) using BO1 and 98% avoidance rate.	Species baseline mortality rate (Robinson 2005)	Humber Estuary SPA species baseline mortality (per annum)	SPA citation population baseline mortality rate percentage increase (%)
Dark-bellied brent goose	2,098	0	0	0	0.100	210	0.00 (0.00 – 0.00)
White-fronted goose	6.4	0	0	0	0.276	2	0.00 (0.00 – 0.00)
Shelduck*	4,989	271 (259 – 284)	594 (568 – 631)	0.15 (0.15 – 0.16)	0.114	569	0.03 (0.03 – 0.03)
Wigeon	5,039	449 (428 – 471)	449 (428 – 471)	0.13 (0.13 – 0.14)	0.470	2368	0.01 (0.01 – 0.01)
Teal	1,977	176 (167 – 184)	176 (167 – 184)	0.05 (0.05 – 0.05)	0.470	929	0.01 (0.01 – 0.01)
Goldeneye	467	56 (53 – 59)	56 (53 – 59)	0.02 (0.02 – 0.02)	0.228	106	0.02 (0.02 – 0.02)
Hen harrier	8	0.4 (0.3 – 0.4)	0.4 (0.3 – 0.4)	<0.01	0.190	2	0.03 (0.03 – 0.03)
Oystercatcher	4,002	481 (461 – 509)	481 (461 – 509)	0.26 (0.25 – 0.28)	0.120	480	0.05 (0.05 – 0.06)
Avocet	128 (breeding); 59 (non-breeding)	0	0	0	0.220	28 (breeding)	0.00 (0.00 – 0.00)
Ringed plover	1,766	157 (149 – 165)	157 (149 – 165)	0.03 (0.03 – 0.04)	0.228	403	0.01 (0.01 – 0.01)
Grey plover	2,018	179 (170 – 188)	179 (170 – 188)	0.08 (0.08 – 0.09)	0.140	283	0.03 (0.03 – 0.03)
Golden plover*	30,709	0	0	0	0.270	8291	0.00 (0.00 – 0.00)
Lapwing	22,765	2,025 (1,937 – 2,122)	2,025 (1,937 – 2,122)	1.02 (0.98 – 1.07)	0.295	6716	0.02 (0.01 – 0.02)
Knot*	28,165	2,511 (2,386 – 2,633)	2,511 (2,386 – 2,633)	1.11 (1.05 – 1.16)	0.159	4478	0.02 (0.02 – 0.03)
Sanderling	916	82 (77 – 86)	82 (77 – 86)	0.03 (0.03 – 0.04)	0.170	156	0.02 (0.02 – 0.03)

Turnstone	530	47 (45 – 49)	47 (45 – 49)	0.02 (0.02 – 0.02)	0.140	74	0.03 (0.03 – 0.03)
Dunlin*	22,222	640 (540 – 747)	640 (540 – 747)	0.28 (0.24 – 0.33)	0.260	5778	0.00 (0.00 – 0.01)
Redshank*	7,462	124 (112 – 137)	124 (112 – 137)	0.06 (0.05 – 0.07)	0.260	1940	0.00 (0.00 – 0.00)
Black-tailed godwit*	1,113	311 (296 – 327)	311 (296 – 327)	0.02 (0.02 – 0.02)	0.060	67	0.03 (0.03 – 0.03)
Bar-tailed godwit*	2,752	44 (40 – 48)	44 (40 – 48)	0.15 (0.14 – 0.16)	0.285	784	0.02 (0.02 – 0.02)
Curlew	3,565	486 (458 – 509)	486 (458 – 509)	0.27 (0.25 – 0.28)	0.101	360	0.07 (0.07 – 0.08)
Whimbrel	101	9.0 (8.6 – 9.5)	9.0 (8.6 – 9.5)	<0.01	0.110	11	0.04 (0.04 – 0.04)
Ruff	128	12 (11 – 13)	12 (11 – 13)	0.01 (0.01 – 0.01)	0.476	61	0.02 (0.02 – 0.02)

Table Note: Species in *italic* are waterbirds named in the assemblage feature of the Humber Estuary SPA. Species with * after them refer to those listed in the Ramsar designation as occurring at levels of international importance.

10.4.4.285 There is, therefore, no potential for an AEoI to the conservation objectives of the non-breeding waterbird features of Humber Estuary SPA and Ramsar in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, the non-breeding waterbirds will be maintained as a feature in the long term.

Hornsea Mere SPA – Gadwall

10.4.4.286 Gadwall has been screened into the assessment of the O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objective for this species, as a feature of the SPA:

- Restore the populations of each of the qualifying features.

10.4.4.287 Gadwall has been screened into the assessment of the O&M phase on a precautionary basis as a result of the potential for a proportion of its twice yearly migratory flights across the North Sea (to spend the non-breeding bio-season at the SPA) to pass across the array area and at a height that places them at risk of collision with the turning blades of the WTGs. It has been screened in for the migratory non-breeding bio-seasons.

10.4.4.288 The 24 months of aerial survey did not record this species. Quantitative CRM based on the site-specific aerial surveys is not justified for this species that pass through the area on migration. An assessment of all potential migrant birds was undertaken (see **Volume A5: Annex 5.5: Offshore Ornithology Migratory Birds Report**) which identified this species on the basis of it having potential flight paths over Hornsea Four. The resultant modelling through Migropath, which modelled the entire UK migratory population of 31,000 individuals across their North Sea migratory path, provided an estimate of 336 gadwall potentially flying over the Hornsea Four array area during the spring and autumn, which is higher than the population of the Hornsea Mere SPA. Subsequent collision risk modelling for the species provided an estimate of under one individual (0.1 individuals) likely to be subject to mortality per annum in total from all UK SPAs.

10.4.4.289 Should the entire loss of the modelling process be assessed against Hornsea Mere SPA then 0.1 gadwall per annum are estimated to be subject to collision consequent mortality from the population of 216. The baseline mortality rate for gadwall is 28% (Robinson 2005), which would mean 60 individuals would be lost from this population per annum. Therefore, the loss of 0.1 individuals per annum equates to a loss of 0.17% relative to baseline mortality, which is a level of effect that would not be considered to be significant and not of a material contribution to the overall annual natural mortality rate for this species.

10.4.4.290 There is, therefore, no potential for an AEoI to the conservation objectives of the gadwall feature of Honsea Mere SPA in relation to collision risk effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, gadwall will continue to be restored to the size at the point of designation whilst avoiding deterioration from its current level and be maintained as a feature in the long term.

Scottish SPAs – migratory and non-breeding gannets

10.4.4.291 The gannet feature of a number of Scottish SPAs have been screened in for the assessment of the O&M phase to assess the the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for the species, as a qualifying feature of the SPAs:

- Maintain the population of the species as a viable component of the site in the long-term.

10.4.4.292 The gannet feature of a number of Scottish SPAs has been screened in for the assessment of the potential of an adverse effect from collision risk associated with Hornsea Four based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. These SPAs are;

- Forth Islands SPA;
- Outer Firth of Forth and St Andrew's Complex pSPA;
- Fair Isle SPA;
- Noss SPA; and
- Hermaness, Saxa Vord and Valla Field SPA.

10.4.4.293 In order to provide a more concise review of all such sites, and in response to Section 42 Consultation Responses from the RSPB and Natural England (**Table 1**), the methods for considering gannet potentially susceptable to collision risk mortality from more distant designated sites in Scottish waters are considered in this section together.

10.4.4.294 The potential for impact on Scottish SPA gannet features varies by season and accordingly this assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max (plus 1SD) foraging range according to Woodward et al (2019). Outside the breeding bio-season, when the population within UK North Sea waters contains a mix of birds from UK breeding colonies and breeding colonies from further afield, then much lower percentages of birds can be attributed to any particular breeding colony SPA population. In the breeding bio-season the mean max (plus 1SD) foraging distance from Woodward et al (2019) can be used to determine which breeding colonies the birds may be apportioned to, whilst in the migratory bio-seasons the information on populations contained in Furness (2015) is considered most appropriate to be applied.

10.4.4.295 The Hornsea Four array area is within the mean max foraging distance (plus 1 SD) for gannet of 315.2 km (+ / - 194.2 km) to some of these Scottish SPAs, but due to knowledge from tracking studies reported in scientific papers (Wakefield, 2013) it is known that no discernible overlap of gannet foraging areas exists during the breeding season, particularly with respect to Scottish colonies and the foraging areas associated with the colony at Flamboarough and Filey Coast SPA. Accordingly, gannet are only assessed for the migratory (non-breeding) bio-seasons for each of the Scottish SPAs screened in.

10.4.4.296 Following an evidence-led approach the number of gannets estimated to be subject to collision risk mortality from Hornsea Four in total during the post-breeding migration bio-season is five (4.94) and in the return migration bio-season is two (1.84) individuals.

10.4.4.297 In the migratory (non-breeding) bio-seasons these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate, the number which can be attributed to each Scottish SPA can be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea and English Channel population estimates. The UK North Sea and English Channel population during the post-breeding bio-season is 456,298 individuals and during the return migration bio-season is 248,385 individuals for gannets.

10.4.4.298 According to Furness (2015) differing percentages of gannets from each Scottish SPA remain in the UK North Sea in their consistuent migratory (non-breeding) bio-season, which are presented in **Table 25** and **Table 26**. Accordingly, the proportion of birds in the UK North Sea and English Channel that can be attributed to each Scottish SPA is the remaining population as a proportion of the entire population for gannet during this period, for which each Scottish SPA is presented as a percentage. On that basis the number of individual gannets that may potentially be subject to collision risk mortality can be attributed to each Scottish SPA (**Table 25** and **Table 26**). Following this attribution of rates for gannets to specific Scottish SPAs a further calculation of what this represents as a percentage increase relative to baseline mortality is also considered.

Table 25: Apportionment of potential gannet collision mortality values from Hornsea Four to Scottish SPAs during the post-breeding migration bio-season in the UK North Sea and English Channel.

Scottish SPA	Adult population of SPA remaining in UK North Sea & English Channel (Furness 2015)	SPA population as a percentage of North Sea & English Channel (%)	Proportioned Collision mortality for each SPA during post-breeding migration bio-season (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the post-breeding migration bio-season (%)
Forth Islands (UK) SPA	110,964	24.32	1.2	43,200	0.03%
Outer Firth of Forth and St Andrew's Complex pSPA*	10,945	2.40	0.1	10,945	0.01%
Fair Isle SPA	5,494	1.20	0.1	2,332	0.03%
Noss SPA	13,674	3.00	0.1	13,720	0.01%
Hermaness, Saxa Vord and Valla Field SPA	34,094	7.47	0.4	32,800	0.01%

Table Note: *Outer Firth of Forth and St Andrew's Complex pSPA not included in Furness 2015 so citation population of 10,945 individuals used instead with 100% of adults remaining in the North Sea and English Channel.

Table 26: Apportionment of potential gannet collision mortality values from Hornsea Four to Scottish SPAs during the return migration bio-season in the UK North Sea and English Channel.

Scottish SPA	Adult population of SPA remaining in UK North Sea & English Channel (Furness 2015)	SPA population as a proportion of North Sea & English Channel	Proportioned Collision mortality for each SPA during return migration bio-season (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the return migration bio-season (%)
Forth Islands (UK) SPA	77,675	31.27	0.6	43,200	0.02%
Outer Firth of Forth and St Andrew's Complex pSPA*	7,662	3.08	0.1	10,945	0.01%
Fair Isle SPA	5,494	2.21	0.0	2,332	0.02%
Noss SPA	13,674	5.51	0.1	13,720	0.01%
Hermaness, Saxa Vord and Valla Field SPA	34,094	13.73	0.5	32,800	0.01%

Table Note: *Outer Firth of Forth and St Andrew's Complex pSPA not included in Furness 2015 so citation population of 10,945 individuals used instead with 70% of adults remaining in the North Sea and English Channel.

10.4.4.299 The estimated collision mortality rates in **Table 25** and **Table 26** for gannets are so low as to be considered no material contribution to the natural baseline mortality rates at each colony.

10.4.4.300 The impact of collision mortality from Hornsea Four WTGs that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality ranging from under one breeding adult for the majority of Scottish SPAs to approximately two (1.78) breeding adults at a single Scottish SPA over the two migratory bio-seasons together (the non-breeding bio-season). Based on these over-precautionary rates the increase in mortality relative to baseline mortality would be well under 0.1% across the non-breeding bio-seasons for any of the Scottish SPAs assessed, which will not affect the achievement of the conservation objectives for any of these Scottish SPAs and as a result Hornsea Four will not have an adverse effect on the integrity of the gannet feature of any Scottish SPAs.

10.4.4.301 There is, therefore, no potential for an AEoI to the conservation objectives of the gannet feature of Scottish SPAs in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, gannet will be maintained as a feature in the long term.

Scottish SPAs – migratory skua species

10.4.4.302 The great and Arctic skua features of a number of Scottish SPAs have been screened in for the assessment of the O&M phase to assess the the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for the species, as a qualifying feature of the SPAs:

- Maintain the population of the species as a viable component of the site in the long-term.

10.4.4.303 A number of SPAs within Scottish waters were screened into the assessment of the potential of an adverse effect from collision risk associated with Hornsea Four with respect to these SPA's skua species features (Arctic and great skuas). These SPAs are;

- Hoy SPA (Arctic skua and great skua);
- Rousay SPA (Arctic skua);
- West Westray SPA (Arctic skua);
- Fair Isle SPA (Arctic skua & great skua);
- Noss SPA (great skua);
- Foula SPA (Arctic skua & great skua);
- Fetlar SPA (Arctic skua & great skua); and
- Hermaness, Saxa Vord and Valla Field SPA (great skua).

10.4.4.304 In order to provide a more concise review of all such sites, and in response to Section 42 Consultation Responses from the RSPB and Natural England (**Table 1**), the methods for considering skua species potentially susceptable to collision risk from these more distant designated sites in Scottish waters are considered in this section together.

10.4.4.305 A review of migratory skua pathways and potential risks to skuas during such passage movements was undertaken, the results of which are in **Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Annex**.

10.4.4.306 Arctic skua tend to migrate and winter along coasts, often lingering for some time where there are aggregations of terns and small gulls such as in estuaries (Taylor 1979). The birds that migrate along the coasts of Britain and Ireland comprise both UK-breeding birds and those that breed in the north of Europe (Furness 1978). The most recent assessment of Arctic skua migration undertaken by Wildfowl and Wetlands Trust (WWT) and MacArthur Green (2013), which concluded that the majority of UK Arctic skua migrate within 20 km from the UK coastline based on observations from coastal watches and offshore surveys.

10.4.4.307 Great skua are considered, overall, to avoid coasts except during periods of bad weather, but the extent of that avoidance has been described differently by different authors. Wright et al. (2012) describe great skuas on migration as tending to avoid the coast, Wernham et al. (2002) suggests they remain at least 2-5km from the shore, whilst Stienen et al. (2007) states that they are an offshore species that is rarely observed within 20 km from the shoreline. Whilst avoiding the coast, great skua are considered to travel rarely into pelagic waters, tending to remain over the shallow seas of the continental shelf (Wernham et al. 2002). The most recent assessment of great skua migration undertaken by WWT and MacArthur Green (2013), concluded that the majority of UK great skua migrate within 40 km from the UK coastline based on observations from coastal watches and offshore surveys.

10.4.4.308 The Hornsea Four array area is located 65 km offshore at its nearest point, this is considerably further offshore than any of the migration corridors summarised above for Arctic or great skuas from Scottish SPAs. Following the same methodology for apportioning migratory seabirds used by Norfolk Boreas (Norfolk Boreas Ltd 2019) in their final DCO application submissions, it can be concluded that none of the Scottish population of migratory Arctic or great skuas are at risk of collision from Hornsea Four due to evidence supporting their migratory flights being closer to the coast. There is, therefore, no potential for an AEoI to the conservation objectives of the Arctic or great skua features of any Scottish SPAs in relation to collision risk effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, both species of skuas will be maintained as features in the long-term.

Scottish SPAs – migratory (non-breeding) kittiwake

10.4.4.309 The kittiwake feature of a number of Scottish SPAs have been screened in for the assessment of the O&M phase to assess the the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for the species, as a qualifying feature of the SPAs:

- Maintain the population of the species as a viable component of the site in the long-term.

10.4.4.310 The kittiwake feature of a number of Scottish SPAs has been screened in for the assessment of the potential of an adverse effect from collision risk associated with Hornsea Four based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. It has been screened in for the return migration and post-breeding migration bio-seasons. These SPAs are:

- St Abb's SPA;
- Forth Islands (UK) SPA;
- Outer Firth of Forth and St Andrew's Complex pSPA;
- Fowlsheugh SPA;
- Buchan Ness to Collieston Coast SPA;
- Troup, Pennan and Lion's Heads SPA;
- East Caithness Cliffs SPA;
- North Caithness Cliffs SPA;
- Copinsay SPA;
- Hoy SPA;
- Marwick Head SPA;
- Rousay SPA;
- Calf of Eday SPA;
- West Westray SPA;
- Fair Isle SPA;
- Sumburgh Head SPA;
- Noss SPA;
- Foula SPA; and
- Hermaness, Saxa Vord and Valla Field SPA.

10.4.4.311 In order to provide a more concise review of all such sites, and in response to Section 42 Consultation Responses from the RSPB and Natural England (**Table 1**), the methods for considering kittiwake potentially susceptable to collision risk mortality from more distant designated sites in Scottish waters are considered in this section together.

10.4.4.312 The potential for impact on Scottish SPA kittiwake features varies by season and accordingly this assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max (plus 1SD) foraging range according to Woodward et al (2019). Outside of the breeding bio-season, when the population within UK North Sea waters contains a mix of birds from UK breeding colonies and breeding colonies from further afield, then a much lower percentages of birds can be attributed to any particular breeding colony SPA population. In the breeding season the mean max (plus 1SD) foraging distance from Woodward et al. (2019) can be used to determine which breeding colonies the birds may be apportioned to, whilst in the migratory bio-seasons the information on populations contained in Furness (2015) is considered most appropriate to be applied.

10.4.4.313 The Hornsea Four array area is beyond the mean max foraging distance (plus 1SD) for kittiwake of 156.1 km (+/- 144.5 km) to any of these Scottish SPAs screened in. Accordingly, kittiwake are only assessed for the migratory (non-breeding) bio-seasons for each of the Scottish SPAs screened in.

10.4.4.314 Following an evidence-led approach the total number of kittiwakes estimated to be subject to collision risk mortality from Hornsea Four during the post-breeding migration bio-season is 40 (40.25) individuals and in the return migration bio-season is 27 (27.48) individuals.

10.4.4.315 In the migratory (non-breeding) bio-seasons these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to each Scottish SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea population estimates. The UK North Sea population during the post-breeding bio-season is 829,937 individuals and during the return migration bio-season is 627,816 individuals for kittiwake.

10.4.4.316 According to Furness (2015) differing percentages of kittiwake from each Scottish SPA remain in the UK North Sea in their consistuent migratory (non-breeding) bio-season, which are presented in **Table 27**. Accordingly, the proportion of birds in the UK North Sea that can be attributed to each Scottish SPA is the remaining population as a proportion of the entire population for kittiwake during this period, for which each Scottish SPA is presented as a percentage. On that basis the number of individual kittiwakes that may potentially be subject to collision risk mortality can be attributed to each Scottish SPA (**Table 27**). Following this attribution of mortatlity rates for kittiwakes to specific Scottish SPAs a further calculation of what this represents as a percentage increase relative to baseline mortality is also considered.

Table 27: Apportionment of potential kittiwake collision mortality values from Hornsea Four to Scottish SPAs during the migratory bio-seasons in the UK North Sea.

Scottish SPA	Adult population of the SPA remaining in UK North Sea & English Channel during migratory bio-seasons (Furness 2015)	SPA population as a percentage of North Sea during return migration bio-season (%)	SPA population as a percentage of North Sea during post-breeding migration bio-season (%)	Proportioned Collision mortality rate for each SPA during return migration bio-season (breeding adults per annum)	Proportioned Collision mortality rate for each SPA during post-breeding migration bio-season (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the migratory bio-seasons (%)
St Abb's SPA	4,084	0.65	0.49	0.2	0.2	42,340	0.01
Forth Islands (UK) SPA	3,720	0.59	0.45	0.2	0.2	16,800	0.01
Outer Firth of Forth and St Andrew's Complex pSPA*	5,481	0.87	0.66	0.2	0.3	12,020	0.03
Fowlsheugh SPA	11,204	1.78	1.35	0.5	0.5	73,300	0.01
Buchan Ness to Collieston Coast SPA	15,050	2.40	1.81	0.7	0.7	60,904	0.01
Troup, Pennan and Lion's Heads SPA	17,875	2.85	2.15	0.8	0.9	63,200	0.02
East Caithness Cliffs SPA	48,492	7.72	5.84	2.1	2.4	65,000	0.04
North Caithness Cliffs SPA	12,180	1.94	1.47	0.5	0.6	26,200	0.03
Copinsay SPA	799	0.13	0.10	0.0	0.0	19,100	0.00
Hoy SPA	476	0.08	0.06	0.0	0.0	6,000	0.00
Marwick Head SPA	631	0.10	0.08	0.0	0.0	15,400	0.00

Scottish SPA	Adult population of the SPA remaining in UK North Sea & English Channel during migratory bio-seasons (Furness 2015)	SPA population as a percentage of North Sea during return migration bio-season (%)	SPA population as a percentage of North Sea during post-breeding migration bio-season (%)	Proportioned Collision mortality rate for each SPA during return migration bio-season (breeding adults per annum)	Proportioned Collision mortality rate for each SPA during post-breeding migration bio-season (breeding adults per annum)	SPA citation population (breeding adults)	SPA citation population baseline mortality rate percentage increase during the migratory bio-seasons (%)
Rousay SPA	2,117	0.34	0.26	0.1	0.1	9,800	0.01
Calf of Eday SPA	896	0.14	0.11	0.0	0.0	3,434	0.02
West Westray SPA	14,466	2.30	1.74	0.6	0.7	47,800	0.02
Fair Isle SPA	925	0.15	0.11	0.0	0.0	36,320	0.00
Sumburgh Head SPA	252	0.04	0.03	0.0	0.0	2,732	0.01
Noss SPA	608	0.10	0.07	0.0	0.0	14,040	0.00
Foula SPA	392	0.06	0.05	0.0	0.0	7,680	0.00
Hermaness, Saxa Vord and Valla Field SPA	469	0.07	0.06	0.0	0.0	1,844	0.02

Table Note: *Outer Firth of Forth and St Andrew's Complex pSPA not included in Furness 2015 so citation population of 12020 individuals used instead with 60% of adults remaining in the North Sea and English Channel.

10.4.4.317 The estimated collision mortality rates in **Table 27** for kittiwake are so low as to be considered no material contribution to the natural baseline mortality rates at each colony.

10.4.4.318 The impact of collision mortality from Hornsea Four WTGs that would occur throughout the operational life of Hornsea Four is a prediction of consequent mortality ranging from under one for the majority of Scottish SPAs to approximately four (4.18) breeding adults at a single Scottish SPA over the two migratory bio-seasons combined (the non-breeding bio-season). Based on these over-precautionary rates the increase in baseline mortality would be well under 0.1% across the non-breeding bio-seasons, which will not affect the achievement of the conservation objectives for any of these SPAs and as a result Hornsea Four will not have an adverse effect on the integrity of the kittiwake feature of any Scottish SPAs.

10.4.4.319 There is, therefore, no potential for an AEoI to the conservation objectives of the kittiwake feature of Scottish SPAs in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, kittiwake will be maintained as a feature in the long term.

Scottish and English SPAs – migratory tern species

10.4.4.320 The common, Arctic and Sandwich tern features of a number of English and Scottish SPAs have been screened in for the assessment of the O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objectives for the species, as a qualifying feature of the SPAs:

- Maintain the population of the species as a viable component of the site in the long term.

10.4.4.321 The tern features of a number of English and Scottish SPAs to the North of Hornsea Four have been screened in for the assessment of the potential for an adverse effect from collision risk associated with Hornsea Four. The English SPAs are:

- Northumbria Coast SPA (Arctic tern);
- Teesmouth and Cleveland Coast SPA (common tern & Sandwich tern);
- Coquet Island SPA (common tern, Arctic tern, roseate tern & Sandwich tern);
- Farne Islands SPA (common tern, Arctic tern & Sandwich tern); and
- Northumberland Marine SPA (common tern, Arctic tern, roseate tern & Sandwich tern)

10.4.4.322 The Scottish SPAs are:

- Forth Islands (UK) SPA (common, Arctic tern & Sandwich tern);
- Rousay SPA (Arctic tern);
- West Westray SPA (Arctic tern);
- Fair Isle SPA (Arctic tern);
- Sumburgh Head SPA (Arctic tern);

- Foula SPA (Arctic tern); and
- Fetlar SPA (Arctic tern).

10.4.4.323 In order to provide a more concise review of all such sites, and in response to Section 42 Consultation Responses from the RSPB and Natural England (**Table 1**), the assessment of tern species potentially susceptible to collision risk from more distant designated sites in both Scottish and English waters are considered in this section together.

10.4.4.324 A review of migratory tern pathways and potential risks to terns during such passage movements was undertaken, the results of which are in **Volume A5, Annex 5.5: Offshore Ornithology Migratory Birds Annex**. A summary is provided below for each species.

10.4.4.325 For common tern much of the movement of juveniles and adults post-fledgling within Britain is considered to be overland (Ward 2000; Wernham et al. 2002). In addition, during the early autumn months there is a strong southward movement of common terns along the coast of southwest Europe and away from Britain and Ireland, migration follows the coasts (Wernham et al. 2002). Many UK breeding birds are back at their breeding areas by April. The lack of records at west coast observatories implies that there is little movement through the Irish Sea to the Scottish colonies, and the frequency of inland sightings suggests that much of the spring passage takes place directly overland to the breeding sites. In fact, the only British observatories to record substantial numbers in spring are Dungeness and Portland Bill. At both sites, spring passage peaks in late April and early May and is mainly eastward, suggesting that these birds are most likely to be on their way to breeding areas elsewhere in northern Europe (Wernham et al. 2002).

10.4.4.326 For Arctic terns, Britain is at the southern edge of their breeding range and colonies are concentrated in the north of England and Scotland (Wright et al. 2002). At the end of the breeding season, the main post-breeding movement of adult birds is southwards. Movements through Britain and Ireland are thought to occur mainly offshore (Wernham et al. 2002). The migration continues southwards via the coast of western and southern Africa to wintering sites along the West African coast and around the Antarctic (Wright et al. 2012). The return passage begins in March, with birds heading for European colonies heading northwards through the eastern Atlantic, with a similar route to that undertaken in autumn taken in spring (Wernham et al. 2002). In Britain, overland northward movements of Arctic terns are indicated by observations of hundreds or even thousands of birds during some spring months at reservoirs in central England. These observations may be the result of poor flying conditions at sea or at high altitudes over land (Kramer 1995).

10.4.4.327 Roseate terns are among the most marine of terns, with inland records extremely rare. In North West Europe, the species is predominantly found in the Irish Sea, although breeding colonies also occur along the East coast of the UK in Northumberland and Lothian (Wernham et al. 2002). Breeding occurs on offshore islands or islets in coastal lagoons within foraging range of sandeels and sprats which they feed upon during the breeding season. Juveniles fledge in July and pre-migratory dispersal occurs in August. Migration south to wintering grounds occurs between August to October, with birds tending to migrate within 10 to 20 km of the coast, a rapid migration to the wintering grounds with no discrete staging areas en- route is suggested by the quickly diminishing numbers of ring recoveries and broadly dispersed ring recoveries along the western Iberian and West African coastlines (Wernham et al. 2002). All roseate terns from Britain and Ireland share the same migration route and wintering grounds (Wernham et al. 2002). Adults begin the return migration back to Britain and Ireland during summer, with birds arriving at the earliest in April and in Europe return in late June and July. Although there are less ring recoveries during spring migration, the available evidence suggests they follow a similar route to that in autumn (Wernham et al. 2002).

10.4.4.328 Sandwich terns are a strictly coastal and a mainly warm-water species (del Hoyo et al. 1992-2013). After the breeding season, birds move north and south to favourable feeding grounds, dispersing around the coasts of Britain and Ireland and across the North Sea to the Netherlands and Denmark in late-June, July and August before southward migration begins in mid-September to wintering grounds (Wernham et al. 2002; del Hoyo et al. 1992-2013). Birds from Europe follow the coasts of the Netherlands, France and Iberia towards the western coasts of Africa (BirdGuides 2011), wintering mainly in the tropics with a few remaining in Western Europe (del Hoyo et al. 1992-2013). Return migration occurs between March and May and is more direct than in autumn, with many fewer birds going via the eastern North Sea (Wright et al., 2012). In Britain and Ireland, Sandwich terns are concentrated in three main areas along the east coast of Britain: Northeast Scotland, Northumberland and Norfolk, whilst they are listed in Stienen et al. (2007) as an inshore species that is most abundant within 20 km from the shoreline.

10.4.4.329 Another series of assessments on common, Arctic and Sandwich tern migration undertaken by WWT and MacArthur Green (2013) concluded that the majority of UK populations of these three tern species migrate within 10 km, 20 km and 10 km, respectively, from the UK coastline based on observations from coastal watches and offshore surveys.

10.4.4.330 The Hornsea Four array area is located 65 km offshore at its nearest point, this is considerably further offshore than any of the migration corridors summarised above for common, Arctic, roseate or Sandwich terns from UK SPAs. Following the same methodology for apportioning migratory seabirds used by Norfolk Boreas (2019) in their final DCO application submissions, it can be concluded that none of the UK population of migratory common, Arctic, roseate or Sandwich terns are at risk of collision from Hornsea Four due to evidence supporting their migratory flights being closer to the coast.

10.4.4.331 There is, therefore, no potential for an AEoI to the conservation objectives of the common, Arctic, roseate or Sandwich tern features of any Scottish or English SPAs in relation to collision risk effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, all four species of terns will be maintained as features in the long term.

Coquet Island SPA – kittiwake

10.4.4.332 Kittiwake has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the populations of each of the qualifying features.

10.4.4.333 Based on the above the conservation objective for the Coquet Island SPA the specific target for the seabird assemblage is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 47,662 individuals, whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.334 Although kittiwake is a listed component of the seabird assemblage and not a designated feature in its own right, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on kittiwake as a feature, but more as an important component of the seabird assemblage.

10.4.4.335 Kittiwake has been screened into the assessment of the O&M phase based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. However, the population of kittiwake is only small (426 breeding pairs) at Coquest Island SPA and it is also neither a designated feature or a named species within the seabird assemblage.

10.4.4.336 The potential for impact on the SPA varies by season and accordingly the assessment is carried out on a seasonal basis. The Hornsea Four array area is beyond the mean max foraging distance (plus 1SD) for kittiwake of 156.1 km (+/- 144.5 km) to Coquet Island SPA. Accordingly, kittiwake are only assessed for the migratory (non-breeding) bio-seasons for Coquet island SPA. Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the non-breeding bio-seasons, for which this species is assessed, the information on populations contained in SPA citation is applied.

10.4.4.337 Following an evidence-led approach the total number of kittiwake estimated to be subject to collision risk mortality from Hornsea Four during the post-breeding migration bio-season is 38 (38.43) individuals and in the return migration bio-season is 25 (25.05) individuals.

10.4.4.338 In the migratory (non-breeding) bio-seasons these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed Coquet Island SPA has to be calculated. Furness (2015) did not provide population data for Coquet Island SPA from which those calculations can be carried out, so in this instance the citation population of 426 breeding adults is used as the source data. The UK North Sea population during the post-breeding bio-season is 829,937 individuals and during the return migration bio-season is 627,816 individuals for kittiwake.

10.4.4.339 No data is within Furness (2015) for kittiwake at Coquet Island SPA, as it is not a significant population or a qualifying feature of the SPA, so it is assumed they are similar to the Farne Islands SPA with respect to the percentage that remains within each migratory bio-season (that percentage is 60%). Accordingly, the proportion of birds in the UK North Sea that can be attributed to Coquet Island SPA is the remaining population as a proportion of the entire population for kittiwake during this period, for which Coquet Island SPA is 0.03% during the post-breeding migration bio-season and 0.04% during the return migration bio-season. On that basis the number of individual kittiwakes that may potentially be subject to collision risk mortality that can be attributed to Coquet Island is less than a single (0.02) breeding adult when considering both migratory bio-seasons together. This represents only a slight increase of 0.04% in the baseline mortality rate of the citation population.

10.4.4.340 There is, therefore, no potential for an AEoI to the conservation objectives of the kittiwake as a component part of the seabird assemblage feature of Coquet Island SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, kittiwake will be maintained as a feature of the seabird assemblage in the long term.

Farne Islands SPA – kittiwake

10.4.4.341 Kittiwake has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the populations of each of the qualifying features.

10.4.4.342 Based on the above the conservation objective for the Farne Islands SPA the specific target for the seabird assemblage is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 163,819 individuals, whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.343 Although kittiwake is listed component of the seabird assemblage and not a designated feature in its own right, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on kittiwake as a feature, but more as an important component of the seabird assemblage.

10.4.4.344 Kittiwake has been screened into the assessment of the O&M phase based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs.

10.4.4.345 The potential for impact on the SPA varies by season and accordingly the assessment is carried out on a seasonal basis. The Hornsea Four array area is beyond the mean max foraging distance (plus 1 SD) for kittiwake of 156.1 km (+/- 144.5 km) to the Farne Islands SPA. Accordingly, kittiwake are only assessed for the migratory (non-breeding) bio-seasons for the Farne islands SPA. Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the non-breeding bio-seasons, for which this species is assessed, the information on populations contained in Furness (2015) is applied.

10.4.4.346 Following an evidence-led approach the total number of kittiwakes estimated to be subject to collision risk mortality from Hornsea Four during the post-breeding migration bio-season is 38 (38.43) individuals and in the return migration bio-season is 25 (25.05) individuals.

10.4.4.347 In the migratory (non-breeding) bio-seasons these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to the Farne Islands SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea population estimates. The UK North Sea population during the post-breeding migration bio-season is 829,937 individuals and during the return migration bio-season is 627,816 individuals for kittiwake.

10.4.4.348 According to Furness (2015) the percentage of kittiwakes from the Farne Islands SPA that remain in the UK North Sea in each of the two migratory (non-breeding) bio-seasons is 60%. Accordingly, the proportion of birds in the UK North Sea that can be attributed to the Farne Islands SPA is the remaining population as a proportion of the entire population for kittiwake during this period, for which the Farne Islands SPA is presented as a percentage is 0.50% during the post-breeding migration bio-season and 0.66% during the return migration bio-season. On that basis the number of individual kittiwakes that may potentially be subject to collision risk mortality can be attributed to the Farne Islands SPA is under one (0.36) breeding adult per annum. This represents only a slight increase of 0.03% in the baseline mortality rate of the citation population.

10.4.4.349 There is, therefore, no potential for an AEoI to the conservation objectives of the kittiwake component part of the seabird assemblage feature of the Farne Islands SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, kittiwake will be maintained as a feature of the seabird assemblage in the long term.

Northumberland Marine SPA – kittiwake

10.4.4.350 Kittiwake has been screened into the assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the populations of each of the qualifying features.

10.4.4.351 Based on the above the conservation objective for the Northumberland Marine SPA the specific target for the seabird assemblage is as follows based on Natural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level, which is above 214,669 individuals, whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

10.4.4.352 Although kittiwake is listed as a component of the seabird assemblage and not a designated feature in its own right, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four alone on kittiwake as a feature, but more as an important component of the seabird assemblage.

10.4.4.353 Although kittiwakes within the Northumberland Marine SPA are from Coquet Island SPA (426 breeding adults) and the Farne Islands SPA (8,241 breeding adults), for the purpose of this assessment they have been considered together for completeness (total 8,667 breeding adults).

10.4.4.354 Kittiwake has been screened into the assessment of the O&M phase based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs.

10.4.4.355 The potential for impact on the SPA varies by season and accordingly the assessment is carried out on a seasonal basis. The Hornsea Four array area is beyond the mean max foraging distance (plus 1 SD) for kittiwake of 156.1 km (+/- 144.5 km) to the Northumberland Marine SPA. Accordingly, kittiwake are only assessed for the migratory (non-breeding) bio-seasons for the Northumberland Marine SPA. Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the non-breeding bio-seasons, for which this species is assessed, the information on populations contained in Furness (2015) is applied. However, Furness (2015) did not provide population data for Coquet Island SPA from which those calculations can be carried out, so in this instance the citation population of 426 breeding adults is used as the source data for that colony within the Northumberland Marine SPA.

10.4.4.356 Following an evidence-led approach the total number of kittiwakes estimated to be subject to collision risk mortality from Hornsea Four during the post-breeding migration bio-season is 38 (38.43) individuals and in the return migration bio-season is 25 (25.05) individuals.

10.4.4.357 In the migratory (non-breeding) bio-seasons these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to the two separate SPA colonies within the Northumberland Marine SPA (at the Farne Islands SPA and Coquet Island SPA) has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea population estimates. The UK North Sea population during the post-breeding migration bio-season is 829,937 individuals and during the return migration bio-season is 627,816 individuals for kittiwake.

10.4.4.358 According to Furness (2015) the percentage of kittiwakes from the Farne Islands SPA that remain in the UK North Sea in each of the two migratory (non-breeding) bio-seasons is 60%. Accordingly, the proportion of birds in the UK North Sea that can be attributed to the Northumberland Marine SPA is the remaining population as a proportion of the entire population for kittiwake during this period, for which the Northumberland Marine SPA is presented as a percentage is 0.53% during the post-breeding migration bio-season and 0.70% during the return migration bio-season. On that basis the number of individual kittiwakes that may potentially be subject to collision risk mortality can be attributed to the Northumberland Marine SPA is under one (0.38) breeding adult per annum. This represents only a slight increase of 0.03% in the baseline mortality rate of the citation population.

10.4.4.359 There is, therefore, no potential for an AEoI to the conservation objectives of the kittiwake component part of the seabird assemblage feature of the Northumberland Marine SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, kittiwake will be maintained as a feature of the seabird assemblage in the long term.

<u>*Calf of Eday SPA – great black-backed gull*</u>

10.4.4.360 Great black-backed gull has been screened into the assessment of the O&M phase to assess the impacts from collision from Hornsea Four alone in relation to the following conservation objective for this species, as a feature of the SPA:

- Maintain the population of the species as a viable component of the site in the long-term.

10.4.4.361 Great black-backed gull has been screened into the assessment of the O&M phase based on the density of birds in flight in the array area and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. It has been screened in for the non-breeding bio-seasons.

10.4.4.362 The potential for impact on the SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds that can be attributed to breeding colonies (including SPAs) within the species' mean max foraging range of 73 km (there is no mean max plus 1D for this species) according to Woodward et al. (2019). Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the non-breeding bio-season, for which this species is assessed, the information on populations contained in Furness (2015) is applied.

10.4.4.363 Following an evidence-led approach the total number of great black-backed gulls estimated to be subject to collision risk mortality from Hornsea Four during the non-breeding bio-season is four (3.94) individuals.

10.4.4.364 In the non-breeding bio-season these birds will have come from a wide range of seabird breeding colonies in the UK and overseas. From that consequent mortality estimate the number which can be attributed to the Calf of Eday SPA has to be calculated. Furness (2015) provides the overall population data and SPA colony data from which those calculations can be carried out. In this instance the population in Furness (2015) is 562 breeding adults. It must be noted that the colony counts in Furness (2015) may differ from the SPA citation populations for some species, but in order to provide a level of consistency within this assessment the same source is used for both the colony counts and the wider UK North Sea population estimates. The UK North Sea population during the non-breeding bio-season is 91,399 individuals for great black-backed gull.

10.4.4.365 According to Furness (2015) the percentage of great black-backed gulls from the Calf of Eday SPA that remain in the UK North Sea in each of the two constituent migratory (non-breeding) bio-seasons is 100%. Accordingly, the proportion of birds in the UK North Sea that can be attributed to the Calf of Eday SPA is the remaining population as a proportion of the entire population for great black-backed gull during this period, for which the Calf of Eday SPA is presented as a percentage. Threfore, based on all 562 adults from Calf of Eday remaining in the wider North Sea non-breeding bio-season population of 62,736 adults then birds from this colony represent 0.98% of the North Sea non-breeding population. On that basis the number of individual great black-backed gulls that may potentially be subject to collision risk mortality can be attributed to the Calf of Eday SPA is well under one (0.04) breeding adult per annum. This represents only a slight increase of 0.03% in the baseline mortality rate of the citation population.

10.4.4.366 There is, therefore, no potential for an AEoI to the conservation objectives of the great black-backed gull feature of the Calf of Eday SPA in relation to collision mortality effects in the O&M phase from Hornsea Four alone and therefore, subject to natural change, great black-backed gull will be maintained as a feature in the long term.

Combined Displacement and Collision Risk

10.4.4.367 The potential for combined disturbance and displacement with collision risk to result in an AEoI relates to the following designated site and the relevant feature:

- Flamborough and Filey Coast SPA; gannet during the breeding and non-breeding bio-seasons.

Flamborough and Filey Coast SPA – gannet

10.4.4.368 Gannet has been screened into the assessment of the O&M phase to assess the impacts from both displacement and collision combined from Hornsea Four alone in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

10.4.4.369 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- To maintain the size of the breeding population at a level, which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts (Aitken et al. 2017).

10.4.4.370 Previous sections have concluded no AEoI from either collision risk or displacement acting alone; however, the combined impact of both collision risk and displacement may be greater than either one acting alone. Further consideration of both impacts acting together is therefore required.

10.4.4.371 As detailed in **paragraph 10.4.4.56** and **10.4.4.246** the combined predicted gannet mortality for the FFC SPA from displacement and collision impacts is a total of 12 (11.77) to 13 (12.85) breeding adults per annum. The prediction of a total consequential additional mortality of between 12 and 13 breeding adults per annum represents an increase 0.86% to 0.94% in baseline mortality when considering the citation population or an increase of 0.54% to 0.59% when considering the recent 2017 colony count across all bio-seasons per annum.

10.4.4.372 The conservation objective for the gannet feature of the FFC SPA is to maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts.

10.4.4.373 The addition of between 12 to 13 possible additional breeding adult mortalities per annum equates to under 1% increase in baseline mortality, when considering either the citation or the latest 2017 colony count. This level of impact would be indistinguishable from natural fluctuations in annual mortality rates at the population. Furthermore, it should be noted that the impacts associated with both displacement and collison risk combined assessed in this simplistic additive manner are almost certainly an overestimate, as a bird which has been displaced from the array area can no longer collide with a WTG and vice versa. Therefore, the potential for an AEoI to the conservation objectives of the gannet feature of FFC SPA in relation to combined displacement and collision effects in the O&M phase from Hornsea Four alone can be ruled out and, subject to natural change, gannet will be maintained as a feature in the long term.

Barrier Effect - Flamborough and Filey Coast SPA – Guillemot, razorbill and puffin

10.4.4.374 Guillemot, razorbill and puffin has been screened into the assessment of the O&M phase to assess the impacts from potential barrier effects in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the distribution of the qualifying features within the site.

10.4.4.375 In the operational phase of Hornsea Four the presence of WTGs could create a barrier to the movements of seabirds. This may result in permanent changes in flight routes for the birds concerned and an increase in energy demands associated with those movements. It may also result in a lower rate of breeding success or in reduced survival chances for the individuals affected.

10.4.4.376 Ecological theory suggests that birds, while they are breeding, will take the shortest (energetically most efficient) route to and from known areas that provide good foraging resources. For birds breeding at the FFC SPA those routes would, if the location of food resources is known, result in straight-out-and-back flights from the breeding cliffs to known foraging areas. For the Hornsea projects in general, and Hornsea Four specifically, to create a barrier to such flights then they/it would need to be sited across such flight lines and the bird species concerned would have to be known, or suspected, not to enter an operational wind farm (i.e. exhibit a high degree of avoidance). Given the location of the Hornsea projects it is flights in an almost due east-west alignment from the FFC SPA that would encounter the under-construction, consented or proposed Hornsea projects.

10.4.4.377 The assessment of Hornsea Four and the potential for its construction and operation to create a barrier to the movement of seabirds breeding at the FFC SPA can be informed by knowledge of the existing routes that seabirds take as they commute back and forth from their breeding sites to forage offshore. As clearly presented in **Figure 17** to **Figure 20** (there is no tracking data available for puffin, but due to being ecologically similar it's likely they will forage in the same areas as guillemot and razorbill) and described in **paragraph 10.4.4.84** above the Hornsea Four array area and 2 km buffer does not lie within an area of sea of importance regardless of the season for foraging, therefore any impacts from displacement would not restrict movements to key feeding areas or inhibit auks from utilising the waters considered to make up the Flamborough Front.

10.4.4.378 There is, therefore, no potential for an AEoI to the conservation objectives of these three auks species in relation to a barrier effect in the O&M phase from Hornsea Four alone and therefore, subject to natural change, all three auk species will be maintained as a feature in the long term.

10.5 Onshore Ecology

10.5.1.1 As all potential effects related to onshore ecology have been screened out, as confirmed within the Screening Report and Screening Matrix (**Appendix A** and **Appendix B**), no assessment is presented with regard to onshore ecology. Full details on impacts and effects related to onshore ecology is presented within **Volume A3, Chapter 3: Ecology and Nature Conservation**.

10.6 Migratory Fish

10.6.1.1 As all potential effects related to migratory have been screened out, as confirmed within the Screening Report and Screening Matrix (**Appendix A** and **Appendix B**), no assessment is presented with regard to migratory fish. Full details on impacts and effects related to fish ecology is presented within **Volume A2, Chapter 3: Fish and Shellfish Ecology**.

11 Assessment of Adverse Effect In-Combination

11.1.1.1 Screening for designated sites and features in-combination is presented in **Section 8.2**, identifying the plans and projects to be considered for assessment. The assessment presented here draws on that presented within relevant topic specific chapters of the ES, tailored for the requirements of the RIAA, to inform the assessment of AEoI in-combination to the features and effects screened in.

11.1.1.2 In assessing the potential for in-combination effects associated with Hornsea Four, it is important to bear in mind that some projects, predominantly those 'proposed' or identified in development plans etc. may or may not actually be taken forward, or taken forward in the same design envelope as currently presented. There is thus a need to build in some consideration of certainty (or uncertainty) with respect to the potential impacts which might arise from such proposals. For example, relevant projects/ plans with consent and (if required) CfD (or similar) are more likely to contribute to in-combination impact with Hornsea Four (providing temporal and spatial pathways exist), whereas projects/ plans not yet approved or not yet submitted are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors.

11.1.1.3 For this reason, all relevant projects/ plans considered in-combination alongside Hornsea Four have been allocated into 'Tiers', reflecting their current stage within the planning and development process. Where the tiering approach differs between receptor groups, this is noted in the relevant section. The tiering approach allows the in-combination impact assessment to present several future development scenarios, each with a differing potential for being ultimately built out. The definition of each tier is described in (**Section 8.2**), with the plans and projects screened in for further consideration here defined within **Table 28.**

11.1.1.4 For each plan/ project screened in, the in-combination maximum adverse scenario draws on the information presented in topic specific chapters of the ES. The aim is to identify, for each receptor group, the aspects of the plans, projects and programmes screened in to be assessed. Consideration is given to the following points:

- Level of detail available for project/ plans;
- Potential for an effect-pathway-receptor link;
- Potential for a physical interaction; and
- Potential for temporal interaction.

11.1.1.5 **Table 28** below identifies, for all plans and projects screened in for consideration in-combination, the relevant receptor group(s), the maximum adverse scenario as it applies to that receptor group(s) and the relevant years within which the works are planned to occur. It is of note that, for a number of projects, insufficient information exists to provide a maximum adverse scenario, with that noted where relevant Equivalent information for ornithology is provided in **Section 11.4**.

Table 28: In-Combination Projects and Relevant Years (excluding ornithology).

Status	Project/ Plan Name	Tier	Relevant Receptor[62]					Relevant Years
			Benthic and Intertidal Ecology	Harbour porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal	
Offshore Wind Farms								
In-Planning (including a project awaiting re-determination)	Norfolk Boreas	1						Piling Q2 2026-Q3 2027, UXO clearance Q3 2025- Q1 2026
	Norfolk Vanguard	1						Piling scheduled Q2 2024-Q1 2025 OR Q2 2024-Q1 2025 and Q2 2027-Q1 2028
	Marr Bank & Berwick Bank	2						Not yet submitted
	East Anglia One North	1						Piling 2026-2028
	East Anglia Two	1						Piling 2025-2027
	North Falls (previously Greater Gabbard Extension)	3						Not known
	Five Estuaries (previously Galloper Extension)	3						Not known
	Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2						Earliest construction expected to start 2024, offshore construction to follow in 2 years (2026)[63]
	Round 4 – Leasing Area 1 (Bidding Area 1)	3						Not known
	Round 4 – Leasing Area 2 (Bidding Area 1)	3						Not known
	Round 4 – Leasing Area 3 (Bidding Area 2)	3						Not known

[62] Note that for marine mammal species, if Table 8.2 found 'no' to the potential for overlap with construction, the plan or project has not been screened in for construction effects and therefore has not been carried over here. Effects during O&M may draw on additional projects as appropriate.
[63] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

Status	Project/ Plan Name	Tier	Relevant Receptor[62]					Relevant Years
			Benthic and Intertidal Ecology	Harbour porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal	
Consented	Hornsea Project Three	1						Piling scheduled Q1 2022- Q2 2023 and/or Q1 2027-Q2 2028
	Dogger Bank A (previously Dogger Creyke Beck A)[64]	1						Construction window unclear but potential for all phases
	Dogger Bank B (previously Dogger Creyke Beck B)[65]	1						Construction window unclear but potential for all phases
	Dogger Bank C (previously Dogger Teesside A)[66]	1						Construction window unclear but potential for all phases
	Sofia[67]	1						Construction window unclear but potential for all phases
	EnBW He Dreiht	1						Commissioning 2025, potential for in-combination during operation and maintenance only
Under construction, operational	Hornsea Project One	1						Potential for in-combination during operation and maintenance only, all projects currently under construction will be complete prior to start of Hornsea Four construction
	Hornsea Project Two	1						
	East Anglia One	1						
	Triton Knoll	1						
	Neart na Gaoithe	1						
	Inch Cape	1						
	SeaGreen Alpha Bravo	1						
	Kincardine	1						

[64] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023 https://doggerbank.com/construction/offshore/
[65] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023 https://doggerbank.com/construction/offshore/
[66] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023 https://doggerbank.com/construction/offshore/
[67] Noting that current project information states offshore construction to start 2023, piling in 2024, turbines installed 2025 and complete by 2026 https://sofiawindfarm.com/offshore-construction/

Status	Project/ Plan Name	Tier	Relevant Receptor[62]					Relevant Years
			Benthic and Intertidal Ecology	Harbour porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal	
	Moray East	1						
	Moray West	1						
	East Anglia Three[68]	1						
Other Sectors as relevant								
Cable, pipeline, O&G	Scotland England Green Link 2 (SEGL2) Cable – Peterhead to Drax	3						In planning - it is expected that construction activities will commence in 2025 with operations commencing in 2030.
	Viking Link	1						Potential for in-combination during operation and maintenance only
	Dana Petroleum Platypus	1						Operational phase of pipeline only
	Tolmount Wellhead	1						Operational phase of asset only
	Johnston Template Manifold	1						Decommissioning of asset only, expected from 2022
	Johnston WHSP	1						Decommissioning of asset only, expected from 2022
Marine aggregates	Humber Overfalls Area 493	1						Active
	Off Saltfleet Area 197	1						
	Humber Estuary Area 400	1						
	Humber 1 Area 514/1	1						
	Humber 2 Area 514/2	1						
	Humber Estuary Area 514/3	1						
Carbon Capture Storage	Endurance	3						Unknown – project is pre-planning with no relevant information available in the public domain
Operational	Bridlington A disposal site	1						Open
	Humber 4	1						

[68] Piling scheduled for 2021-2023 and therefore no potential for temporal overlap. In-combination assessment based on operation and maintenance phase only https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010056/EN010056-001849-East%20Anglia%20Three%20Limited%207.pdf .

Status	Project/ Plan Name	Tier	Relevant Receptor[62]					Relevant Years
			Benthic and Intertidal Ecology	Harbour porpoise	Bottlenose Dolphin	Harbour Seal	Grey Seal	
Dredge spoil dumping	Humber 3a	1						
	Humber 2	1						Open
	Goole Reach	1						
	Whitgift Bight (River Ouse)	1						
	Hedon Haven	1						
	Bull Sand Fort Extension	1						
	Sunk Dredge Channel Window C	1						
	Humber 1a	1						
	Holme Channel Deep	1						
	Humber 4B/Hook Extension	1						
	Humber 4B Hook	1						

11.1.1.6 Following the identification of the plans and projects with the potential to result in an AEoI in-combination with Hornsea Four, the assessment is made below. The information is presented according to the following receptor groupings:

- Subtidal and Intertidal Benthic Ecology;
- Marine Mammals;
- Offshore Ornithology; and
- Onshore Ecology.

11.2 Subtidal and Intertidal Benthic Ecology

11.2.1 Construction and Decommissioning

Temporary increases in suspended sediment concentration during construction

11.2.1.1 The potential for an AEoI in-combination as a result of effect on subtidal and intertidal benthic ecology during construction and decommissioning relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to, and potentially less than, those outlined in the construction phase.

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves (from the cable corridor works only).

11.2.1.2 The plans and projects identified in **Table 28** above with the potential to contribute to an in-combination effect on one or more designated site are as follows, together with the relevant feature:

- Bridlington A Dredge Spoil Site, Tier 1, ongoing intermittent use (reefs; and submerged or partially submerged sea caves (s));
- Dogger Bank A and B, Tier 1, construction timescale not known but potentially any project stage (reefs; and submerged or partially submerged sea caves (s)); and
- Scotland England Green Link 2 (SEGL2) Cable – Peterhead to Drax, Tier 3, not consented; It is expected that construction activities will commence in 2025 with operations commencing in 2030 (reefs; and submerged or partially submerged sea caves (s)).

11.2.1.3 Plans and projects identified within Volume A2, Chapter 2: Benthic and Intertidal Ecology but screened out of in-combination assessment are detailed in **Section 8.2.2**.

Bridlington Bay HU015

11.2.1.4 Disposal site HU015 is located in Bridlington Bay, to the northwest of the South Smithic sandbank. Charted water depth is approximately 7 m. The site has been in use since the inception of the Food and Environment Protection Act in 1985. Currently, HU015 is used for the disposal of maintenance dredged material from the port of Bridlington. The maximum quantity that is currently authorised for disposal in any one year is 30,000 tonnes. Material deposited at HU015 varies in composition but is generally a mixture of fine sands and silts, and can therefore be expected to move by both wave and tidal currents. The effects of the Bridlington A Dredge Spoil Site on the Flamborough Head SAC have been considered by Cefas. They concluded that there would not be a likely significant effect on the features for which the SAC had been identified as a result of the disposal of dredged material at Bridlington A (CEFAS 2009).

11.2.1.5 The interaction of Bridlington Bay disposal site and Hornsea Four have been considered in **Volume A5, Annex 1.1: Marine Processes Technical Report**. This stated that during these times when the disposal site is being used, plumes will form at the disposal site as the silts are rapidly dispersed away. The use of the spoil site is expected to be relatively infrequent and on demand. The number of disposals varies year to year and month to month.

11.2.1.6 If Hornsea Four is discharging overspill of fine silts and sands in the nearshore from cable trenching on an ebb tide period at the same time as spoil disposal is occurring at HU015 then a larger and sediment plume may form, however, this will also quickly disperse given the location of the spoil site in an area of faster flows. **Volume A5, Annex 1.1: Marine Processes Technical Report** concluded that the cumulative impact is considered to be negligible due to the low likelihood of occurrence and relatively short-term impacts.

Dogger Bank A and B

11.2.1.7 The Dogger Bank A and B landfall is around 1.2 km to the south of the Hornsea Four landfall. The anticipation is that this installation will be completed first (noting that as in **Table 28** Dogger Bank A is expected to be operational by 2023, with B and C following) and the Hornsea Four export cable will cross the Dogger Bank A and B export cable east of Smithic Sands. Depending on the period between completion of the Dogger Bank A and B landfall works and commencement of Hornsea Four landfall works there may be a potential for the (undesignated at Hornsea Four landfall) intertidal to be in a state of partial recovery.

11.2.1.8 For Dogger Bank A and B, the applicant considered the effects of their Export Cable on the Flamborough Head SAC, which is situated 5 km from their ECC. In their potential LSE Screening report (Forewind 2013a) they concluded that there was the potential for LSE because, potential indirect effects could arise from the re-suspension of sediment, sediment deposition, and introduction of contaminants during the construction phase when physical disturbance activities occur to the seabed. Therefore, potential LSE was determined.

11.2.1.9 This concern was subsequently resolved following confirmation of the distance between the cable and site and hydrodynamic modelling of sediment deposition. Forewind (2013) concluded that "The temporary and short-term (3 days) increase in suspended sediment concentrations that are predicted to occur during the construction of Dogger Bank A and B in-combination with the other projects would not be expected to result in physical damage to reefs and submerged and partially submerged sea caves communities due to the short-term nature of this impact which would remain within the levels of natural variability (e.g. storm induced suspended sediment concentrations). Consequently, the favourable condition of the sensitive communities would not be affected'.

11.2.1.10 No increases in suspended sediments would extend from Dogger Bank A and B to the SAC during the operation phase, therefore no impact could arise alone and/ or in-combination. The impacts from suspended sediment concentrations during decommissioning would be similar to, though possibly lesser in extent and magnitude than those for construction, again being temporary and short-term in duration. Therefore as with construction, the favourable condition of the sensitive communities would not be affected (Forewind, 2013b). No AEoI was concluded (DECC 2015).

11.2.1.11 The potential interaction of Hornsea Four and Dogger Bank A and B was considered in the **Volume A5, Annex 1.1: Marine Processes Technical Report**. The report was written on the expectation that Hornsea Four will take place after any similar landfall works required for Dogger Bank A and B offshore wind farm (noting that landfall works do not necessarily occur simultaneously with offshore works and Dogger Bank A and B onshore construction works having already commenced, with Dogger Bank A expected to be operational by 2023 and all construction onshore and offshore anticipated to have completed by 2025). This expectation removes the opportunity for cumulative impacts between two activities occurring in a similar timescale and close together (n.b. Dogger Bank A and B landfall is around 1.2 km to the south of Hornsea Four landfall), with all sedimentary impacts which may impact on the SAC having short durations (i.e. hours to days), are temporary and localised and with any resulting suspended sediment levels being within natural variation within the SAC boundary. There is therefore no potential for any measurable in-combination effect to arise at the Flamborough Head SAC as a result of Dogger Bank A and B and Hornsea Four.

Scotland England Green Link 2 (SEGL2) Cable

11.2.1.12 The Scotland England Green Link 2 (SEGL2) cable could have the potential to create an in-combination temporary habitat disturbance and resulting release of suspended sediment with Hornsea Four. Construction of the cable is planned to commence in 2025 (and therefore after Dogger Bank A and B will have completed construction), with the aim of being operational by 2030. As a result, there is the potential for an overlap with the construction of Hornsea Four, with the remainder of the SEGL2 construction phase overlapping with the Hornsea Four operation and maintenance phase. There is currently limited detail on the SEGL2 cable and therefore it is not possible to make a detailed assessment of the significance of any such effect. However, the impact associated with the Scotland England Green Link 2 (SEGL2) is predicted to be minimal, short-term and localised to the site. As such, it is not anticipated that any effects, once quantified, would result in a significant impact.

Conclusion on the potential for an in-combination effect to arise as a result of temporary increases in suspended sediment concentration during construction

11.2.1.13 In all cases, the potential for a release of sediment from the projects identified in-combination will be short term, temporary and localised, with levels falling to within background within the SAC boundary. Further, and for the projects identified in-combination, it is expected that works will be consequetive and not simultaneous. There is no evidence to suggest that the relevant benchmark within the SAC (the relevant designated site 'Advice on Activities' (see **Appendix D**) identifies a pressure benchmark of >5cm deposition in a single event) will be even close to being met.

11.2.1.14 Therefore, it is concluded that there is no potential for an AEoI to the conservation objectives of the reef and submerged cave features of the Flamborough Coast SAC in relation to increases in suspended sediment from Hornsea Four in-combination with other plans or projects and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term with respect to this effect.

Invasive non-native species

11.2.1.15 The potential for an AEoI in-combination as a result of effect on subtidal and intertidal benthic ecology during construction and decommissioning relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to, and potentially less than, those outlined in the construction phase.

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves (from the cable corridor works only).

11.2.1.16 The assessment alone (**Section 10**) identified that there is a risk that the project could increase the spread of INNS through the movement of vessels in and out of the benthic subtidal study area. It was concluded that the risk was of negligible significance and no potential for AEoI for the project alone.

11.2.1.17 The plans or projects listed in **Table 28** which are considered to have the potential to have an in-combination effect with Hornsea Four with respect to the spread of INNS are Dogger Bank A and B, Bridlington A and the Scotland England Green Link 2 (SEGL2) Cable. The risk of Dogger Bank A and B increasing the spread of INNS is likely to be very similar to that of Hornsea Four, as the projects are of a similar type and location, with the mitigation measures proposed for Hornsea Four being the industry standard and consequently will also be applied for Dogger Bank A and B (for example, the Dogger Bank Creyke Beck (now Dogger Bank A and B) DCO includes requirements for offshore plans and programmes[69]). For disposal of material at sea, that process is controlled through Marine Licensing (if relevant)[70], providing assurance that any future such disposals would not contribute to any in-combination effect with respect to INNS (and in line with the conclusions drawn by Cefas (2009) with respect to disposal of dredged material at the disposal site and the Flamborough Head SAC). For the SEGL2 Cable, the risk of introduction and or spread of INNS is linked to vessel movements only (installation followed by any maintenance vessels), with any such risk to be assessed by that project and an expectation of appropriate mitigation to be identified (if required). It is therefore considered that Dogger Bank A and B, Bridlington A and the SEGL2 Cable are highly unlikely to represent an in-combination risk for the introduction or spread of INNS and are therefore of negligible significance to the Flamborough Head SAC.

11.2.1.18 Given the negligible significance of effects of both projects, it is considered that in-combination there would be no potential for an AEoI to the conservation objectives of

[69] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010021/EN010021-000023-Development%20Consent%20Order%20as%20made%20by%20the%20Secretary%20of%20State%20for%20Energy%20and%20Climate%20Change.pdf
[70] https://www.gov.uk/disposal-of-dredged-material-at-sea

the reef and submerged cave features of the Flamborough Coast SAC through risk of spread of INNS and that the reef and submerged cave features will maintain in the long term with respect to this effect.

Accidental pollution

11.2.1.19 The potential for an AEoI as a result of accidental pollution during construction and decommissioning relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

11.2.1.20 The potential for accidental pollution to affect benthic habitats was not considered in the ES (**Volume A2, Chapter 2: Benthic and Intertidal Ecology**), given the project specific mitigation (contained within Table 2.11 of that chapter) and conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the ES. The reason for that is given as the development of a Marine Pollution Contingency Plan (MPCP), which will form part of a wider CPEMMP. The CPEMMP is provided for under Co111. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**).

11.2.1.21 It is noted that the above plans are included through Co111 (**Table 3**) and secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d). Further, similar mitigation measures to prevent accidental pollution are expected to be required for all plans and projects identified within the in-combination assessment for accidental pollution if required (Dogger Bank A and B, Bridlington disposal site and Scotland England Green Link 2 (SEGL2) Cable). It is noted that for the Dogger Bank projects for example, the Dogger Bank Creyke Beck (now Dogger Bank A and B) DCO includes requirements for offshore plans and programmes[71]. For disposal of material at sea, that process is controlled through Marine Licensing (if relevant)[72], providing assurance that any future such disposals would not contribute to any in-combination effect with respect to accidental pollution (and in line with the conclusions drawn by Cefas (2009) with respect to disposal of dredged material at the disposal site and the Flamborough Head SAC). Similar information is not available for the SEGL2 Cable given the planning status of that project, however the project will be subject to marine licensing in a similar way.

11.2.1.22 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, together with either the known requirement for or expectation of equivalent plans to be attached to the plans and projects assessed in-combination, enables the conclusion that there is, therefore, no AEoI to benthic habitats in relation to accidental pollution from Hornsea Four alone and/ or in-combination and

[71] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010021/EN010021-000023-Development%20Consent%20Order%20as%20made%20by%20the%20Secretary%20of%20State%20for%20Energy%20and%20Climate%20Change.pdf
[72] https://www.gov.uk/disposal-of-dredged-material-at-sea

therefore, subject to natural change, the benthic habitat features will be maintained in the long term with respect to the potential for accidental pollution.

Nitrogen Oxides (NOx) and Nutrient Nitrogen (NN) Nitrogen deposition

11.2.1.23 The potential for an AEoI to result from project contributions (from construction traffic) of airborne NOx, NH_3 and the deposition of NN (derived from NOx) in-combination with external sources has been assessed for the following designated sites and sensitive features:

Humber Estuary SAC

- Atlantic saltmeadows; and
- Salicornia and other annuals colonising mud and sand.

Humber Estuary Ramsar

- Saltmarshes.

Humber Estuary SPA

- Saltmarshes (as a supporting habitat of designated species).

11.2.1.24 As described in the assessment of project effects acting alone (**Section 10.2.3**), air quality modelling has been undertaken to determine potential rates of NOx, NH3 and NN associated with Hornsea Four traffic along the A63. Levels of NOx, NH3 and NN deposition have been predicted and compared to air quality limit values (critical loads / levels) provided by APIS.

11.2.1.25 The traffic component of the model includes the effect of current traffic using the A63 but also future traffic growth. As such, the air quality forecasts account for potential cumulative and in combination effects.

11.2.1.26 In response to stakeholder comments (see **Volume A3, Chapter 9: Air Quality**), the applicant has further reviewed agricultural and industrial projects in the Hull area. Projects that met the relevant criteria of size or capacity were identified within the distances specified in the SSSI Impact Risk Zones layer on Magic. Only one project was found to be of relevance to the Humber Estuary that had available supporting data. This project concerns the "Erection of a free-range egg laying unit with associated feed bins and hard-standings". The Applicant has included within the modelling, the estimated contribution from this source to nutrient nitrogen loading at the Humber Estuary. There are no reported airborne NOx emissions associated with the development.

11.2.1.27 In terms of agriculture, the Applicant cannot foresee any changes in agricultural practices above the baseline, such as specific applications for intensification of any farming in the vicinity, or similar. Any changes in fertiliser usage, for example, on existing farms cannot be predicted and are not accounted for in the model.

11.2.1.28 There is currently no information available at the time of writing for the Tier 3 Endurance project to enable an assessment to be made (specifically no information on the location, type or scale).

Nitrogen oxides (NOx)

11.2.1.29 As set out in **Section 10.2.3**, the Critical Level for NOx concentrations is 30 (μg m^3) as an annual mean for all features under consideration.

11.2.1.30 As discussed in **Section 10.2.3**, the modelling predicts only very small project contributions, which range from 0.1 (μg m^3) at 10m to 0.03 (μg m^3) 100 m back from the road. Such contributions are at most 0.33% of the Critical Level, and as outlined in **paragraph 10.2.3.27** are unlikely to be measurable or distinguishable from natural change. In-combination with Hornsea Four (and including current and future traffic, industrial and agricultural contributions), the model predicts that NOx concentrations would be in exceedance of the APIS Critical Level until 25 m from the road regardless of whether or not Hornsea Four is included. The in-combination values including Hornsea Four range from 36.20 (μg m^3) at T2-10m to 29.73 (μg m^3) at T2-25m, falling further to 21.92 (μg m^3) at T2-3 (100m).

11.2.1.31 The modelled contours presented to the top of **Figure 21** indicate where the 1% screening criterion value (relative to the Critical Load for NN and Critical Level for NH3 and NOx) would be met in-combination, with the bottom image showing where the Critical Load for NN and Critical Level for NH3 and NOx would be met during construction. These contours are presented relative to saltmarsh extent in the immediate vicinity of the A63 (based on Environment Agency mapping data from 2011 (Environment Agency 2011)), noting that this is a small proportion of the total saltmarsh across the Humber. From the overlay of this information, it is estimated that 43,114 m^2 of saltmarsh would fall within the area of temporary exceedance of the Critical Level for NOx, due to in-combination sources. This represents 0.21% of the total saltmarsh within the SAC and 0.20% of the saltmarsh within the SPA.

11.2.1.32 This exceedance of the Critical Level is accounted for only in very small part by the project, with such contributions modelled on very precautionary parameters and occurring on a short term and temporary basis. These are outlined in full in **Section 10.2**, but for example the assumptions assume the maximum HGV traffic from the first year, with all other years having a reduced volume of traffic. The reduction in HGV volume in subsequent years is in the order of 56-74% and although such a reduction in project HGV load would not directly equate to an equivalent fall in project contributions to NOx, NH_3 or NN, it is reasonable to assume a similar order of magnitude reduction would be likely. Notwithstanding the project's contributions, the modelling predicts that the Critical Level would be exceeded within 25 m of the road side due to the potential release of pollutants from a range of (non-project related) activities, including current and future traffic growth. The Supplementary Advice on Conservation Objectives for the SAC (Natural England 2019), advises that the achievement of the cited targets may be subject to measures to tackle diffuse air pollution, within realistic timescales. The project's 0.1 – 0.33% contribution to the Critical Level for a period of 36 months (noting that the numbers present a precautionary worst case for the first year, with subsequent years all contributing less) would be of inappreciable significance in this context. Such a contribution should be considered in light of the ability to measure a contribution less than 1% or distinguish it from natural change (see **paragraph 10.2.3.27**).

11.2.1.33 Noting the temporary and localised nature of the predicted effect, relative to saltmarsh extent and distribution over 100 kms of the Humber, it is considered that the elevated levels of NOx would have an immeasurable and inconsequential level of impact on saltmarsh condition, or the ecological coherence of the SAC, SPA or Ramsar.

Ammonia (NH_3)

11.2.1.34 As set out in **Section 10.2.3**, the Critical Level for NH_3 concentrations is 3 μg m-^{3} as an annual mean for all features under consideration.

11.2.1.35 As discussed in **Section 10.2.3**, the modelling predicts only very small project contributions, which range from 0.02 (μg m^3) at 10m to 0.01 (μg m^3) 100 m back from the road. Such contributions are at most 0.7% of the Critical Level, and as outlined in **paragraph 10.2.3.27** are unlikely to be measurable or distinguishable from natural change. In-combination with Hornsea Four (and including current and future traffic, industrial and agricultural contributions), the model predicts that NH3 concentrations would be in exceedance of the APIS Critical Level until 25 m from the road regardless of whether or not Hornsea Four is included. The in-combination values including Hornsea Four range from 3.41 (μg m^3) at T2-10m to 2.96 (μg m^3) at T2-25m, falling further to 2.41 (μg m^3) at T2-3 (100m).

11.2.1.36 The modelled contours presented to the top of **Figure 21** indicate where the 1% screening criterion value (relative to the Critical Load for NN and Critical Level for NH3 and NOx) would be met in-combination, with the bottom image showing where the Critical Load for NN and Critical Level for NH3 and NOx would be met during construction. These contours are presented relative to saltmarsh extent in the immediate vicinity of the A63 (based on Environment Agency mapping data from 2011 (Environment Agency 2011)), noting that this is a small proportion of the total saltmarsh across the Humber. From the overlay of this information, it is estimated that 42,102 m^2 of saltmarsh would fall within the area of temporary threshold exceedance of the Critical Level for NH3, due to in-combination sources. This represents 0.21% of the total saltmarsh within the SAC and 0.20% of the saltmarsh within the SPA.

11.2.1.37 This exceedance of the Critical Level is accounted for only in very small part by the project, with such contributions modelled on very precautionary parameters and occurring on a short term and temporary basis. These are outlined in full in **Section 10.2**, but for example the assumptions assume the maximum HGV traffic from the first year, with all other years having a reduced volume of traffic. The reduction in HGV volume in subsequent years is in the order of 56-74% and although such a reduction in project HGV load would not directly equate to an equivalent fall in project contributions to NOx, NH_3 or NN, it is reasonable to assume a similar order of magnitude reduction would be likely. Notwithstanding the project's contributions, the modelling predicts that the Critical Level would be exceeded within 25 m of the road side due to the potential release of pollutants from a range of (non-project related) activities, including current and future traffic growth. The Supplementary Advice on Conservation Objectives for the SAC (Natural England 2019), advises that the achievement of the cited targets may be subject to measures to tackle diffuse air pollution, within realistic timescales. The project's 0.2 – 0.7% contribution to the Critical Level for a period of 36 months (noting that the numbers present a precautionary worst case for the first year, with subsequent years all contributing less) would be of inappreciable significance in this context. Such a contribution should be considered in light of the ability to measure a contribution less than 1% or distinguish it from natural change (see **paragraph 10.2.3.27**).

11.2.1.38 Noting the temporary and localised nature of the predicted effect, relative to saltmarsh extent and distribution over 100 kms of the Humber, it is considered that the elevated levels of NH_3 would have an immeasurable and inconsequential level of impact on saltmarsh condition, or the ecological coherence of the SAC, SPA or Ramsar.

Nutrient Nitrogen deposition

11.2.1.39 The Critical Load for saltmarsh features is 20 - 30 (kg N ha^{-1} $year^{-1}$) and as discussed in **Section 10.2**, the upper end of this range is most appropriate for the current assessment. As discussed in **Section 10.2.3**, the modelling predicts only very small project contributions, which range from 0.118 (kg N ha^{-1} $year^{-1}$) at 10m to 0.033 (kg N ha^{-1} $year^{-1}$) 100 m back from the road. Such contributions are at most 0.4% of the upper limit of the Critical Load, and as outlined in **paragraph 10.2.3.27** are unlikely to be measurable or distinguishable from natural change. In-combination with Hornsea Four (and including current and future traffic, industrial and agricultural contributions), the model predicts that NN deposition will be within the upper limit of the Critical Load at T2-10m, being at most 99% of that Critical Load.

11.2.1.40 It is considered that these marginally elevated contributions from Hornsea Four to the in-combination totals of NN deposition would have inconsequential, if even discernible impacts on a very small proportion of the designated sites and on a precautionary, short term and temporary basis only. The project alone would elevate the Critical Load only slightly above the current level. Whilst the construction period would be 36 months, vehicle numbers would diminish after the first year and where the model presents a highly precautionary and worst-case estimate, the duration of the magnitude of effect described could be expected to be less.

11.2.1.41 Although background deposition is already just above the lower value of the Critical Load range, it is well within the more relevant upper value, and it is noted that nutrient loading or eutrophication are not highlighted as a current threat to the condition of the saltmarsh. Further, APIS advises that overall N deposition is likely to be of low importance for coastal saltmarsh systems, as the inputs are probably significantly below the large nutrient loadings from river and tidal inputs[73].

11.2.1.42 If an impact were to occur, it would be temporary and intermittent and only a very small area of the sites would be affected. Excess forms of soluble nitrogen within the rooting zone of salt marsh plants can either be taken up by the plants or they would be washed out by the regular tidal inundation (CCW 2012). On balance, these effects would not result in a change to the extent, distribution, structure or function of the habitats present.

[73] http://www.apis.ac.uk/node/968

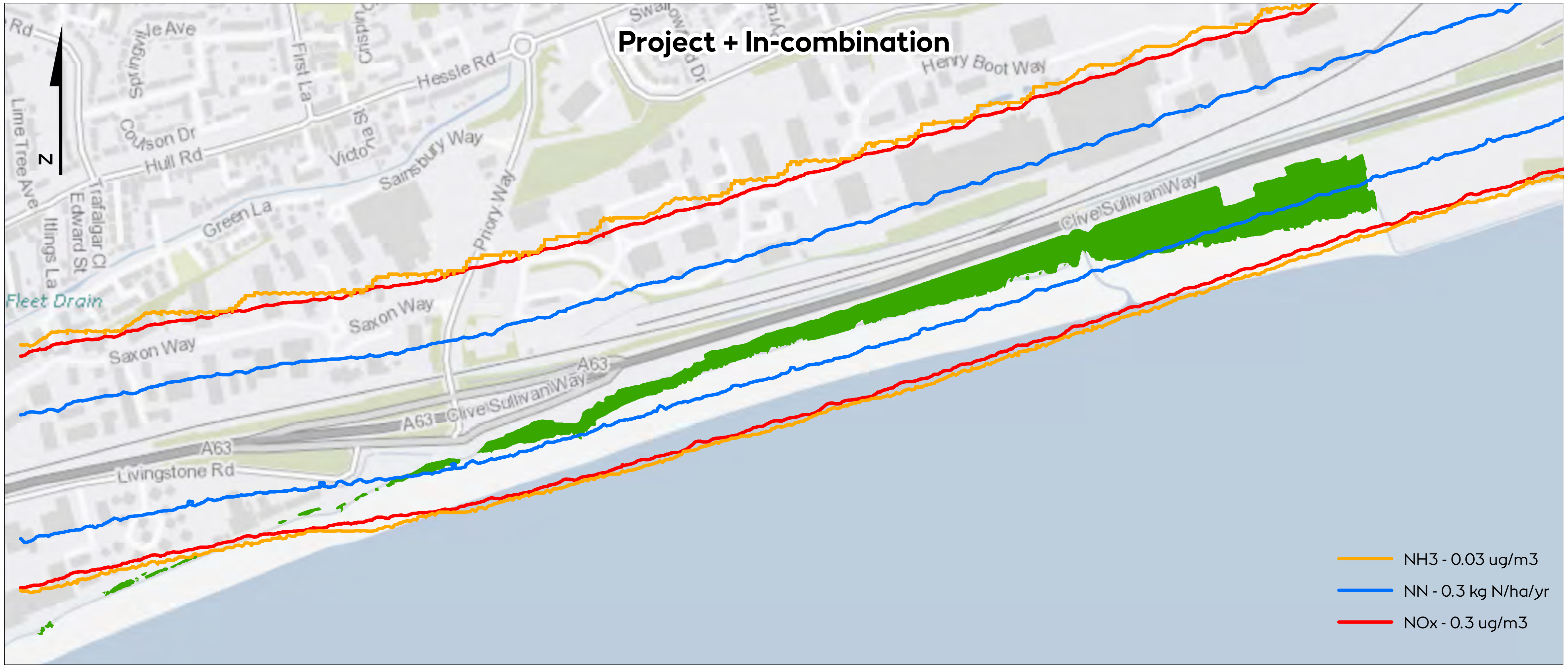
Summary

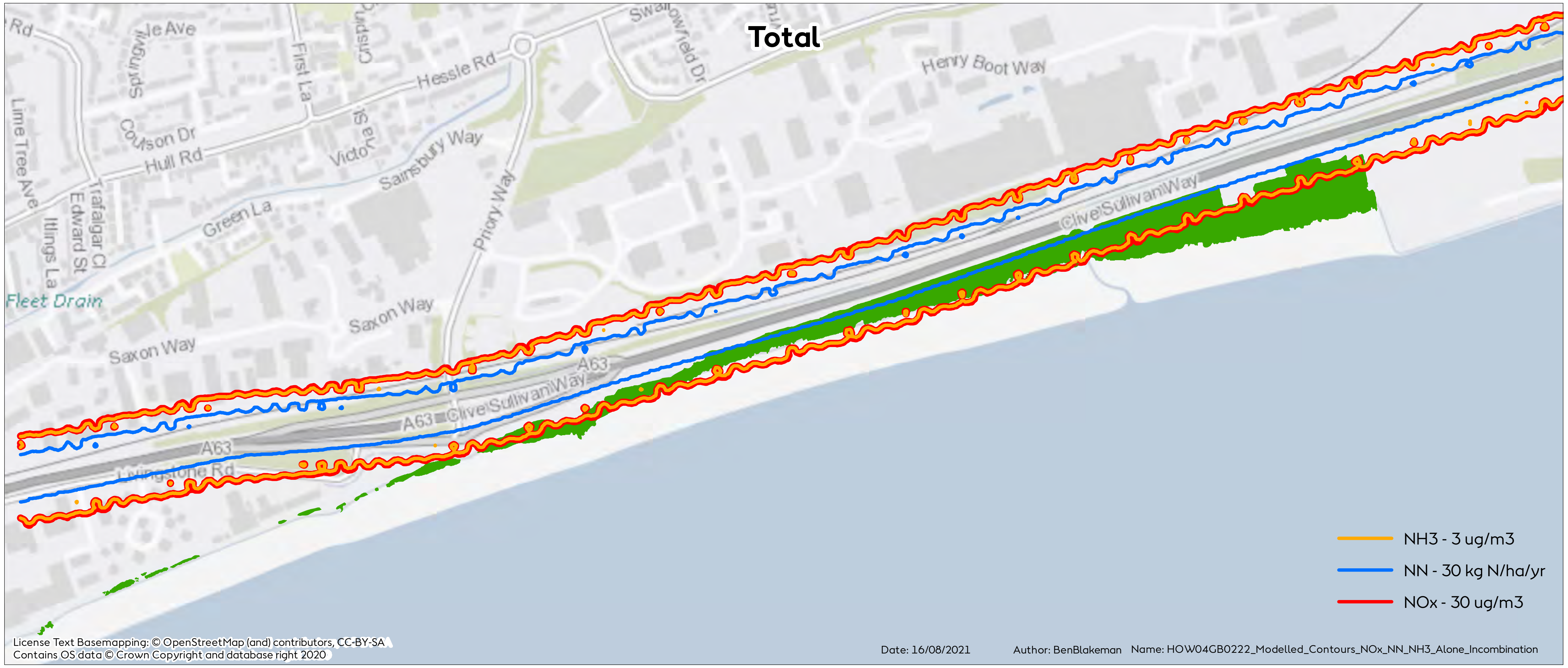
11.2.1.43 Noting the temporary and localised nature of the predicted effect, relative to saltmarsh extent and distribution over 100 km of the Humber, it is considered that the elevated levels of NN, NOx and NH_3 would have an immeasurable and inconsequential level of impact on saltmarsh condition, or the ecological coherence of the SAC, SPA or Ramsar.

11.2.1.44 With regards the SPA, the Conservation Objectives suggest that levels may be considered as an average across the site, with elevations in any one area countered elsewhere. This further negates the possibility that any discernible impacts could result from the elevations of the level and scale predicted.

11.2.1.45 On this basis, the NOx, NH_3 and NN contributions predicted would not result in a change to the extent, distribution, structure or function of the habitats present, or the species dependent on them.

11.2.1.46 In light of the above, it is concluded that there is no potential for an AEoI to the Conservation Objectives of the saltmarsh features of the Humber Estuary SAC, SPA and Ramsar in relation to increased NOx, NH_3 or NN deposition from Hornsea Four incombination and therefore, subject to natural change, the habitat and supported features would be maintained in the long term.





Date: 16/08/2021 Author: BenBlakeman Name: HOW04GB0222_Modelled_Contours_NOx_NN_NH3_Alone_Incombination

Hornsea Four

Figure 21

Modelled contours for air quality pollutants (NOx, NH3 and NN) in relation to construction traffic on the A63 and project contributions alone and in-combination

Saltmarsh Extent (Environment Agency, 2011)

Coordinate system: British National Grid
Scale@A3: 1:8,000

0 200 400 Metres

0 500 1,000 Feet

REV	REMARK	DATE
...	First Issue	16/08/2021

NOx, NH3 and NN Contours
Project Alone and In-combination
Document no: HOW04GB0222
Created by: BPHB
Checked by: SK
Approved by: LK

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11.2.2 Operation & Maintenance

Temporary increases in suspended sediment concentration during operation and maintenance

11.2.2.1 The potential for an AEoI in-combination as a result of effect on subtidal and intertidal benthic ecology during operation and maintenance relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE).

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves (from the cable corridor works only).

11.2.2.2 The plans and projects identified during construction and decommissioning in **paragraph 11.2.1.2** above are considered here during operation and maintenance. The potential for Hornsea Four to contribute to an in-combination effect during operation and maintenance is less than that during construction, with that concluded in **paragraph 11.2.1.14**.

11.2.2.3 In all cases, the potential for a release of sediment from the projects identified in-combination will be short term, temporary and localised, with levels falling to within background within the SAC boundary. Further, and for the projects identified in-combination, it is expected that works will be consequetive and not simultaneous. There is no evidence to suggest that the relevant benchmark within the SAC (the relevant designated site 'Advice on Activities' (see **Appendix D**) identifies a pressure benchmark of >5cm deposition in a single event) will be even close to being met.

11.2.2.4 Therefore, it is concluded that there is no potential for an AEoI to the conservation objectives of the reef and submerged cave features of the Flamborough Coast SAC in relation to increases in suspended sediment from Hornsea Four in-combination with other plans or projects and therefore, subject to natural change, the reef and sea cave features will be maintained in the long term with respect to this effect.

Changes to physical processes

11.2.2.5 The potential for an AEoI in-combination as a result of effect on subtidal and intertidal benthic ecology during operation and maintenance relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE).

Flamborough Head SAC

- Reefs.

11.2.2.6 The plans and projects identified in **Table 28** above with the potential to contribute to an in-combination effect through changes to physical processes on one or more designated site are as follows, together with the relevant feature:

- Bridlington A Dredge Spoil Site, Tier 1, ongoing intermittent use (reefs);
- Dogger Bank A and B, Tier 1, timescale not known but anticipated to be completed before construction of Hornsea Four commences (reefs); and

- Scotland England Green Link 2 (SEGL2) Cable, Tier 3, not consented; It is expected that construction activities will commence in 2025 with operations commencing in 2030 (reefs).

11.2.2.7 For disposal of material at sea at Bridlington A, which has been an active disposal site since 1985, that process is controlled through Marine Licensing (if relevant)[74], providing assurance that any future such disposals would not contribute to any in-combination effect with respect to physical processes (and in line with the conclusions drawn by Cefas (2009) with respect to disposal of dredged material at the disposal site and the Flamborough Head SAC).

11.2.2.8 For Dogger Bank A and B, in the potential LSE Screening report (Forewind 2013a) changes to physical processes were not identified as a potential impact and were not screened in for potential LSE. The potential for an in-combination effect between Dogger Bank A and B and Hornsea Four is considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes** specifically in relation to the cable crossing.For the Scotland England Green Link 2 (SEGL2) Cable, no project information is currently available to include in an in-combination assessment for physical processes, with the project yet to progress through the appropriate licensing process.

11.2.2.9 In light of the above, it is considered that in-combination there would be no potential for an AEoI to the conservation objectives of the reef feature of the Flamborough Coast SAC through changes to physical processes and that the reef feature will maintain in the long term with respect to this effect.

Invasive non-native species

11.2.2.10 The potential for an AEoI in-combination as a result of effect on subtidal and intertidal benthic ecology during operation and maintenance relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE).

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves (from the cable corridor works only).

11.2.2.11 The assessment alone (**Section 10**) identified that there is a risk that the project could increase the spread of INNS through the introduction of hard substrate into a sedimentary habitat and also the movement of vessels in and out of the benthic subtidal study area. It was concluded that the risk was of negligible significance and, in light of the project commitments in **Table 3**, no potential for AEoI for the project alone was identified.

11.2.2.12 The plans or projects listed in **Table 28** considered to have the potential to increase the spread of INNS are the Dogger Bank A and B project, Bridlington A and the Scotland England Green Link 2 (SEGL2) Cable. As for the assessment in construction and decommissioning above, the risk from each plan and project is expected to be controlled by the relevant licensing process, with any in-combination contribution from these plans and projects to any risk of INNS therefore controlled and highly unlikely to represent an

[74] https://www.gov.uk/disposal-of-dredged-material-at-sea

in-combination risk for the introduction or spread of INNS and are therefore of negligible risk to the Flamborough Head SAC.

11.2.2.13 Given the negligible significance of effects of both projects, it is considered that in-combination there would be no potential for an AEoI to the conservation objectives of the reef and submerged cave features of the Flamborough Coast SAC through risk of spread of INNS and that the reef and submerged cave features will be maintained in the long term with respect to this effect.

Accidental pollution

11.2.2.14 The potential for an AEoI as a result of accidental pollution during operation and maintenance relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

Flamborough Head SAC

- Reefs; and
- Submerged or partially submerged sea caves.

11.2.2.15 The potential for accidental pollution to affect benthic habitats was not considered in the ES (**Volume A2, Chapter 2: Benthic and Intertidal Ecology**), given the project specific mitigation (contained within Table 2.11 of that chapter) and conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the ES. The reason for that is given as the development of a Marine Pollution Contingency Plan (MPCP), which will form part of a wider CPEMMP. The CPEMMP is provided for under Co111. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**).

11.2.2.16 It is noted that the above plans are included through Co111 (**Table 3**) and secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d). Further, similar mitigation measures to prevent accidental pollution are expected to be required for all plans and projects identified within the in-combination assessment for accidental pollution if required (Dogger Bank A and B, Bridlington disposal site and Scotland England Green Link 2 (SEGL2) Cable – Peterhead to Drax). It is noted that for the Dogger Bank projects for example, the Dogger Bank Creyke Beck (now Dogger Bank A and B) DCO includes requirements for offshore plans and programmes[75]. For disposal of material at sea, that process is controlled through Marine Licensing (if relevant)[76], providing assurance that any future such disposals would not contribute to any in-combination effect with respect to accidental pollution (and in line with the conclusions drawn by Cefas (2009) with respect to dispol of dredged material at the disposal site and the Flamborough Head SAC). Similar information is not available for the SEGL2 Cable given the planning status of that project, however the project will be subject to marine licensing in a similar way.

11.2.2.17 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, together with either the known requirement for or

[75] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010021/EN010021-000023-Development%20Consent%20Order%20as%20made%20by%20the%20Secretary%20of%20State%20for%20Energy%20and%20Climate%20Change.pdf
[76] https://www.gov.uk/disposal-of-dredged-material-at-sea

expectation of equivalent plans to be attached to the plans and projects assessed in-combination, enables the conclusion that there is, therefore, no AEoI to benthic habitats in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the benthic habitat features will be maintained in the long term with respect to the potential for accidental pollution.

11.3 Marine Mammals

11.3.1.1 A description of the significance of potential in-combination effects upon the receptors grouped under 'marine mammals' is provided below, drawing on **Volume A2, Chapter 4: Marine Mammals**.

11.3.2 Construction and Decommissioning

Underwater Noise

11.3.2.1 The potential for an AEoI in-combination as a result of underwater noise on marine mammals during construction and decommissioning relates to the following designated sites and the relevant features (i.e. the features screened in for potential LSE). The potential for LSE during decommissioning would be similar to, and potentially less than, those outlined in the construction phase.

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin)
- Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary sites (for harbour seal, specifically Doggersbank (Netherlands) SAC and Klaverbank SCI); and
- Transboundary sites (twelve sites for grey seal, specifically Doggersbank (Netherlands) SAC, Klaverbank SCI, Bancs des Flandres, Vlaamse Banken, SBZ 1, SBZ 2, SBZ 3, Vlakte van de Raan, Westerschelde & Saeftinghe, Voordelta, Noordzeekustzone and Waddenzee).

11.3.2.2 The plans and projects with the potential to contribute to an in-combination effect on one or more designated site with respect to marine mammals are identified in **Table 28** above. Of these, those with the potential for an in-combination effect with Hornsea Four with respect to underwater noise are limited to those with potential for a temporal overlap of the construction phases (specifically piling or, if known, UXO or seismic survey). Plans and projects with potential for overlap during operation and maintenance (either Hornsea Four O&M or the O&M of the plan or project) will contribute to the in-combination assessment under separate effects (notably habitat loss, vessel collision, vessel disturbance). Plans and projects relevant to the in-combination assessment of construction (and decommissioning) underwater noise are therefore as follows, together with the relevant species:

- Dogger Bank A, Tier 1 (consented), construction window unclear[77] but planned to be operational by 2023, potential for all phases (harbour porpoise, harbour seal and grey seal);
- Dogger Bank B, Tier 1 (consented), construction window unclear[78], potential for all phases (harbour porpoise, harbour seal and grey seal);
- Dogger Bank C, Tier 1 (consented), construction window unclear[79], potential for all phases (harbour porpoise, harbour seal and grey seal);
- Sofia, Tier 1 (consented), construction window unclear[80], potential for all phases (harbour porpoise, harbour seal and grey seal);
- Norfolk Vanguard, Tier 1 (awaiting re-determination), Piling scheduled Q2 2024-Q1 2025 OR Q2 2024-Q1 2025 and Q2 2027-Q1 2028 (harbour porpoise, harbour seal and grey seal);
- Hornsea Three, Tier 1 (consented), Piling scheduled Q1 2022- Q2 2023 and/or Q1 2027-Q2 2028 (harbour porpoise, harbour seal and grey seal);
- Norfolk Boreas, Tier 1 (in planning), Piling Q2 2026-Q3 2027, UXO clearance Q3 2025- Q1 2026 (harbour porpoise, harbour seal and grey seal);
- East Anglia One North, Tier 1 (in planning), Piling 2026-2028 (harbour porpoise, harbour seal and grey seal);
- East Anglia Two, Tier 1 (in planning), piling 2025-2027 (harbour porpoise, harbour seal and grey seal);
- Marr Bank and Berwick Bank, Tier 2 (in planning), (bottlenose dolphin and grey seal);
- Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions, Tier 2 (in planning), (harbour porpoise, harbour seal and grey seal);
- North Falls, Tier 3 (pre-planning), not known (harbour porpoise, harbour seal and grey seal);
- Five Estuaries, Tier 3 (pre-planning), not known (harbour porpoise and grey seal);
- Round 4 – Leasing Area 1 (Bidding Area 1), Tier 3 (pre-planning), not known (harbour porpoise, harbour seal and grey seal);
- Round 4 – Leasing Area 2 (Bidding Area 1), Tier 3 (pre-planning), not known (harbour porpoise, harbour seal and grey seal);
- Round 4 – Leasing Area 3 (Bidding Area 2), Tier 3 (pre-planning), not known (harbour porpoise, harbour seal and grey seal);and
- Endurance CCS, Tier 3 (pre-planning), no specific information published to date (July 2021) as regards potential noise generating activities or timeframe of works.

11.3.2.3 Effectively for a project to be screened in for in-combination assessment, there needs to be potential for relevant works (in this case noisy activity) to occur within the same timeframe as relevant works at Hornsea Four, with these identified in **Table 7**. The sites/features included in-combination are then those that are located within the species-specific screening distance from one or more of the projects identified for in-combination assessment.

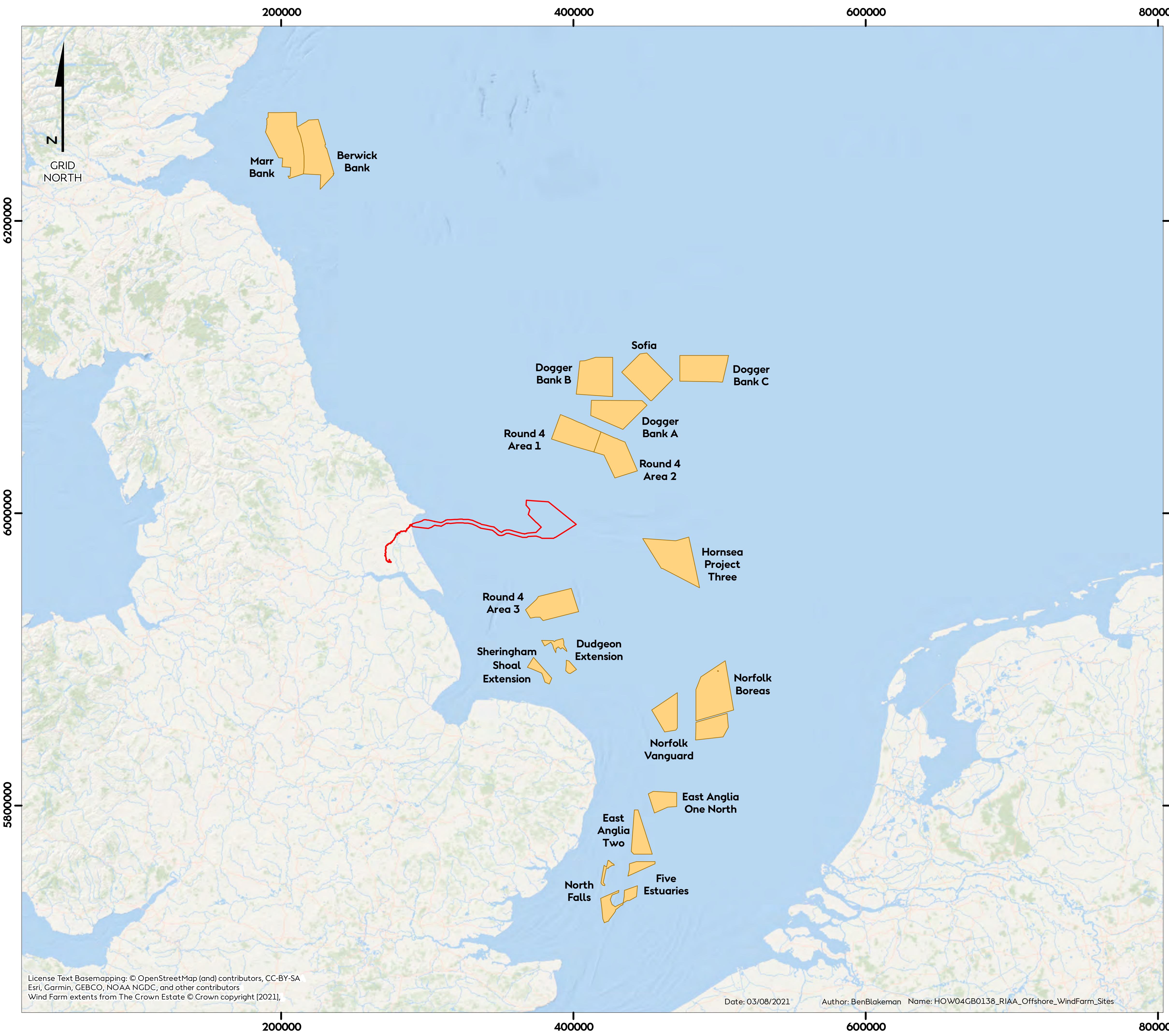
[77] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023
[78] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023
[79] Noting that current project information states onshore construction has started, offshore construction expected to start 2022, with Dogger Bank A operational by 2023
[80] Noting that current project information states offshore construction to start 2023, piling in 2024, turbines installed 2025 and complete by 2026

11.3.2.4 The locations of these projects (excluding the Endurance CCS), in relation to Hornsea Four, are shown in **Figure 22**.

Hornsea Four

Figure 22

Projects considered in-combination for underwater noise in marine mammals



Order Limits

Offshore Wind Farm

Coordinate system: ETRS 1989 UTM Zone 31N

Scale@A3: 1:2,500,000

0 50 100 Kilometres

0 25 50 Nautical Miles

REV	REMARK	DATE
....	First Issue	26/06/2019
A	Updated following PEIR consultation, for DCO	03/08/2021

Offshore Wind Farm Sites

Document no: HOW04GB0138

Created by: BPHB

Checked by: SK

Approved by: LK

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11.3.2.5 Timeframes for decommissioning are highly uncertain for all projects and therefore an assessment of the potential for an in-combination effect during decommissioning cannot be made at this time. However, it is likely that the potential for effect during decommissioning would be less than that during construction and would in any case be assessed in line with the regulatory requirements at the time.

11.3.2.6 As highlighted in the assessment of AEoI for the project alone, there are a number of potential sources of underwater noise associated with construction of an OWF. Comment on these for the purposes of the in-combination assessment is provided below:

- Percussive piling – to be carried through to the assessment for projects screened in in-combination;
- UXO clearance – planned and licensed UXO activity associated with projects screened in is included (where that information is in the public domain)[81];
- Geophysical and seismic survey –planned geophysical/seismic survey included within the screening range (where that information is in the public domain); and
- Seabed preparation and cable laying – as noted in **Section 10**, such activities associated with Hornsea Four would result in a highly localised and short-term level of effect only, with these therefore not taken forward in-combination as no pathway exists for a contribution to an in-combination effect.

11.3.2.7 No information on noisy activities related to the Round 4 Leasing/ Bidding Areas or Endurance CCS are available at the time of writing. It is of note that vessel disturbance is considered separately, as is operational noise.

11.3.2.8 The potential for underwater noise to result during construction of Hornsea Four, together with the sensitivity of harbour porpoise, bottlenose dolphin, harbour seal and grey seal to such noise, has been discussed in **Section 10.3** as part of the assessment of AEoI alone, with that information not repeated here.

11.3.2.9 The assessment in-combination is made below, initially for harbour porpoise and then for bottlenose dolphin, harbour seal and grey seal.

Potential for an In-combination Effect on Harbour Porpoise from Underwater Noise

11.3.2.10 **Table 29** below provides further information on the potential for temporal in-combination effects in relation to the above plans and projects screened in for assessment in relation to harbour porpoise only and is therefore limited to the SNS SAC. It is noted that the projects assigned into Tier 1 within the RIAA include projects assigned into Tiers 1, 2, 3, 4 and 5 within the marine mammal chapter for ES – the marine mammal tiering differentiating between the certainty of projects (tier 1 including operational/in construction, having consent and CfD, tier 2 having consent but no CfD, tier 3 application submitted but not determined, tier 4 application not yet submitted and tier 5 all relevant projects expected to be submitted). That tiering is differentiated here from the tiering

[81] Comment is made in Section 8.2.3 as regards the potential for further activities to contribute to underwater nosie in-combinaiton. However, without an application (or information in planning) it is not possible to include such activities here. However, any such activities that are brough forward subsequently would be expected to be subject to appropriate licensing (and, if necessary, HRA). Any additional plans or projects would also need to be taken into consideration within the SIP

used in the marine mammal chapter for ES by the suffix Tier 1a (analogous to ES Tier 1), Tier 1b (ES Tier 2), Tier 1c (ES Tier 3), Tier 1d (ES Tier 4) and Tier 1e (ES Tier 5) for clarity.

Table 29: Temporal Overlap with Hornsea Four of Plans and Projects Considered In-Combination (SNS SAC and Harbour Porpoise).

Project	Temporal Overlap with Construction Window					Relevant Activity
	Winter Season (2025-26)	Summer Season (2026)	Winter Season (2026-27)	Summer Season (2027)	Winter Season (2027-28)	
Hornsea Four	Survey and/or UXO clearance					Pre-construction works (including UXO clearance if required plus geophysical survey scheduled Q1 2026 (winter season 2025/26) to Q3 2026 (summer season 2026)
Hornsea Four			Piling			Percussive piling. To occur in the window Q4 2026 (winter season 2026/27) to Q4 2027 (winter season 2027/28)
Tier 1a (*Grey shading represents the construction window within which the activity may occur*)						
Dogger Bank A						No clear construction window (but anticipated to be completed by 2023).
Dogger Bank B						No clear construction window.
Dogger Bank C						No clear construction window.
Sofia						No clear construction window (but turbines anticipated to be installed 2025).
Tier 1b (*Grey shading represents the construction window within which the activity may occur*)						
Hornsea Project Three	UXO or geophysical survey only – not piling		Piling only			Piling scheduled Q1 2022- Q2 2023 and/or Q1 2027-Q2 2028. No dates for UXO, geophysical or seismic (outside piling window). Maximum 23 UXO.
Tier 1c (*Grey shading represents the construction window within which the activity may occur*)						
Norfolk Vanguard	UXO or geophysical survey only – not piling			Piling only		Piling scheduled Q2 2024-Q1 2025 OR Q2 2024-Q1 2025 and Q2 2027-Q1 2028. No dates for UXO, geophysical or seismic, 42 UXO maximum.
Norfolk Boreas	UXO only	Piling only				Survey Q4 2024-Q2 2025, UXO Q3 2025-Q1 2026 and piling Q2 2026-Q3 2027 OR Q2 2026-Q4 2026 and Q2 2027-Q4 2027Max 80 UXO.
East Anglia One North						Piling expected 2026-2028. Assumed that UXO and/or survey to predate this.

Project	Temporal Overlap with Construction Window					Relevant Activity
	Winter Season (2025-26)	Summer Season (2026)	Winter Season (2026-27)	Summer Season (2027)	Winter Season (2027-28)	
East Anglia Two						Piling expected 2025-2027.
Tier 1d and 1e (*Grey shading represents the construction window within which the activity may occur*)						
None identified						
Tier 2 (*Grey shading represents the construction window within which the activity may occur*)						
Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	Potential for offshore construction			Post piling		Earliest construction expected to start 2024, offshore construction to follow in 2 years (2026)[82]
Tier 3 (*Grey shading represents the construction window within which the activity may occur*) (no information available at the time of writing)						
Endurance CCS.						
North Falls.						
Five Estuaries.						
Round 4 – Leasing Area 1 (Bidding Area 1).						
Round 4 – Leasing Area 2 (Bidding Area 1).						
Round 4 – Leasing Area 3 (Bidding Area 2).						

[82] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

11.3.2.11 There is strong presumption of certainty that Tier 1a projects will proceed to construction on the specified timeframe and scale, with these projects having achieved consent, CfD and preparing for construction (not least because the CfD sets milestones and long-stop dates). Hornsea Four is progressing on the timeframe and scale specified by the Applicant, as included within the assessment process as the project design and project programme (**Section 6.5**), and therefore can be afforded the same level of certainty within the in-combination assessment here.

11.3.2.12 For Tier 1b, 1c, 2 and 3 projects, there is a much lower (and decreasing with the increasing tier allocation) degree of certainty in terms of project programme timeframe and project scale. Whilst it is recognised that the planned construction windows of thesewind farm projects, where publicly available, may overlap with (and may extend beyond) the construction window of Hornsea Four, it is acknowledged, in common with all such projects with such a large construction window during the planning process and prior to securing a Contract for Difference (CfD), that actual construction will last for a proportion of the total construction window and that in reality the actual construction window may shift further. In addition, it is common for the scale of a project to change following consent or achieving CfD, for example a reduced number of WTGs (potentially with an increased capacity per WTG) may be progressed to final scheme design.

11.3.2.13 Therefore, the quantitative assessment is presented in stages – essentially increasing the potential for impact as each tier is added (while increasing the uncertainty that such a scenario would ever occur). The purpose is to provide a comprehensive assessment while enabling the areas of 'risk' in-combination to be identified[83]. The areas of risk are effectively seasons where there is a risk of an in-combination exceedance of the thresholds. The certainty of that exceedance being driven by the tier within which the relevant project(s) sit. All such risk is highlighted here for the Outline SNS SAC SIP (which accompanied the application). The main purpose of the SIP (with the SIP provided for in the DCO) is to manage the risk posed by such uncertainty going forward, and to provide certainty in planning terms that where a risk of threshold exceedance has been identified, measures are in place to address that risk and ensure the thresholds are not breached. Such an approach was first used on East Anglia Three, a project which achieved consent in August 2017.

11.3.2.14 The assessment of the potential for AEoI with respect to underwater noise for plans and projects in-combination with Hornsea Four in relation to harbour porpoise is determined below, with regard to the conservation objectives of the site.

The Species potential to remain a Viable Component of the Site

11.3.2.15 For the purposes of the assessment of AEoI in-combination for harbour porpoise, the methodology applied to the assessment alone for the Conservation Objectives

[83] The certainty attached to the projects within various tiers has been explored by previous projects, for example during the Examination of Hornsea Three. In that case, the Applicant provided text at Deadline 1 in response to the ExA question 1.1.6 (https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-001153-DI_HOW03_ExAFirstWQ.pdf)

concerned with viability (in relation to potential for injury), has been extended to consider the potential for effect from the above projects in-combination.

11.3.2.16 It has been concluded for Hornsea Four alone that, given the proposed mitigation and project commitments (as controlled through the MMMP and, where necessary, the EPS licensing process), the risk of such injurious or lethal effects is appropriately managed. As a result of these existing controls, the type, scale and extent of potential impacts arising from Hornsea Four (and indeed other licenced projects and activities) means that there is no AEoI for harbour porpoise viability (in relation to injury or mortality effects) as a result of the construction, operation and decommissioning of Hornsea Four. The potential for impact is such that it can similarly be concluded (and confirmed within the Screening and Integrity Matrices (**Appendix B** and **Appendix C**), taking account of the similar controls on all licenced projects and or activities (noting that all projects have either a SIP condition applied with their DCO or are required, through the Review of Consents[84], to account for this) that may result in underwater noise sufficient to result in injurious and or lethal effects on harbour porpoise) that no pathway exists for a contribution to AEoI in-combination from Hornsea Four. The same logic applies to all other projects identified within **Table 29**.

11.3.2.17 There is, therefore, no AEoI to the viability of harbour porpoise in relation to mortality or injury effects from Hornsea Four in-combination and therefore, subject to natural change, harbour porpoise will be maintained as a 'viable component' of the SNS SAC in the long-term.

Potential for Significant Disturbance to the Species within the Site

11.3.2.18 For the purposes of the assessment of AEoI in-combination for harbour porpoise, the methodology applied to the assessment alone for the Conservation Objective concerned with significant disturbance in harbour porpoise has been extended to consider the potential for effect from the above projects in-combination.

11.3.2.19 The overall aim of the assessment of disturbance within the SNS SAC is to identify the percentage of the relevant part of the SAC within which harbour porpoise may exhibit avoidance behaviour (displacement) together with an understanding of the total duration of such disturbance, within the overall construction window. The approach takes account of both spatial and temporal elements, as required by the definition of significance. As the overall indicative construction window falls at least partially within more than one season (although in total it will extend across an estimated 12 months), the assessment is presented on a seasonal basis – to enable the potential for effect to be fully understood for each of the seasons within which works may occur at Hornsea Four.

11.3.2.20 The following assessment includes a number of assumptions, with these summarised as follows:

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[84] https://www.gov.uk/government/publications/review-of-consented-offshore-wind-farms-in-the-southern-north-sea-harbour-porpoise-special-area-of-conservation

- Only relevant works planned for the period 1st October 2025 – 31st March 2028 (i.e. the seasons that fall across the period within which relevant project related works at Hornsea Four may result in underwater noise, with pre piling works commencing Q1 2026 at the earliest and piling completing Q4 2027) to be included;
- An assumption that all UXO clearance, geophysical/seismic survey and foundation piles at Hornsea Four will be installed within this timeframe, but UXO/geophysical survey will preceed piling (in any case adding totals would be inaccurate given the high degree of EDR overlap that would result);
- PIling within the Hornsea Four array is relevant to the summer season only – piling at the HVAC search area is relevant to the summer and winter seasons;
- Piling may be consequetive (single piling event per 24 hours) or concurrent (up to two piling rigs per 24 hours);
- Piling may be monopiles (26 km EDR) or pinpiles (15 km EDR);
- Should geophysical/seismic survey occur, a 5 km buffer has been applied (as the 12km EDR applies to air gun surveys not typical of an offshore wind farm); and
- The maximum spatial overlap that may occur from an individual UXO clearance or piling location within each project has been assumed (based on a 26 km EDR).

11.3.2.21 **Table 30** summarises the potential for effect from a single event (assumed worst case, whether that be monopiles or UXO clearance) per day. The potential effect from two activities (whichever would result in the worst footprint), to occur per 24 hours is summarised in **Table 31**. Values are presented as minimum and maximum (where relevant) as the location of noise relevant to the SNS SAC will affect the degree of spatial overlap. It is also particularly relevant to note that the calculations assume that all projects will progress in the timeframes specified, that activities will occur at the worst possible locations for each project simultaneously, do not take account of overlap between projects and do not include the possibility of noise mitigation at source. It is therefore clear that the values in-combination represent a highly unlikely scenario – with considerable precaution built into the assessment. These assumptions are particularly relevant to Dogger Bank A, B and C and Sofia. These projects have a latest start date but no specified end date in the relevant DCOs; however these projects are also clear in published statements on project websites that construction will (or is) starting in a timeframe that is likely to avoid temporal overlap with construction at Hornsea Four for at least some if not all construction works. The inclusion of these projects across the full construciton window assessed for Hornsea Four is therefore highly precautionary.

Table 30: Spatial Effect In-Combination from a Single Event in a Single Day per Season (cells highlighted in red are at risk of exceeding the threshold if unmitigated through the SIP process).

Project		Season					Relevant Activity
		Winter Season (2025-26)	Summer Season (2026)	Winter Season (2026-27)	Summer Season (2027)	Winter Season (2027-28)	
Hornsea Four	Max (km^2)	352	2,124	Not concurrent with piling			Pre-construction works (including UXO clearance if required plus geophysical survey scheduled Q1 2026 (winter season 2025/26) to Q3 2026 (summer season 2026)
	Min (km^2)	277	0	Not concurrent with piling			
Hornsea Four	Max (km^2)	N/A	N/A	352	2,124	352	Percussive piling. To occur in the window Q4 2026 (winter season 2026/27) to Q4 2027 (winter season 2027/28)
	Min (km^2)			277	1,930	277	
Total for Hornsea Four	**Max (km^2)**	**352**	**2,124**	**352**	**2,124**	**352**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min (km^2)	**277**	**0**	**277**	1,930	**277**	
Total for Hornsea Four	**Max %**	**2.8**	**7.9**	**2.8**	**7.9**	**2.8**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min %	**2.2**	**0**	**2.2**	**7.1**	**2.2**	
Tier 1a							
Dogger Bank A	Max (km^2)	0	2,124	0	2,124	0	No clear construction window (but anticipated to be constructed by 2023).
	Min (km^2)	0	1,246	0	1,246	0	
Dogger Bank B	Max (km^2)	0	2,124	0	2,124	0	No clear construction window.
	Min (km^2)	0	1,556	0	1,556	0	
Dogger Bank C	Max (km^2)	0	25	0	25	0	No clear construction window.
	Min (km^2)	0	0	0	0	0	
Sofia	Max (km^2)	0	1,509	0	1,509	0	No clear construction window (but turbines anticipated to be installed 2025.
	Min (km^2)	0	125	0	125	0	
Total for Hornsea Four and Tier 1a	**Max (km^2)**	**352**	**7906**	**352**	**7906**	**352**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min (km^2)	**277**	**2927**	**277**	**4,857**	**277**	
Total for Hornsea Four and Tier 1a	**Max %**	**2.8**	**29.3**	**2.8**	**29.3**	**2.8**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min %	**2.2**	**10.8**	**2.2**	**18.0**	**2.2**	
Tier 1b							
Hornsea Project Three	Max (km^2)	0	432	0	432	0	Piling scheduled Q1 2022- Q2 2023 and/or Q1 2027-Q2 2028. No dates for UXO, geophysical or seismic (outside piling window). Maximum 23 UXO, here assumed to predate piling.
	Min (km^2)	0	0	0	0	0	
Total for Hornsea Four and Tier 1a and 1b	**Max (km^2)**	**352**	**8,338**	**352**	**8,338**	**352**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min (km^2)	**277**	**2,927**	**277**	**4,857**	**277**	
Total for Hornsea Four and Tier 1a and 1b	**Max %**	**2.8**	**30.9**	**2.8**	**30.9**	**2.8**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min %	**2.2**	**10.8**	**2.2**	**18.0**	**2.2**	
Tier 1c							
Norfolk Vanguard	Max (km^2)	1,081	2,124	1,081	2,124	1,081	Piling scheduled Q2 2024-Q1 2025 OR Q2 2024-Q1 2025 and Q2 2027-Q1 2028. No dates for UXO, geophysical or seismic, 42 UXO maximum – here assumed to predate piling.
	Min (km^2)	2	1,345	2	1,345	2	
Norfolk Boreas	Max (km^2)	292	2,109	292	2,109	292	Survey Q4 2024-Q2 2025, UXO Q3 2025-Q1 2026 and piling Q2 2026-Q3 2027 OR Q2 2026-Q4 2026 and Q2 2027-Q4 2027Max 80 UXO.
	Min (km^2)	0	383	0	383	0	
East Anglia One North	Max (km^2)	2,124	1,181	2,124	1,181	2,124	Piling expected 2026-2028. Assumed that UXO and/or survey to predate this.
	Min (km^2)	2,089	305	2,089	305	2,089	
East Anglia Two	Max (km^2)	2,124	179	2,124	179	N/A	Piling expected 2025-2027.

Project		Season: Winter Season (2025-26)	Summer Season (2026)	Winter Season (2026-27)	Summer Season (2027)	Winter Season (2027-28)	Relevant Activity
	Min (km^2)	2,034	0	2,034	0		
Total for Hornsea Four and Tier 1a, 1b and 1c	**Max (km^2)**	**5,973**	**13,931**	**5,973**	**13,931**	**3,849**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min (km^2)	**4,402**	**4,960**	**4,402**	**6,890**	**2,368**	
Total for Hornsea Four and Tier 1a, 1b and 1c	**Max %**	**47.1**	**51.6**	**47.1**	**51.6**	**30.3**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min %	**34.7**	**18.4**	**34.7**	**25.5**	**18.7**	
Tier 1d and 1e							
None identified							
Tier 2							
Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	Max (km^2)	30.15	35.6	30.15	0	0	Earliest construction expected to start 2024, offshore construction to follow in 2 years (2026)[85]
	Min (km^2)	0	0	0	0	0	
Total for Hornsea Four and Tier 1a, 1b, 1c and 2	**Max (km^2)**	**6,003**	**13,967**	**6,003**	**13,931**	**3,849**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min (km^2)	**4,402**	**4,960**	**4,402**	**6,890**	**2,368**	
Total for Hornsea Four and Tier 1a, 1b, 1c and 2	**Max %**	**48.4**	**51.7**	**48.4**	**51.6**	**30.3**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min %	**34.7**	**18.4**	**34.7**	**25.5**	**18.7**	
Tier 3 No information available at the time of writing with regards timeframe or relevant activity							
Endurance CCS.							
North Falls							
Five Estuaries							
Round 4 – Leasing Area 1 (Bidding Area 1)							
Round 4 – Leasing Area 2 (Bidding Area 1)							
Round 4 – Leasing Area 3 (Bidding Area 2)							

[85] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

Table 31: Spatial Effect In-Combination from two Events in a Single Day per Season (cells highlighted in red are at risk of exceeding the threshold if unmitigated through the SIP process).

Project		Season					Relevant Activity
		Winter Season (2025-26)	Summer Season (2026)	Winter Season (2026-27)	Summer Season (2027)	Winter Season (2027-28)	
Hornsea Four	Max (km²)	352	3,683	Not concurrent with piling			Pre-construction works (including UXO clearance if required plus geophysical survey scheduled Q1 2026 (winter season 2025/26) to Q3 2026 (summer season 2026)
	Min (km²)	277	0	Not concurrent with piling			
Hornsea Four	Max (km²)	N/A	N/A	352	3,797	352	Percussive piling. To occur in the window Q4 2026 (winter season 2026/27) to Q4 2027 (winter season 2027/28)
	Min (km²)			277	1,930	277	
Total for Hornsea Four	**Max (km²)**	**352**	**3,683**	**352**	**3,797**	**352**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	Min (km²)	**277**	**0**	**277**	**1,930**	**277**	
Total for Hornsea Four	**%**	**2.8**	**13.6**	**2.8**	**13.6**	**2.8**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	%	**2.2**	**0.0**	**2.2**	**7.1**	**2.2**	
Tier 1a							
Dogger Bank A	Max (km²)	0	3,569	0	3,569	0	No clear construction window.
	Min (km²)	0	1,246	0	1,246	0	
Dogger Bank B	Max (km²)	0	3,640	0	3,640	0	No clear construction window.
	Min (km²)	0	1,556	0	1,556	0	
Dogger Bank C	Max (km²)	0	25	0	25	0	No clear construction window.
	Min (km²)	0	0	0	0	0	
Sofia	Max (km²)	0	2,080	0	2,080	0	No clear construction window.
	Min (km²)	0	125	0	125	0	
Total for Hornsea Four and Tier 1a	**Max (km²)**	**352**	**12,997**	**352**	**12,997**	**352**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	Min (km²)	**277**	**2927**	**277**	**4,857**	**277**	
Total for Hornsea Four and Tier 1a	**%**	**2.8**	**48.1**	**2.8**	**48.1**	**2.8**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	%	**2.2**	**10.8**	**2.2**	**18.0**	**2.2**	
Tier 1b							
Hornsea Project Three	Max (km²)	0	502	0	502	0	Piling scheduled Q1 2022- Q2 2023 and/or Q1 2027-Q2 2028. No dates for UXO, geophysical or seismic (outside piling window). Maximum 23 UXO, here assumed to predate piling.
	Min (km²)	0	0	0	0	0	
Total for Hornsea Four and Tier 1a and 1b	**Max (km²)**	**352**	**13,499**	**352**	**13,499**	**352**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	Min (km²)	**277**	**2,927**	**277**	**4,857**	**277**	
Total for Hornsea Four and Tier 1a and 1b	**%**	**2.8**	**50.0**	**2.8**	**50.0**	**2.8**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	%	**2.2**	**10.8**	**2.2**	**18.0**	**2.2**	
Tier 1c							
Norfolk Vanguard	Max (km²)	1,485	3,616	1,485	3,616	1,485	Piling scheduled Q2 2024-Q1 2025 OR Q2 2024-Q1 2025 and Q2 2027-Q1 2028. No dates for UXO, geophysical or seismic, 42 UXO maximum, here assumed to predate piling.
	Min (km²)	2	1,345	2	1,345	2	
Norfolk Boreas	Max (km²)	292	2,490	292	2,490	292	Survey Q4 2024-Q2 2025, UXO Q3 2025-Q1 2026 and piling Q2 2026-Q3 2027 OR Q2 2026-Q4 2026 and Q2 2027-Q4 2027Max 80 UXO.
	Min (km²)	0	383	0	383	0	
East Anglia One North	Max (km²)	3,173	1,336	3,173	1,336	3,173	Piling expected 2026-2028. Assumed that UXO and/or survey to predate this.
	Min (km²)	2,089	305	2,089	305	2,089	

Project		Season					Relevant Activity
		Winter Season (2025-26)	Summer Season (2026)	Winter Season (2026-27)	Summer Season (2027)	Winter Season (2027-28)	
East Anglia Two	Max (km[2])	3,606	179	3,606	179	N/A	Piling expected 2025-2027.
	Min (km[2])	2,034	0	2,034	0		
Total for Hornsea Four and Tier 1a, 1b and 1c	**Max (km[2])**	**8,908**	**21,120**	**8,908**	**21,120**	**5,302**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	Min (km[2])	**4,402**	**4,960**	**4,402**	**6,890**	**2,368**	
Total for Hornsea Four and Tier 1a, 1b and 1c	**%**	**70.2**	**78.2**	**70.2**	**78.2**	**41.8**	**Daily unmitigated maximum/minimum (assuming two unmitigated activities per project per day based on an EDR of 26km)**
	%	**34.7**	**18.4**	**34.7**	**25.5**	**18.7**	
Tier 1d							
None identified							
Tier 2							
Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	Max (km[2])	30.15	35.6	30.15	0	0	Earliest construction expected to start 2024, offshore construction to follow in 2 years (2026)[86]. Draft RIAA identifies no concurrent piling.
	Min (km[2])	0	0	0	0	0	
Total for Hornsea Four and Tier 1a, 1b, 1c and 2	**Max (km[2])**	**8,938**	**21,155**	**8,938**	**21,120**	**5,302**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min (km[2])	**4,402**	**4,960**	**4,402**	**6,890**	**2,368**	
Total for Hornsea Four and Tier 1a, 1b, 1c and 2	**Max %**	**71.5**	**78.3**	**71.5**	**78.2**	**41.8**	**Daily unmitigated maximum/minimum (assuming a single unmitigated activity per project per day and therefore an EDR of 26km)**
	Min %	**34.7**	**18.4**	**34.7**	**25.5**	**18.7**	
Tier 3 No information available at the time of writing with regards timeframe or relevant activity							
Endurance CCS.							
North Falls							
Five Estuaries							
Round 4 – Leasing Area 1 (Bidding Area 1)							
Round 4 – Leasing Area 2 (Bidding Area 1)							
Round 4 – Leasing Area 3 (Bidding Area 2)							

[86] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

11.3.2.22 It should be noted that the above tables are very much an unmitigated worst case scenario and do not take account of any overlap between individual activities associated with individual projects – which would occur in the unlikely event that all such activity occurred in the same day. Once such double counting is taken into account, the remaining potential for overlap (based on each project piling at the worst possible location for each project and assuming an unrealistic build out) is provided below as a maximum design scenario.

Table 32: Maximum Potential for Overlap with the SNS SAC for Single Activity Only, Excluding Project Overlap.

Scenario		Winter Season Overlap		Summer Season Overlap	
		Km²	%	Km²	%
Hornsea Four plus Tier 1a projects (Dogger Bank A, Dogger Bank B, Dogger Bank C and Sofia)	Max	0	0	6,912.7	**25.6**
	Min	0	0	3,972.4	14.7
Hornsea Four plus Tier 1a projects plus Tier 1b projects (as above plus Hornsea Project Three)	Max	0	0	7,344.3	**27.2**
	Min	2.43	0.02	3,972.4	14.7
Hornsea Four plus Tier 1a, Tier 1b and Tier 1c projects (as above plus Norfolk Vanguard, Norfolk Boreas, East Anglia One North, East Anglia Two)	Max	5,053.6	**39.8**	11,547.3	**42.8**
	Min	2,655.8	**20.9**	5,748.9	**21.3**
Hornsea Four plus Tier 1a, Tier 1b, Tier 1c and Tier 2 projects (as above plus Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions)	Max	5,053.6	**39.8**	11,750.3	**43.5**
	Min	2,655.8	**20.9**	5,748.9	**21.3**

11.3.2.23 The minimum values in **Table 32** above remain highly precautionary, as the timeframe of projects means that such a risk on a day by day basis would not actually materialise, with the maximum values even more so (as this requires simultaneous works at all projects at the worst location). The values do, however, provide an indication of the reduction in potential effect afforded by removal of the 'double counting' that occurs from such overlap, which is typically in the order of approximately 15-25%. That removal of double counting reinforces the relevance of the primary mitigation approach noted above – effectively adding certainty to the case that primary mitigation, the application of spatial and/or temporal mitigation on activity, has potential to provide sufficient and appropriate mitigation to avoid the risk of threshold exceedance (as applied through the SIP). The exact scenario or suite of measures that would be required can only be determined when there is certainty on construction timeframes for the in-combination projects.

11.3.2.24 As concluded in **Section 10.3**, it is clear that Hornsea Four alone would not trigger the 20% threshold under any circumstance. However, there are apparent risks to the 20% threshold when other projects are screened in for assessment in-combination – on the assumption that all projects would in fact undertake such activity on the same day. Such risks need to be placed in context, to determine where risk may actually exist and what measures are available to help mitigate that risk. Key to the process is the requirement on all projects assessed here in-combination to be subject to a SIP, which will ensure on a case by case basis that the thresholds will not be exceeded (alone and in-combination).

11.3.2.25 **Table 30** determines the risk from Hornsea Four together with all in-combination projects, assuming a single event per day (on a minimum and maximum basis). For Hornsea Four together with Tier 1a and Tier 1b projects, the potential for the daily 20% threshold exceedance is primarily limited to the summer seasons (2026 and 2027) when a worst case is assumed for all projects simuntaneously. The only exception is a small risk of threshold exceedance in the summer 2027 season, even under the minimum scenarios. It should be noted that Information currently available for the Dogger Bank projects, specifically Dogger Bank A, it is expected that the project will be operational by 2023[87], with Dogger Bank B and C following rapidly behind. For Sofia, the expectation is for the turbines to be installed in 2025 and the project operational by 2026[88]. Onshore construction began in 2020 on Dogger Bank A. Even just the removal of the Dogger Bank A totals from the in-combination assessment with Tier 1a and Tier 1b would reduce the summer total as a maximum to 23%.

11.3.2.26 Once all Tier 1c projects are included, the risk increases, although the threshold is still not exceeded under all scenarios. As expected, as concurrent activity is introduced in **Table 31** the risk of the 20% threshold being exceeded increases if all projects simultaneously chose to undertake concurrent piling. However, the risk follows a similar pattern to that noted for a single activity per day, with the result being that threshold exceedance is not anticipated under all scenarios (in particular risk is much lower in the winter season, for the minimum overlap measure and for Hornsea Four in-combination with Tier 1a compared to Tier 1c).

11.3.2.27 It is therefore clear that although there is potential for a threshold exceedance to occur if all activity is unmitigated, capacity does exist for projects to progress unmitigated and without exceeding the thresholds, depending on the build out scenario applied. The Outline SNS SAC SIP that accompanies the Hornsea Four application contains the process to be followed to determine the need for any mitigation as well as the type of mitigation required. Should mitigation be required to remain within the threshold, the Outline SNS SAC SIP includes as a primary mitigation measure the potential to vary schedules or location of works. Such mitigation could be applied here, to manage the risk from a worst case scenario (e.g. multiple projects all working at their worst case location simultaneously) and ensure that the thresholds are not exceeded. Given the number of variables involved, it is not possible to be clear on the exact scenario that will eventually be chosen or what primary mitigation measure will actually be required (if any). However, it is clear that there are several routes that can be taken to avoid an exceedance of the daily 20% threshold and that the Outline SNS SAC SIP provides for this to be applied.

11.3.2.28 In addition to the primary mitigation referred to above, the Outline SNS SAC SIP also includes provision for secondary mitigation. A number of potential solutions are identified, including noise mitigation at source, with the caveat that these are options that could be applied should the SIP require it. The application of such mitigation has

[87] https://doggerbank.com/construction/offshore/
[8888] https://sofiawindfarm.com/offshore-construction/

been identified by JNCC as resulting in a reduction in the monopile EDR from 26 km to 15 km[89].

11.3.2.29 Overall, despite the precaution inherent in the assessment, the assessment has enabled the identification of capacity within the daily 20% threshold (in the context of project certainty and availability of primary or secondary mitigation if required), to ensure that the 20% threshold would not be exceeded by Hornsea Four in-combination. It would be disproportionate to identify the required mitigation at this point, since the need for any mitigation is not certain (and depends on the final construction timeframe of individual projects). It is the purpose of the SIP to acknowledge these risks, and to identify the appropriate measures should they be required (including the timeframe attached to the SIP process) to ensure that Hornsea Four, alone and/ or in-combination, would not exceed the 20% or 10% threshold. Such a SIP is understood to be a requirement on all OWF within 26 km of the SNS SAC going forward. As noted in **Section 8.2.3**, the Outline SNS SAC SIP for Hornsea Four accompanied the application and is secured within the draft DCO in Condition 13(1)(j).

In-combination Effects on Disturbance Across A Season

11.3.2.30 As regards the consideration of the potential for an in-combination effect across a season (the 10% value), as for the assessment of the project alone a number of highly precautionary assumptions have been made (following the precedent set by the determination for the project alone in **Section 10**). These are based on the following two scenarios to consider the worst case in both summer and winter seasons (both assuming a maximum of 1 activity per day per project):

- Scenario 1 (to test the requirement for winter season UXO clearance at Hornsea Four OR monopile installation within the HVAC location): Hornsea Four plus Tier 1a, 1b 1c and 2 projects in any winter season. Assumes 86 UXO clearances at Hornsea Four, of which it is assumed that up to 20 may occur within range of the winter extents of the SNS SAC, OR 20 days of piling at the HVAC at Hornsea Four (one activity per day for 20 days, each at the worst location possible), together with piling at East Anglia Two (75 WTGs), East Anglia One North (67 WTGs), Norfolk Boreas (90-180 WTGs but maximum of 154 piling days winter, 173 summer[90]), Norfolk Vanguard (158 WTGs, 59 days piling per season[91]) and Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions (combined maximum of 30 piling days per season[92]) (the only projects with potential for overlap in that season). The number of piling days assumed per project is equivalent to the maximum number of WTGs per project OR the maximum number of piling per season identified in project literature (the overlap for both based on an average value of the min/max overlap possible);
- **Scenario 2 (to test Hornsea Four array piling in a summer season):** Hornsea Four plus Tier 1a, 1b, 1c and 2 projects in summer season 2027 – assumes piling at Hornsea Four, together with piling at Dogger Bank A (up to 200 WTGs, assumed to

[89] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/889842/SACNoiseGuidanceJune2020.pdf
[90] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010087/EN010087-000374-5.3%20Information%20to%20Support%20Habitats%20Regulations%20Assessment%20Report%20(HRA).pdf
[91] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010079/EN010079-001479-5.03%20Norfolk%20Vanguard%20Information%20to%20Support%20HRA.pdf
[92] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

be installed on 2/3 of the available days), Dogger Bank B (up to 200 WTGs, assumed to be installed on 2/3 of the available days), Dogger Bank C (up to 200 WTGs, assumed to be installed on 2/3 of the available days), Sofia (up to 200 WTGs, assumed to be installed on 2/3 of the available days), Norfolk Vanguard (59 days per season), Hornsea Project Three (project HRA has 111 piling days per summer season[93]), Norfolk Boreas (154 piling days), East Anglia Two (75 piling days), East Anglia One North (67 piling days) and Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions (assumes 30 piling days) (the overlap for all based on an average value of the min/max overlap possible).

11.3.2.31 Based on the above assumptions, there is a risk of the seasonal threshold being exceeded under Scenario 1 – regardless of whether or not Hornsea Four is included (Hornsea Four contributes approximately 0.3% of the 15.4% total). The key risks are East Anglia Two and East Anglia One North, with both projects being within Tier 1c and therefore having a low level of certainty attached. Excluding those projects, the total is just 2.7% and well within the seasonal threshold. It should also be noted that the assessment assumes 20 UXO to be cleared at Hornsea Four, all at the worst possible location relative to the winter season extents, a highly precautionary assumption. Given the requirement for a SIP on all these projects, together with the need for all projects to seek licensing for UXO clearance, it is considered that sufficient controls exist to ensure no seasonal threshold exceedance would occur.

11.3.2.32 As regards Scenario 2, the number of projects whose piling window includes summer 2027 means that there is a risk of the 10% seasonal threshold being exceeded, should all projects be in a position to construct to the maximum level assessed within that timeframe. Noting that no account of overlap between projects has been taken into consideration. It is clear that the risk is highly precautionary and an over estimate, for a number of reasons:

- As noted above, it is expected that Dogger Bank A will be constructed by 2022, with Dogger Bank B and C following rapidly behind (and are therefore unlikely to contribute to any seasonal totals in 2027);
- As noted above, it is expected that turbines at Sofia will be installed in 2025 and completed by 2026 (and is therefore unlikely to contribute to any seasonal totals in 2027);
- Should Dogger Bank A, B and C and Sofia be excluded from the seasonal totals, that would reduce the seasonal value to 8% for Hornsea Four plus Tiers 1a and 1b;
- For a number of the projects, no total piling days exist and a precautionary assumption has been made;
- A number of the projects have a very large construction window, are highly likely to progress to constuction well before 2027 and it is therefore extremely unlikely that all projects will be in a position to construct within the same summer season (and for individual projects to the extent assumed);
- The assessment does not take overlap between projects into account – which as shown in **Table 32** accounts for approximately 15-25% of the total on a daily basis;

[93] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000521-HOW03_5.2_Report%20to%20Inform%20Appropriate%20Assessment.pdf

- As noted above, the Tiering structure reflects project certainty, with significant uncertainty for most of the projects as regards final scheme design and for all projects final construction window; and
- All projects within the in-combination assessment are similarly constrained by the SNS SAC and the requirement for a SIP (As a result of the Review of Consents process or individual project DCO) – which will prevent any project exceeding the thresholds alone and/ or in-combination.

11.3.2.33 Given that Hornsea Four has submitted an Outline SNS SAC SIP to accompany the Application, thus providing certainty of no AEoI with respect to the SNS SAC, the following table summarises the risks in a summer season of piling at Hornsea Four as regards the 10% seasonal threshold. From **Table 33**, it is clear that the key risks in-combination will depend on which project builds out within the same timeframe as Hornsea Four, with the level of certainty attached to these varying depending on the tier. All these projects are subject to the requirement for a SIP[94], which provides certainty that the thresholds will not be breached by any project.

[94] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/753026/RoC_SNS_cSAC_HRA_5.0.pdf

Table 33: Summary of Risk to the 10% Threshold In-Combination from Piling in a Summer Season.

Project	Tier	Activities per season[95][96]	Average % overlap per day	Average % per season	Threshold Risk?
Hornsea Four	N/A	Assumes piling every day of the season	7.5%	7.5%	Represents a considerable proportion. However, it is extremely unlikely that piling would (could) occur every day of the season. Capacity therefore exists for primary mitigation (through management of activities) as provided for in the SIP.
Dogger Bank A	1a	Assumes piling on 2/3 of the days in a season (133 days)	6.24%	4.54%	Expected to be constructed by 2022 (and therefore not contribute to the 2027 seasonal totals). As yet does not have a published SIP. Will require consideration of the SNS SAC (requirement of the Review of Consents).
Dogger Bank B	1a		6.81%	4.95%	Expected for construction to follow on from Dogger Bank A (and therefore unlikely to contribute to the 2027 seasonal totals) As yet does not have a published SIP. Will require consideration of the SNS SAC (requirement of the Review of Consents).
Dogger Bank C	1a		0.05%	0.03%	Expected for construction to follow on from Dogger Bank A (and therefore unlikely to contribute to the 2027 seasonal totals) Very small contribution to the total. As yet does not have a published SIP. Will require consideration of the SNS SAC (requirement of the Review of Consents).
Sofia	1a		3.03%	2.20%	Expected for offshore construction 2025, complete 2026 (and therefore unlikely to contribute to the 2027 seasonal totals) As yet does not have a published SIP. Will require consideration of the SNS SAC (requirement of the Review of Consents).

[95] The summer season is 183 days
[969696] Piling days per season and per project as per Scenario 1 and 2 above

Project	Tier	Activities per season[95][96]	Average % overlap per day	Average % per season	Threshold Risk?
Hornsea Project Three	1b	111 days (project HRA[97])	0.80%	0.48%	Very small contribution to the total. Consented but as yet no CfD. Will require consideration of the SNS SAC (requirement of the project level SIP).
Norfolk Vanguard	1c	59 days	6.42%	2.07%	Small contribution to the total. As yet, no consent (awaiting re-determination) or CfD. Will require consideration of the SNS SAC (requirement of the project level SIP).
Norfolk Boreas	1c	154 days	4.62%	3.88%	Very small contribution to the total. As yet, no consent or CfD. Will require consideration of the SNS SAC (requirement of the project level SIP).
East Anglia Two	1c	75 (maximum number of WTGs)	0.33%	0.14%	Very small contribution to the total. As yet, no consent or CfD. Will require consideration of the SNS SAC (requirement of the project level SIP).
East Anglia One North	1c	67 (maximum number of WTGs)	2.75%	1.01%	Ssmall contribution to the total. As yet, no consent or CfD. Will require consideration of the SNS SAC (requirement of the project level SIP).
Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2	30 piling days	Max 1.32	0.2%	Very small contribution to the total. PEIR recently submitted. Application not yet made. Will require consideration of the SNS SAC (requirement of the project level SIP).

[97] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000521-HOW03_5.2_Report%20to%20Inform%20Appropriate%20Assessment.pdf

11.3.2.34 It is clear that where a project applies a more realistic number of piling days in a season, the proportional contribution of that project to the overall totals reduces considerably. The risks to the 10% seasonal threshold in **Table 33** above come from project certainty, those projects that do not identify a maximum number of piling days per season coupled with the inability to take account of project overlap given current uncertainty; these risks will be managed through the SIP process.

How the SIP will Manage Adherence to the Thresholds

11.3.2.35 An Outline SNS SAC SIP accompanies the Application (see **Section 8.2.3**) and is secured within the draft DCO in Condition 13(1)(j). The document addresses the risks with respect to the SNS SAC identified in **Section 11**. In particular, confirmation of the relevant project design for Hornsea Four alone but also the in-combination scenario, to confirm the risk when certainty on individual project construction timescales and build out is known, and includes measures that would fully address that risk (drawing on the range of mitigation options available, should any be required).

11.3.2.36 It is important to note that the understanding of underwater noise, the potential for impact and how best to mitigate it is constantly evolving. For example, the current BEIS workstream that is providing much greater clarity on the risk posed by UXO clearance[98]. A recent paper by SMRU[99] also highlights how solutions to underwater noise are constantly developing. Further, the recent paper by Hastie et al. (2019) provide evidence, for the first time, demonstrating the change in impulsive noise to non-impulsive noise characteristics over distance, which when developed further is expected to considerably affect predicted impact ranges for impulsive noise sources (such as piling and UXO). The Outline SNS SAC SIP includes a requirement for review on a specified timeframe and will therefore enable the process to draw on such advances and ensure, in the context of the risks posed by Hornsea Four alone and/ or in-combination, that the daily 20% and seasonal 10% thresholds with respect to the SNS SAC are not exceeded.

11.3.2.37 In that context, it can be concluded that, with the mitigation afforded by the SIP, the MMMP and the anticipated requirement for a UXO-specific MMMP (which will be a condition of the UXO ML if UXO clearance is required and the ML applied for) (and certainty on their delivery given the requirement to consult with SNCBs and the commitment within the DCO), an AEoI will not occur as a result of disturbance to harbour porpoise (as defined by the daily 20% and seasonal 10% thresholds) in-combination with other projects during all relevant seasons, within which geophysical survey, UXO clearance and piling activity may take place at Hornsea Four.

Seismic and geophysical survey

11.3.2.38 No specific information on the requirement for seismic and geophysical survey for Hornsea Four alone are identified at this point; although any surveys that are required will occur within the period Q1 2026 – Q3 2026 (**Figure 3**). In any case, the potential for effect from such surveys will be less than that considered here for UXO clearance (and occurring within that timeframe) and is therefore incorporated within the current assessment (as the footprint of effect from any such survey would be incorporated into

[98] https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/893773/NPL_2020_-_Characterisation_of_Acoustic_Fields_Generated_by_UXO_Removal.pdf
[99] https://www.nature.scot/snh-research-report-1070-review-noise-abatement-systems-offshore-wind-farm-construction-noise-and

the footprint of effect from the UXO clearance; the footprints are not additive). Further, the requirement for a project level SIP provides certainty that the conclusions drawn for the project alone will remain valid and that no adverse effect would result in-combination, including a suite of measures that can be drawn on if required to ensure that conclusion holds true. No specific information on planned or proposed surveys in-combination has been identified within the relevant timeframe for inclusion in the assessment here.

Key Points for Hornsea Four in-combination with respect to the SNS SAC

11.3.2.39 A summary of the key points for Hornsea Four in relation to the SNS SAC are provided in **Table 34** below.

11.3.2.40 In the context of the MMMP, the Outline SNS SAC SIP and the anticipated requirement for a UXO-MMMP (if/when a UXO licence is applied for), there is, therefore, no AEoI resulting from disturbance of harbour porpoise within the SNS SAC from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the feature will be maintained in the long-term.

Table 34: Summary of the In-Combination Risk for Hornsea Four and the SNS SAC.

Project Element	Winter Season	Summer Season	Risk Management
Piling within the Hornsea Four array area	No potential for overlap and therefore no implications for the SNS SAC	Risk of exceedance of the daily 20% threshold for Horsnsea Four in-combination with Tier 1a projects on a maximum basis only. As Tier 1b (and then Tier 1c and 2) projects are added, risk rises on a minimum scenario basis (excluding double counting between projects). Risk of exceedance of the seasonal 10% threshold in-combination depending on the number of piling days committed to in a season by individual projects, location of any such piling and which projects are in a position to proceed.	Requirement for a SIP is understood to apply to all OWF within 26 km of the SNS SAC. The SIPs are provided for within individual project DCOs or the Review of Consents (as relevant) and provide management and mitigation measures that ensure compliance with the thresholds in all cases, alone and/ or in-combination.
Piling at the HVAC booster station search area	Minimal potential for overlap from Hornsea Four. No Tier 1a projects contribute in-combination, with Tier 1b in-combination remaining within the threshold in all scenarios. The addition of Tier 1c represents the main risk to the threshold, with minimal contribution from Tier 2	The contribution to the thresholds from piling at the HVAC is significantly less than piling within the array boundary (e.g. compare Figure 9 to Figure 10). The calculations are made on a worst case basis, and it is clear that potential for overlap from piling at the HVAC is less than in the array and therefore the risk is less than that described for array piling.	Risk is far less than piling within the array. Requirement for a SIP is understood to apply to all OWF within 26 km of the SNS SAC. The SIPs are provided for within individual project DCOs or the Review of Consents (as relevant) and provide management and mitigation measures that ensure compliance with the thresholds in all cases, alone and/ or in-combination.
UXO clearance within the Hornsea Four array area	No potential for overlap and therefore no implications for the SNS SAC	Risk of exceedance of the daily 20% threshold for Horsnsea Four in-combination with Tier 1a projects on a maximum basis only. As Tier 1b (and then Tier 1c and 2) projects are added, risk rises on a minimum scenario basis (excluding double counting between projects). Risk of exceedance of the seasonal 10% threshold in-combination depending on the number of piling/UXO clearance days committed to in a	Requirement for a SIP is understood to apply to all OWF within 26 km of the SNS SAC. The SIPs are provided for within individual project DCOs or the Review of Consents (as relevant) and provide management and mitigation measures that ensure compliance with the thresholds in all cases, alone and/ or in-combination.

Project Element	Winter Season	Summer Season	Risk Management
		season by individual projects, location of any such activities and which projects are in a position to proceed.	
UXO clearance within the offshore ECC	Some locations are outside consideration of the SNS SAC. Potential for daily threshold exceedance in-combination depending on UXO location and which Tier is added. Seasonal threshold complied with when Tier 1a and Tier 1b included, with a risk of exceedance should Tier 1c be included (with minimum contribution from Hornsea Four, even assuming a worst case location clearance of 20 UXO).	Some locations are outside consideration of the SNS SAC. Potential for daily threshold exceedance in-combination depending on UXO location and activity at other projects. Potential for seasonal threshold exceedance in-combination depending on UXO location and activity at other projects. Seasonal threshold risk less than for piling (less contribution from Hornsea Four).	Requirement for a SIP is understood to apply to all OWF within 26 km of the SNS SAC. The SIPs are provided for within individual project DCOs or the Review of Consents (as relevant) and provide management and mitigation measures that ensure compliance with the thresholds in all cases, alone and/ or in-combination.
Geophysical and seismic survey	Contribution not calculated given lack of information on planned survey type, location and duration. Any contribution to thresholds expected to be within the footprint of effect from UXO clearance and controlled through the SIP. Given the location of the winter extents relative to Hornsea Four, any contribution would be limited to survey within a short section of the ECC in any case.		Requirement for a SIP is understood to apply to all OWF within 26 km of the SNS SAC. The SIPs are provided for within individual project DCOs or the Review of Consents (as relevant) and provide management and mitigation measures that ensure compliance with the thresholds in all cases, alone and/ or in-combination.

11.3.2.41 For the purposes of the assessment of AEoI in-combination for harbour porpoise, the methodology applied to the assessment alone for the Conservation Objectives concerned with the supporting habitats and processes, together with availability of harbour porpoise prey, within the SNS SAC, has been extended to consider the potential for effect from the above projects in-combination.

11.3.2.42 The Advice on Activities refers to supporting habitats as 'the characteristics of the seabed and water column' in the context of 'ensuring prey is maintained within the site'. Potential for supporting habitats and processes to be affected are considered within **Volume A2, Chapter 1: Marine Geology, Oceanography and Physical Processes**. That chapter has concluded at most a slight adverse effect (which is not considered significant in EIA terms), with no significant cumulative effects on physical processes identified. Further, the potential for an in-combination habitat loss during operation and maintenance of Hornsea Four is assessed below in **Section 11.3.3**, finding a conclusion of no AEoI.

11.3.2.43 There is, therefore, no AEoI to the supporting habitats and processes relevant to harbour porpoise and their prey for the SNS SAC from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the availability and density of suitable harbour porpoise prey will be maintained in the long-term.

Consideration of Bottlenose Dolphin

11.3.2.44 Drawing on the information presented in **Table 28,** just one project (Marr Bank and Berwick Bank) is identified to be assessed for bottlenose dolphin in-combination for potential temporal and spatial effects in relation to construction of Hornsea Four and bottlenose dolphin with connectivity to the Moray Firth SAC. Potential for in-combination effect from other projects are limited to the operation and maintenance phase and are considered under vessel disturbance.

11.3.2.45 Consideration of the potential for an in-combination effect on bottlenose dolphin applies the same conservation objectives as the assessment alone and effectively relate to the habitat (its structure and function, extent and distribution and the supporting processes on which the habitats depend) together with the population viability and distribution of the species throughout the site.

11.3.2.46 There is no potential for underwater noise alone and/ or in-combination to affect the habitats utilised by bottlenose dolphin. **Volume A2, Chapter 3: Fish and Shellfish Ecology** found the potential for effect on fish species to be slight at most, and therefore not significant in EIA terms. Impacts from underwater noise to fish are spatially limited and broadly restricted to the period of ensonification. Unlike marine mammals, fish are not necessarily fully displaced from an ensonified area and consequently will remain within the ensonified area during noisy events and so will still be present upon return of the bottlnose dolphins (should any bottlenose dolphins be displaced). Whilst noise can result in behavioural changes in fish, these are short lived and so will also not lead to any potential implications for hunting behaviour in bottlenose dolphin following cessation of the noise.

11.3.2.47 Given the relative scale and extent of the potential effects on fish species, combined with the scale and location of the relevant designated site (with Hornsea Four some

522 km distant and the Marr and Berwick Banks projects >200 km distant), there is, therefore, no AEoI to the supporting habitats relevant to bottlenose dolphin and their prey as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the supporting habitat for bottlenose dolphin prey will be maintained in the long-term.

11.3.2.48 The potential for Hornsea Four to contribute to any in-combination risk of injury (defined as risk of onset of PTS) with respect to bottlenose dolphin is considered to be negligible. That conclusion is reinforced by the number of individual animals potentially at risk from unmitigated piling from Hornsea Four alone, which for the project alone is less than one animal in all cases. For UXO clearance, the number of bottlenose dolphin potentially affected by Hornsea Four alone remains <1 individual. Such an effect is fully provided for within the MMMP and the anticipated requirement for a UXO-MMMP, with the mitigation area exceeding the <100 m range of effect (a precautionary maximum, being the minimum range feasible within the model). There is, therefore, no potential for AEoI with respect to injury (onset of PTS) for bottlenose dolphin for the Moray Firth SAC as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the population and distribution of bottlenose dolphin will be maintained in the long-term.

11.3.2.49 With respect to the potential for disturbance to result in an in-combination effect on the population and distribution of bottlenose dolphin (noting that the conservation objective refers to 'distribution of bottlenose dolphin throughout the site is maintained by avoiding significant disturbance of bottlenose dolphin[100]), the risk applies to bottlenose dolphin at considerable distance from the Moray Firth SAC (522km for Hornsea Four and >200km for Marr and Berwick Bank) and will therefore not have a direct effect on the distribution of individuals within the SAC itself. Further, the greater the distance between the project and the SAC, and the further offshore the potential for disturbance (given the coastal nature of the Moray Firth dolphins), the less certain it is that an individual bottlenose dolphin shows strong connectivity to the Moray Firth SAC.

11.3.2.50 The information for Marr and Berwick Bank is currently limited to a Scoping Report[101], which does not include information to enable an assessment of disturbance on bottlenose dolphin in-combination and notes that HRA screening has yet to be completed. The project website[102] notes that construction can start in 2024, with first power generation in 2027, which would imply potential for in-combination disturbance would relate to construction at Marr and Berwick Bank and pre-construction works at Hornsea Four only.

11.3.2.51 Despite the highly limited information on which to make an assessment in-combination, given the location of the projects, the timing of the works (and therefore the limited contribution by Hornsea Four to any such in-combination effect, in terms of distance and both quantiy and duration of activity), there is, therefore, no AEoI to the population and distribution of bottlenose dolphin as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the population and distribution of bottlenose dolphin will be maintained in the long-term.

[100] https://apps.snh.gov.uk/sitelink-api/v1/sites/8327/documents/59
[101] https://www.sserenewables.com/media/0t5n05b4/berwick-bank-wind-farm-offshore-scoping-report.pdf
[102] https://www.sserenewables.com/offshore-wind/projects/berwick-bank-and-marr-bank/

Consideration of Harbour Seal and Grey Seal

11.3.2.52 **Table 35** below, drawing on the information presented in **Table 7**, summarises the relevant projects to be assessed in-combination for potential temporal and spatial effects in relation to construction of Hornsea Four. It should be noted that the location of the projects screened in is such that each project is relevant to a different suite of transboundary sites. Further, the projects included are limited to those with potential for construction phase overlap – projects with operation and maintenance phase overlap are considered under vessel disturbance.

Table 35: Plans and Projects Relevant In-Combination to Harbour Seal and Grey Seal Sites.

Designated Site	Relevant Species	Project	Tier
The Wash and North Norfolk Coast SAC	Harbour seal	Norfolk Vanguard	1c
		Hornsea Three	1b
		Norfolk Boreas	1c
		EA One North	1c
		EA Two	1c
		Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2
		North Falls	3
		Round 4 – Leasing Area 3 (Bidding Area 2)	3
		Endurance CCS	3
Humber Estuary SAC	Grey seal	Hornsea Three	1b
		Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2
		Round 4 – Leasing Area 1 (Bidding Area 1)	3
		Round 4 – Leasing Area 2 (Bidding Area 1)	3
		Round 4 – Leasing Area 3 (Bidding Area 2)	3
		Endurance CCS	3
Humber Estuary Ramsar	Grey seal	Hornsea Three	1b
		Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2
		Round 4 – Leasing Area 1 (Bidding Area 1)	3
		Round 4 – Leasing Area 2 (Bidding Area 1)	3
		Round 4 – Leasing Area 3 (Bidding Area 2)	3
		Endurance CCS	3

Designated Site	Relevant Species	Project	Tier
Berwickshire and North Northumberland SAC	Grey seal	Marr Bank and Berwick Bank	2
Doggersbank SCI	Harbour seal and grey seal	Hornsea Three	1b
		Dogger Bank A	1a
		Dogger Bank B	1a
		Dogger Bank C	1a
		Sofia	1a
		Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2
		Round 4 Leasing Area 1 (Bidding Area 1)	3
		Round 4 Leasing Area 2 (Bidding Area 1)	3
		Round 4 Leasing Area 3 (Bidding Area 2)	3
		Endurance CCS	3
	Grey seal only	Norfolk Boreas	1c
Klaverbank SCI	Harbour seal and grey seal	Norfolk Vanguard	1c
		Hornsea Three	1b
		Norfolk Boreas	1c
		Dogger Bank A	1a
		Dogger Bank B	1a
		Dogger Bank C	1a
		Sofia	1a
		Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions	2
		Round 4 - -Leasing area 1 (Bidding Area 1)	3
		Round 4 - -Leasing Area 2 (Bidding Area 1)	3
		Round 4 – Leasing Area 3 (Bidding Area 2)	3
		Endurance CCS	3
Bancs des Flandres SCI	Grey seal	EA One North	2c
		EA Two	2c
Vlaamse Banken SCI	Grey seal	Norfolk Vanguard	1c
		EA One North	1c
		EA Two	1c
SBZ 1 SCI	Grey seal	EA One North	1c
		EA Two	1c
SBZ 2 SCI	Grey seal	EA One North	1c
		EA Two	1c
SBZ 3 SCI	Grey seal	EA One North	1c
		EA Two	1c
Vlakte van de Raan SCI	Grey seal	Norfolk Vanguard	1c

Designated Site	Relevant Species	Project	Tier
		EA One North	1c
		EA Two	1c
Westerschelde & Saeftinghe SCI	Grey seal	Norfolk Vanguard	1c
		EA One North	1c
		EA Two	1c
Voordelta SCI	Grey seal	Norfolk Vanguard	1c
		Norfolk Boreas	1c
		EA One North	1c
		EA Two	1c
Noordzeekustzone SCI	Grey seal	Norfolk Vanguard	1b
		Hornsea Three	1b
		Norfolk Boreas	1c
		EA One North	1c
		EnBW He Dreiht	1a
Waddenzee SCI	Grey seal	Norfolk Vanguard	1c
		Norfolk Boreas	1c
		EnBW He Dreiht	1a

11.3.2.53 There is currently no information available at the time of writing for the Tier 3 projects to enable an assessment to be made (specifically no information on the timescale or nature of the project).

11.3.2.54 Consideration of the potential for an in-combination effect on harbour seal and grey seal, on a site by site basis, applies the same conservation objectives as the assessment alone. For harbour seal and grey seal, the relevant points effectively relate to the habitat (its structure and function, extent and distribution and the supporting processes on which the habitats depend) together with the population and distribution of the species.

11.3.2.55 For both species, there is no potential for underwater noise alone and/ or in-combination to affect the habitats utilised by seals. **Volume A2, Chapter 3: Fish and Shellfish Ecology** found the potential for effect on fish species to be slight at most, and therefore not significant in EIA terms. Impacts from underwater noise to fish are spatially limited and broadly restricted to the period of ensonification. Unlike marine mammals, fish are not necessarily fully displaced from an ensonified area and consequently will remain within the ensonified area during noisy events and so will still be present upon return of the seals (should any seals be displaced). Whilst noise can result in behavioural changes in fish, these are short lived and so will also not lead to any potential implications for hunting behaviour in seals following cessation of the noise. Given the relative scale and extent of the potential effects on fish species, combined with the scale and location of the relevant designated sites and the wide ranging nature of seals, there is, therefore, no AEoI to the supporting habitats relevant to harbour seal and grey seal and their prey for any of the sites under consideration as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the supporting habitat for grey seal and harbour seal prey will be maintained in the long-term.

11.3.2.56 The potential for Hornsea Four to contribute to any in-combination risk of injury (defined as risk of onset of PTS) with respect to harbour seal and grey seal is considered to be negligible. That conclusion is reinforced by the number of individual animals potentially at risk from unmitigated piling, which for the project alone is less than one animal in all cases, based on a PTS range of <100 m (a precautionary maximum, being the minimum range feasible within the model). For UXO clearance, the number of harbour seal potentially affected remains <1 individual and for grey seal during UXO clearance, only runs the risk of rising above 1 individual for the larger charge weights (therefore only likely to occur for a fraction of the total UXO clearances anticipated). Such an effect is fully provided for within the MMMP and the anticipated requirement for a UXO-MMMP, with the mitigation area exceeding the <100 m range of effect. There is, therefore, no potential for AEoI with respect to injury (PTS) for harbour seal or grey seal for any of the sites under consideration as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the population and distribution of grey seal and harbour seal will be maintained in the long-term.

11.3.2.57 With respect to the potential for an in-combination effect on the population and distribution of harbour seal and grey seal, the risk applies to harbour seal and grey seal at sea regardless of the site within which they are associated and therefore is considered here on a species by species basis (not withstanding seals from some sites having a greater potential for connectivity with the region around Hornsea Four than others, as highlighted for the Humber Estuary within **Appendix G**). It should be noted that Section 4.12.1 of **Volume A2, Chapter 4: Marine Mammals** excluded harbour seal from the cumulative assessment 'due to the extremely low levels of impact on this species from the project alone assessment'.

11.3.2.58 **Volume A2, Chapter 4: Marine Mammals** in Section 4.12.2 identifies the potential for construction phase underwater noise from Tier 1 projects (analogous to the Tier 1a projects considered here), finding the potential for a temporary disturbance of up to 1.9 % of the grey seal reference population. The effect was considered to be of minor magnitude, with reproductive rates of individuals potentially impacted in the short term (over a limited number of breeding cycles), and a significance of slight. When the Chapter added in Tier 2 (analogous to the Tier 1b considered here), the temporary average disturbance of the reference population given is up to 2.3 %, with the conclusion remaining as for Tier 1 projects. Finally, the ES added in Tier 3, 4 and 5 projects (referred to as Tier 1c onwards here). As a worst case, the proportion of the reference population that may be disturbed would rise to 4.1% (Tier 3), rising to 13.4% (Tier 5). While the magnitude increased slightly to moderate from Tier 4 onwards (temporary changes in behaviour and/or distribution of individuals at a scale that would result in potential reductions to lifetime reproductive success to some individuals (although not enough to affect the population trajectory over a generational scale)), the conclusion on significance remained slight. The much lower density of harbour seal means that the potential for effect on that species would be significantly lower than for grey seal.

11.3.2.59 Specifically in relation to the Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions draft RIAA[103], it is noted that all transboundary marine mammal sites were screened out on a basis of no LSE, with no information available at the time of writing to include the Tier 3 projects in an in-combination assessment.

[103] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

Table 36: Potential for AEoI with Respect to Harbour Seal and Grey Seal Population and Distribution (Disturbance).

Designated Site	Relevant Species	Assessment	Conclusion
The Wash and North Norfolk Coast SAC	Harbour seal	Very low levels of harbour seal are found at Hornsea Four, with the Marine Mammal Chapter finding the levels so low that no cumulative assessment was required. Whilst harbour seals found within the area impacted by Hornsea Four may originate from the Wash and North Norfolk Coast SAC (between 1 and 5 individuals, and at most that would be up to approximately 0.16% of the Wash population), these are very low numbers (both in total and as a proportion of the population) and, with the MMMP mitigating any potential for injury, the only risk is temporary, intermittent and short term disturbance. Due to the ability of harbour seals to tolerate periods of fasting (e.g. from disturbance), there is no potential for the short term and temporary disturbance from Hornsea Four, on the outer limit of at sea usage for harbour seals associated with the SAC, to contribute in any meaningful way to an in-combination effect on the harbour seal population at the Wash and North Norfolk Coast SAC.	No AEoI
Humber Estuary SAC	Grey seal	The in-combination assessment includes Hornsea Four, Hornsea Three and the Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions only; construction at all other projects is either beyond the screening range applied, outwith the temporal timeframe for Hornsea Four construction or the projects are Tier 3 and no information is available at the time of writing to include in-combination. The cumulative assessment in **Volume A2, Chapter 4: Marine Mammals** found the potential for grey seal disturbance at Hornsea Four and Tier 2 OWF (including Hornsea Three) to overlap, i.e. the disturbance would not be additive, with very little difference in overall disturbance levels when the two projects were combined (i.e. no meaningful in-combination effect will result). For Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions, the draft RIAA[104] found the potential for construction combined to disturb between 0.5 and 1.4% of the Humber grey seal population (noting that the population applied had not been corrected for at sea usage, resulting in a precautionary assessment). The timeframes for works at Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions are not confirmed, however the draft RIAA indicates the earliest start date is 2024, with offshore works to follow in 2026, meaning that construction is most likely to occur during pre construction works at Hornsea Four. Given that the assessment for the Humber Estuary grey seal population presented in **Section 10.3.3** for Hornsea Four alone is no AEoI, with up to 2.6% of the Humber grey seal population potentiall disturbed on a temporary, intermittent and short term basis (and less than that likely to be disturbed in the pre-construction period), combined with the precautionary 0.5-1.4% that may be disturbed during construction at Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions, the very small proportion of the total population that may be disturbed, the tolerance of grey seals to such disturbance and the widespread availability of alternative habitat if required concludes that	No AEoI
Humber Estuary Ramsar	Grey seal		No AEoI

[104] https://commonplace-customer-files.s3-eu-west-1.amazonaws.com/sepanddep/Draft+Information+for+Habitats+Regulations+Assessment.pdf

Designated Site	Relevant Species	Assessment	Conclusion
		there is no potential for the short term and temporary disturbance from Hornsea Four, Hornsea Three and Sheringham Shoal and Dudgeon Offshore Wind Farm Extensions to result in an in-combination effect on the grey seal population at the Humber Estuary SAC and Ramsar.	
Berwickshire and North Northumberland SAC	Grey seal	The SAC is located at a considerable distance from the area of potential disturbance associated with Hornsea Four (171 km) with a number of other foraging grounds apparent for the colony, with uncertainty around the construction window for Marr Bank and Berwick Bank. Given the not significant effect at population level, and the relatively low connectivity at site level, there is no potential for the short term and temporary disturbance from Hornsea Four to contribute in any meaningful way to any in-combination effect on the grey seal population at the Berwickshire and North Northumberland SAC.	No AEoI
Doggersbank SCI	Harbour seal	Although the Doggersbank SCI is within screening range of Hornsea Four (with all the Dogger projects being much closer), the at sea usage of harbour seals from the UK do not show significant connectivity (see Figures 32 and 33 of **Volume A5, Annex 4.1: Marine Mammals Technical Report**), indicating that the location of Hornsea Four does not appear to lie between UK coastal harbour seal sites and the Doggersbank SCI. Further, Figure 34 from the same report similarly does not show significant connectivity between the Dutch coast. In any case, the very low contribution of Hornsea Four to potential disturbance means that Hornsea Four will not make any meaningful contribution to any in-combination effect results in a conclusion of no AEoI on the Doggersbank SCI population.	No AEoI
	Grey seal	Although the Doggersbank SCI is within screening range of Hornsea Four (with all the Dogger projects being much closer), the at sea usage of grey seals from the UK shows limited connectivity, having greater activity to the west of the SCI (see Figures 37 and 38 of **Volume 5, Annex 4.1: Marine Mammals Technical Report**), indicating that the location of Hornsea Four does not appear to lie between UK coastal grey seal sites and the Doggersbank SCI. Figures 40 and 41 from the same report appears to show greater connectivity between the Doggersbank SCI and the Dutch coast (although the seal track in question ranges very widely). Despite being within the screening range of Hornsea Four, the SCI lies beyond the range of disturbance effect and there do not appear to be significant linkages between the areas of sea, with no potential for Hornsea Four to result in any meaningful contribution to any in-combination effect on the Doggersbank SCI population.	No AEoI
Klaverbank SCI	Harbour seal and grey seal	The assessment for the Klaverbank SCI mirrors that for the Doggersbank SCI above. Although the Klaverbank lies to the south of the Doggersbank SCI, the observations on at sea usage by harbour seal and grey seal apply equally to both SCIs, with the potential for impact from Hornsea Four remaining the same; specifically that the at sea usage data indicates seals associated with the Dutch coast have limited connectivity to SACs on the UK east coast. Despite being within the screening range of Hornsea Four, the SCI lies beyond the range of disturbance	No AEoI

Designated Site	Relevant Species	Assessment	Conclusion
		effect and there do not appear to be significant linkages between the areas of sea, with no potential for Hornsea Four to result in any meaningful contribution to any in-combination effect on the Klaverbank SCI population.	
Bancs des Flandres SCI	Grey seal	The Bancs des Flandres SCI is located some 296 km from Hornsea Four, with the potential for in-combination effect coming from two projects awaiting a decision on consent (East Anglia One North and East Anglia Two; referred to here as Tier 1c projects). There is therefore limited potential for an in-combination effect with any degree of certainty. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal as a result of Hornsea Four in-combination.	No AEoI
Vlaamse Banken SCI	Grey seal	The Vlaamse Banken SCI is located some 278 km from Hornsea Four, with the potential for in-combination effect coming from Norfolk Vanguard, East Anglia One North and East Anglia Two, all awaiting a decision on consent and referred to here as Tier 1c projects. There is therefore limited potential for an in-combination effect with any degree of certainty, with all three projects lying between Hornsea Four and the SCI in any case. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal as a result of Hornsea Four in-combination.	No AEoI
SBZ 1 SCI SBZ 2 SCI SBZ 3 SCI	Grey seal	The SCIs are all located >300 km from Hornsea Four, with the potential for in-combination effect associated with two projects (East Anglia One North and East Anglia Two) awaiting a decision on consent (referred to here as Tier 1c projects). There is limited potential for an in-combination effect with any degree of certainty. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal as a result of Hornsea Four in-combination.	No AEoI
Vlakte van de Raan SCI	Grey seal	The Vlakte van de Raan SCI is located some 292 km from Hornsea Four, with the potential for in-combination effect coming from Norfolk Vanguard, East Anglia One North and East Anglia Two, all awaiting a decision on consent and referred to here as Tier 1c projects. There is limited potential for an in-combination effect with any degree of certainty, with all three projects lying between Hornsea Four and the SCI in any case. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaning ful contribution to any significant effect on the population and distribution of grey seal from Hornsea Four in-combination.	No AEoI
Westerschelde & Saeftinghe SCI	Grey seal	The Westerschelde & Saeftinghe SCI is located some 301 km from Hornsea Four, with the potential for in-combination effect coming from Norfolk Vanguard, (East Anglia One North and East Anglia Two, all awaiting a decision on consent and referred to here as Tier 1c projects. There is limited potential for an in-combination effect	No AEoI

Designated Site	Relevant Species	Assessment	Conclusion
		with any degree of certainty, with all three projects lying between Hornsea Four and the SCI in any case. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal as a result of Hornsea Four in-combination.	
Voordelta SCI	Grey seal	The Voordelta SCI is located some 272 km from Hornsea Four, with the potential for in-combination effect coming from Norfolk Vanguard, Norfolk Boreas, East Anglia Two and East Anglia One North, all awaiting a decision on consent and referred to here as Tier 1c projects. Despite the increase in potential project activity, all have significant uncertainty, and all lie between Hornsea Four and the SCI. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal from Hornsea Four in-combination.	No AEoI
Noordzeekustzone SCI	Grey seal	The Noordzeekustzone SCI is located some 221 km from Hornsea Four, with the potential for in-combination effect coming from EnBW He Dreiht, Norfolk Vanguard, Norfolk Boreas, East Anglia Two and East Anglia One North (all UK projects awaiting a decision on consent). Despite the increase in potential project activity, a number have significant uncertainty, and all UK projects lie between Hornsea Four and the SCI. Further, the non UK project do not have consent and it is therefore not certain that there will be any overlap of construction activity. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal from Hornsea Four in-combination.	No AEoI
Waddenzee SCI	Grey seal	The Waddenzee SCI is located some 229 km from Hornsea Four, with the potential for in-combination effect coming from EnBW He Dreiht, Norfolk Vanguard and Norfolk Boreas. Both the UK projects lie between Hornsea Four and the SCI, with the non UK project not having a decision on consent and it is therefore not certain that there will be any overlap of construction activity. Compounded with the considerable distance between SCI and Hornsea Four, with numerous foraging grounds in between both locations, there is no potential for any meaningful contribution to any significant effect on the population and distribution of grey seal as a result of Hornsea Four in-combination.	No AEoI

11.3.2.60 There is, therefore, no AEoI to the population and distribution of harbour seal and grey seal for any of the sites under consideration as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the population and distribution of grey seal and harbour seal will be maintained in the long-term.

Vessel Disturbance

11.3.2.61 The potential for an AEoI in-combination as a result of vessel disturbance on marine mammals during construction and decommissioning relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to, and potentially less than, those outlined in the construction phase.

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- The Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary sites (two sites for harbour seal); and
- Transboundary sites (twelve sites for grey seal).

11.3.2.62 The cumulative assessment presented in **Volume A2, Chapter 4: Marine Mammals** considers the potential for disturbance to marine mammals from vessels as part of the overall risk of disturbance from projects resulting from underwater noise. Effectively, it is difficult to separate the two out, with the potential for disturbance from vessels tending to sit inside (and being less in terms of extent) the potential for disturbance from activities such as piling. Further, the localised nature of vessel disturbance to individual projects, and the widespread nature of those projects, within the context of the overall habitat availability for harbour porpoise, bottlenose dolphin, harbour seal and grey seal means that the potential for an in-combination effect is minimal. It should also be noted that for many of the projects identified in **Table 7**, the risk of an in-combination effect resulting from vessel related disturbance is essentially an ongoing issue as many are licensed activities that have been in operation for some time (and some would therefore be included to some degree within the baseline level of shipping activity assessed for Hornsea Four). For example, **Volume A5 Annex 7.1: Navigation Risk Assessment** reports on shipping and navigation baseline data collected through the period 2019-2021. The shipping and navigation data collected (and therefore the existing vessel movements applied as baseline) will therefore include vessel movements associated with offshore wind farms operational prior to 2019 (for example both East Anglia ONE and Hornsea Project One were completed in 2019 and therefore the later navigation surveys would cover the operational phases only).

11.3.2.63 Jones et al. (2017) presents an analysis of the predicted co-occurrence of ships and seals at sea which demonstrates that UK wide there is a large degree of predicted co-occurrence, particularly within 50 km of the coast close to seal haul-outs. There is no evidence relating decreasing seal populations with high levels of co-occurrence between ships and animals. In fact, in areas where seal populations are showing high levels of growth (e.g. southeast England) ship co-occurrences are highest (Jones et al.

2017). Thomsen et al. (2006) estimated that both harbour and grey seals will respond to both small (~2 kHz) and large (~0.25 kHz) vessels at approximately 400 m. The potential for underwater noise from vessels during construction to disturb seal and grey seals will therefore be significantly less than that resulting from piling disturbance and highly localised to the vessel. Any disturbance associated with vessel movements would be contained within the footprint of wider construction level disturbance and would not significantly add to that.

11.3.2.64 As regards risk of in-combination vessel disturbance during construction for harbour seal and grey seal, in line with the conclusions for disturbance from piling activity (**Table 36**) it can therefore be concluded that no AEoI will result to the habitat (its structure and function, extent and distribution and the supporting processes on which the habitats depend) together with the population and distribution of the species of harbour seal and grey seal for any of the sites under consideration as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the population and distribution of grey seal and harbour seal will be maintained in the long-term.

11.3.2.65 For harbour porpoise, the 2019 advice on operations within the SNS SAC[105] found that although it is expected that overall shipping levels are expected to increase as a result of increased wind farm activity in the North Sea, given the existing levels of shipping in the area it is unlikely that additional management measures will be required. Further, it identified that significant increases in vessel traffic associated with wind farm activity would require assessment – with that assessment for the project alone presented above in **Section 10.3.3**. For the assessment alone during construction, any vessel disturbance was found to be within the footprint of any disturbance resulting from other project activities such as piling. The potential for piling related disturbance in-combination to affect harbour porpoise is controlled by the SIP, thus ensuring no AEoI will result.

11.3.2.66 As regards risk of in-combination vessel disturbance during construction for harbour porpoise and the SNS SAC, there is, therefore, no AEoI from Hornsea Four in-combination and therefore, subject to natural change, the harbour porpoise will be maintained in the long-term.

11.3.2.67 For bottlenose dolphin, the relevant site is the Moray Firth SAC, located some 522 km to the north of Hornsea Four. Projects screened in in-combination are the Marr Bank and Berwick Banks (currently available as a Scoping Report only, with insufficient information for inclusion in an assessment) together with Moray West and Moray East; the latter projects, both of which are considerably closer to the SAC than Hornsea Four (17 km and 36 km respectively) expected to be operational by the time construction starts at Hornsea Four. The projects concluded no AEoI for the Moray Firth SAC and, given the remote location of Hornsea Four in comparison, located at the southerly lmit of the potentil range of bottlenose dolphin that may show connectivity to the SAC, will not contribute in any meaningful way to any in-combination effect resulting from vessel disturbance.

11.3.2.68 As regards risk of in-combination vessel disturbance during construction for bottlenose dolphin and the Moray Firth SAC, there is, therefore, no AEoI from Hornsea Four in-

[105] http://data.jncc.gov.uk/data/206f2222-5c2b-4312-99ba-d59dfd1dec1d/SouthernNorthSea-conservation-advice.pdf

combination and therefore, subject to natural change, the bottlenose dolphin feature will be maintained in the long-term.

Vessel Collision Risk

11.3.2.69 The potential for an AEoI in-combination as a result of vessel collision risk on marine mammals during construction and decommissioning relates to the following designated sites and the relevant feature (i.e. those features screened in for potential LSE). The potential for LSE during decommissioning would be similar to, and potentially less than, those outlined in the construction phase.

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal); and
- Berwickshire and North Northumberland Coast SAC (grey seal).

11.3.2.70 There is currently a lack of information on the frequency of occurrence of vessel collisions as a source of marine mammal mortality. There is little evidence from marine mammals stranded in the UK that injury from vessel collisions is an important source of mortality. The UK Cetacean Standings Investigation Programme (CSIP) data (cited in **Volume A2, Chapter 4: Marine Mammals**) shows that very few standings have been attributed to vessel collisions, therefore, while there is evidence that mortality from vessel collisions can and does occur, it is not considered to be a key source of mortality highlighted from post mortem examinations.

11.3.2.71 Harbour porpoise, bottlenose dolphins and seals are relatively small and highly mobile, and given observed responses to noise, are expected to detect vessels in close proximity and largely avoid collision. Predictability of vessel movement by marine mammals is known to be a key aspect in minimising the potential risks imposed by vessel traffic (e.g. Nowacek et al. 2001; Lusseau 2003, 2006). The vessel management plan for Hornsea Four (a document typically produced for offshore wind farms) will ensure that vessel traffic moves along predictable routes and will define how vessels should behave in the presence of marine mammals. Further, it is highly likely that a proportion of vessels will be stationary or slow moving throughout construction activities for significant periods of time, particularly smaller vessels. Therefore, the actual increase in vessel traffic moving around the site and to/from the port to the site will occur over short periods of the offshore construction activity.

11.3.2.72 **Volume A2, Chapter 4: Marine Mammals** found, in Section 4.12.2 that it is extremely difficult to reliably quantify the increased vessel collision risk to marine mammals resulting from increased vessel activity on a cumulative basis, given the large degree of temporal and spatial variation in vessel movements between projects and regions, coupled with the spatial and temporal variation in marine mammal movements across the region. In addition, vessel routes to and from offshore windfarms and other projects will use existing vessel routes where marine mammals will be accustomed to, and potentially habituated to, regular vessel movements and therefore the additional risk is confined mainly to construction sites. Vessel movements within construction areas are likely to be limited and relatively slow. In addition, most projects (and including Hornsea

Four) are likely to adopt vessel management plans in order to minimise any potential effects on marine mammals. Overall, the chapter found that the increases risk in-combination is low, with no predicted significant effect on the trajectory or size of any marine mammal population. The significance of effect was found to be slight, which is not significant in EIA terms.

11.3.2.73 The potential for Hornsea Four to make a meaningful contribution to any in-combination effect on collision risk for individual marine mammals with connectivity to a designated site is similarly low risk for the same reasons as for the overall population. Specifically, the lack of any predicted significant effect on the populaitons, the key target of the conservation objectives and for many of the designated sites, the distance between Hornsea Four and the designated site.

11.3.2.74 It can therefore be concluded that Hornsea Four will not contribute to any in-combination vessel collision risk to any marine mammal species associated with the designated sites screened in for assessment and that there will be no AEoI to the marine mammal features of these sites as a result of vessel collision risk from Hornsea Four alone and/ or in-combination.

Accidental pollution

11.3.2.75 The potential for an AEoI as a result of accidental pollution during construction and decommissioning relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

- Southern North Sea SAC (Harbour porpoise).

11.3.2.76 The potential for accidental pollution to affect marine mammals was not considered in the ES (**Volume A2, Chapter 4: Marine Mammals**), given the project specific mitigation (contained within Table 4.9 of that chapter) and conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the ES. The reason for that is given as the development of a Marine Pollution Contingency Plan (MPCP), which will form part of a wider CPEMMP. The CPEMMP is provided for under Co111. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**).

11.3.2.77 It is noted that the above plans are included through Co111 (**Table 3**) and secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d).

11.3.2.78 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, enables the conclusion that there is, therefore, no AEoI to marine mammals in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the marine mammal feature will be maintained in the long term with respect to the potential for accidental pollution.

11.3.3 Operation and maintenance

Habitat Loss

11.3.3.1 The potential for an AEoI in-combination as a result of habitat loss on marine mammals during operation and maintenance relates to the following designated site and the relevant feature (i.e. the feature screened in for potential LSE):

- SNS SAC (harbour porpoise).

11.3.3.2 The question of habitat loss was raised by Natural England during consultation, specifically in relation to cable protection within the SNS SAC (see **Table 1**) and relates to concerns in-combination only – for Hornsea Four alone, any potential for impact is so small that it would be de minimis.

11.3.3.3 Calculations have been made here for Hornsea Four together with other projects listed within **Table 7** that have physical overlap with the SNS SAC (i.e. will have a range of 0km to the SNS SAC OR have a cable route that crosses the SNS SAC), to identify as a worst case the potential footprint per project within the SNS SAC boundary. That footprint could result from foundations, scour protection, cable protection and cable crossings, with the information identified drawn from relevant project literature. For projects yet to build, the worst case footprint has been assumed – for example for a foundation footprint, that would typically be gravity base together with scour protection and for cable protection, that would include the maximum percentage of cable that may require protection as well as cable crossings. For projects in construction or operation, the foundation type and number used has formed the basis of the assessment. Ancillery structures include all structures other than the WTGs, with an assumption on footprint made based on the worst case presented in the ES. Tier 3 projects have been excluded (as insufficient information is available).

11.3.3.4 The information presented below is based on the best available information sourced from relevant, named project documents. However, it should be noted that there was no requirement for the projects to calculate potential habitat loss within the SNS SAC and therefore the numbers available are not necessarily a fully accurate picture of individual project impact. Instead, these numbers should be seen as a worst case scenario – in that they take the assumed worst case footprint for all structures (including cabling and cable crossings) presented. The numbers are presented in km^2 and not the m^2 values – given the scale of the SNS SAC. It also allows for rounding up in the figures, as the level of precaution inherent in the numbers means that a more precise value (e.g. decimal place values for a m^2 number) would be disproportionate.

Table 37: Summary of In-combination project Footprints within the SNS SAC.

Information Source	Project Aspect	Maximum Footprint (km^2)	Assumed % within the SNS SAC[106]	Potential Habitat loss (km^2)
Hornsea Project One (operational) (Tier 1a)				
Project website and ES Chapter 3, Project Description	174 7 MW monopile turbines (installed), worst case footprint for monopiles plus scour per turbine (ES)	0.48	12%	0.06
	Ancillary structures (assumed based on ES vales)	0.03		0.00
	Array cable protection (10% of total)	0.45		0.05
	Export cable protection (25% of total)	1.5	22%	0.33
Hornsea Project Two (in construction) (Tier 1a)				
ES Chapter 3, Project Description	Turbine foundations	2.04	65%	1.33
	Ancillary structures	0.19		0.07
	Array cable protection	1.23		0.80
	Export cable protection	1.05	60%	0.63
East Anglia One (operational) (Tier 1a)				
Turbine numbers and jacket foundations (as constructed). All else ES Chapter 4 Description of Development and Chapter 9 Benthic and Epibenthic Environment (including Shellfish)	102 foundations, installed on jackets	0.12	100% of the array, 83% of the export cable corridor	0.12
	Ancillary structures	0.08		0.08
	Cable crossings	0.03		0.03
Viking Link (operational) (Tier 1a)				
Project ES (64km cable route across the SNS SAC, up to 29km cable protection along total cable length, assumed all that could fall within the SNS SAC)	Cable protection	0.64[107]	45%	0.29
East Anglia Three (Tier 1a)				
ES Chapter 5, Description of the Development	Wind turbine foundations	2.55	100%	2.55
	Ancillary structure foundations	0.13		0.13
	Cable protection	0.55	83%	0.46
Dogger Bank A (Tier 1a)				
ES Chapter 5 Project Description	Turbine foundations (120 turbine and scour)	0.74	100%	0.74

[106] For example, if 20% of the Hornsea Four array area falls within the SNS SAC, it is assumed that 20% of the potential habitat loss would occur within the SNS SAC
[107] Assumed cable protection assumed 10m width

Information Source	Project Aspect	Maximum Footprint (km²)	Assumed % within the SNS SAC[106]	Potential Habitat loss (km²)
	Ancillary structures[108]	0.1		0.1
	Array cable protection	0.04		0.04
	Export cable protection	1.4	30%	0.42
Dogger Bank B (Tier 1a)				
ES Chapter 5 Project Description	Turbine foundations (120 turbine and scour)	0.74	100%	0.74
	Ancillary structures[109]	0.1		0.1
	Array cable protection[110]	0.04		0.04
	Export cable protection	1.34	25%	0.34
Dogger Bank C (cable corridor only) (Tier 1a)				
ES Chapter 5 Project Description	Turbine foundations	0.68	0%	0
	Ancillary structures	0.12		0
	Array cable protection	2.15		0
	Export cable protection	2.41	40%	0.96
Sofia (Tier 1a)				
ES Chapter 5 Project Description	Turbine foundations (120 turbine and scour)	0.68	20%	0.14
	Ancillary structures	0.12		0.02
	Array cable protection	2.15		0.43
	Export cable protection	2.41	40%	0.96
Norfolk Vanguard (Tier 1c)				
ES Chapter 5, Project Description	Turbine foundations	11.03	100%	11.03
	Ancillary structures	0.09		0.09
	Array cable protection	0.41		0.41
	Export cable protection	0.08		0.08
Hornsea Three (cable corridor only) (Tier 1b)				
Environmental Statement: Volume A2, Chapter 2 - Benthic Ecology	Export cable protection	0.68	55%	0.38
	Cable crossing protection	0.66		0.36

[108] The values in the document are divided between foundation and scour protection, with indicative numbers presented. The figure here is an assumed value based on those.
[109] The values in the document are divided between foundation and scour protection, with indicative numbers presented. The figure here is an assumed value based on those.
[110] Assumed to be equivalent to Dogger Bank A

Information Source	Project Aspect	Maximum Footprint (km^2)	Assumed % within the SNS SAC[106]	Potential Habitat loss (km^2)
Norfolk Boreas (Tier 1c)				
ES Chapter 5, Project Description	Turbine foundations and scour protection	5.65	98%	5.54
	Ancillary structures	0.08		0.08
	Array cable protection	0.03		0.03
	Export cable protection	0.03	100%	0.03
East Anglia One North (Tier 1c)				
ES Chapter 9, Benthic Ecology	Turbine foundations	1.35	100%	1.35
	Ancillary structures	0.08		0.08
	Array cable protection	0.34		0.34
	Export cable prrotection	0.11	83%	0.09
East Anglia Two (Tier 1c)				
ES, Chapter 9, Benthic Ecology	Turbine foundations	1.53	100%	1.53
	Ancillary structure foundations	0.08		0.08
	Array cable protection	0.31		0.31
	Export cable protection	0.11		0.11
Dana Petroleum platypus (being decommissioned) (Tier 1a)				
Works being decommissioned – therefore seabed expected to be gained				
Johnstone Template Manifold (being decommissioned) (Tier 1a)				
Works being decommissioned – therefore seabed expected to be gained				
Johnstone WHP (being decommissioned) (Tier 1a)				
Works being decommissioned – therefore seabed expected to be gained				
Endurance CCS (Tier 3)				
No information currently in the public domain at the time of writing to enable any estimate to be made.				

11.3.3.5 There is currently no information available at the time of writing for Tier 3 projects to enable an assessment to be made (specifically no information on the location, type or scale).

11.3.3.6 In total, and as a worst case scenario, the in-combination footprint of all projects in-combination (excluding Hornsea Four) would equate to approximately 33.88 km^2 (not counting the 'release' of habitat following decommissioning of a number of the projects or the anticipation that many projects in construction and planning will install piled foundations and not the worst case assumption of gravity bases). Given that the SNS

SAC extends to some 36,950.54 km^2, that represents approximately 0.09% of the SNS SAC. It should also be noted that this does not equate to harbour porpoise habitat – but purely to habitat that may be used by harbour porpoise prey. In that context, such a loss of habitat would be de minimis.

11.3.3.7 The contribution of Hornsea Four as a worst scenario to that total, resulting from foundations, foundation protection, cable crossings and cable protection has been calculated. **Volume A2 Chapter 2: Benthic and Intertidal Ecology** calculated the maximum benthic habitat change, assuming a worst case foundation of suction buckets and maximum use of cable protection. As a maximum, that would extend to some 3.77km^2, across the whole project including a substantial proportion within the export cable corridor (1.28km^2), the majority of which will fall outside the SNS SAC, in particular the cable crossing element. Even including the cable corridor works, the total equates to approximately 0.01% of the total area of the SNS SAC. Excluding cable corridor works, that total reduces to 2.49km^2 or 0.007% of the SNS SAC. The potential for such habitat change during the operation phase (as a worst case maximum) is negligible in the context of the overall available habitat and the negligible potential for impact on prey species (as concluded in **Volume A2 Chapter 2: Benthic and Intertidal Ecology**). Any contribution by Hornsea Four to the de minimis total in-combination is therefore inconsequential.

11.3.3.8 It can therefore be concluded that Hornsea Four will not contribute to any in-combination benthic habitat change within the SNS SAC, in relation to habitat that may be used by harbour porpoise prey species, and that there will be no AEoI to the harbour porpoise feature of the site as a result of habitat change associated with Hornsea Four alone and/ or in-combination.

Increase in Underwater Noise

11.3.3.9 The potential for an AEoI in-combination as a result of underwater noise on marine mammals during operation and maintenance relates to the following designated site and the relevant feature (i.e. the feature screened in for potential LSE):

- SNS SAC (harbour porpoise).

11.3.3.10 Operational noise in relation to Hornsea Four is highlighted in Table 4.8 of **Volume A2, Chapter 4: Marine Mammals** , specifically that no likely significant effect was concluded at PEIR and therefore the issue is not discussed in detail in the ES – including both the alone and cumulative assessments.

11.3.3.11 A summary of operational noise from Hornsea Four alone is provided above in **Section 10**. The conclusion of no risk of PTS for the project alone removes the possibility of any contribution to an in-combination total and therefore results in a conclusion of no AEoI in-combination. Similarly, the risk to harbour porpoise prey alone is viewed as negligible, being an effect only at very close range to individual turbines. Such a small and localised effect from projects dispersed across the SNS SAC does not have the potential to result in any material changes to prey distribution or availability and so does not have the potential to contribute to any AEoI in-combination.

11.3.3.12 As regards the risk of disturbance to harbour porpoise from operational noise from Hornsea Four in-combination, the low level and localised nature of sound predicted to result from individual turbines, combined with the lack of evidence in general of displacement of harbour porpoise following construction of an offshore wind farm, supports the conclusion that any response would be highly localised to individual turbines, with no alteration of distribution or range of harbour porpoise within the SAC. The lack of any significance is supported by the Marine Mammal chapter, with the effect effectively scoped out of further assessment for all species. There is therefore no potential for Hornsea Four to contribute in any meaningful way to any in-combination effect.

11.3.3.13 It is therefore concluded that operational noise from Hornsea Four alone and/ or in-combination will not, subject to natural change, result in any AEoI and that the marine mammal feature will be maintained in the long term with respect to operational noise.

Vessel Disturbance

11.3.3.14 The potential for an AEoI in-combination as a result of vessel disturbance on marine mammals during operation and maintenance relates to the following designated sites and the relevant features (i.e. the features screened in for potential LSE):

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- The Wash and North Norfolk Coast SAC (harbour seal);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal);
- Berwickshire and North Northumberland Coast SAC (grey seal);
- Transboundary sites (two sites for harbour seal); and
- Transboundary sites (twelve sites for grey seal).

11.3.3.15 **Volume A2, Chapter 4: Marine Mammals** considers the potential for disturbance to marine mammals from vessels as part of the overall risk of disturbance from projects resulting from underwater noise. Effectively, it is extremely difficult to reliably quantify the level of increased noise related disturbance to marine mammals resulting from increased vessel activity on a cumulative basis, given the large degree of temporal and spatial variation in vessel movements between projects and regions, coupled with the spatial and temporal variation in marine mammal movements across the region. Operational noise for Hornsea Four is effectively scoped out of further assessment within the ES.

11.3.3.16 Vessel routes to and from offshore windfarms and other projects will use existing vessel routes where marine mammals will be accustomed to regular vessel movements and therefore the underwater noise from vessels will already be an existing feature of the ambient noise landscape. Vessel activity within array areas are likely to be limited and relatively slow. Increases in underwater noise from vessels during the operational phases of projects are likely to be small in relation to current and ongoing levels of shipping. The potential for effect is predicted to be highly localised, intermittent and reversible for the duration of all projects. Such a low-level additional contribution to existing levels of shipping disturbance is not predicted (Table 4.8 of **Volume A2, Chapter 4: Marine**

Mammals) to have a significant effect on any marine mammal population, with no anticipated changes to range or distribution of any species. There is therefore no potential for Hornsea Four to contribute in any meaningful way to any in-combination effect. It can therefore be concluded that therefore, no AEoI will result from vessel related disturbance for any of the sites under consideration as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the features will be maintained in the long-term.

Vessel Collision Risk

11.3.3.17 The potential for an AEoI in-combination as a result of vessel collision risk on marine mammals during operation and maintenance relates to the following designated sites and the relevant features (i.e. the features screened in for potential LSE):

- Southern North Sea SAC (harbour porpoise);
- Moray Firth SAC (bottlenose dolphin);
- Humber Estuary SAC (grey seal);
- Humber Estuary Ramsar (grey seal); and
- Berwickshire and North Northumberland Coast SAC.

11.3.3.18 **Volume A2, Chapter 4: Marine Mammals** considers the potential for disturbance to marine mammals from vessels during operation and maintenance in Table 4.8, with the risk of collision during the operation and maintenance phase effectively scoped out of assessment. The reason for the assessment is that it is not expected that the level of vessel activity during operation and maintenance would cause an increase in the risk of mortality from collisions. The adoption of a vessel management plan (Commitment Co108 in Table 3) will minimise the potential for any impact.

11.3.3.19 Given that, in the context of existing shipping levels, the increase in vessel traffic proposed during operation and maintenance at Hornsea Four (in the context of relevant project mitigation) is insufficient to result in an increase in the risk of mortality or injury in marine mammals as a result of collisions, there is therefore no potential for Hornsea Four to contribute in any meaningful way to any in-combination effect. That assessment applies equally to all marine mammals and therefore includes harbour porpoise that may be associated with the SNS SAC, bottlenose dolphin that may be associated with the Moray Firth SAC as well as grey seal that may be connected to the Humber Estuary SAC and Ramsar or the Berwickshire and North Northumberland Coast SAC, given the localised nature of any effect.

11.3.3.20 It can therefore be concluded that therefore, no AEoI will result from vessel collision risk for any of the sites under consideration as a result of Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the features will be maintained in the long-term.

Accidental pollution

11.3.3.21 The potential for an AEoI as a result of accidental pollution during operation and maintenance relates to the following designated site and the relevant features (i.e. those features screened in for potential LSE):

- Southern North Sea SAC (Harbour porpoise).

11.3.3.22 The potential for accidental pollution to affect marine mammals was not considered in the ES (**Volume A2, Chapter 4: Marine Mammals**), given the project specific mitigation (contained within Table 4.9 of that chapter) and conclusion of no significant effect, which enabled the effect to be scoped out from assessment in the ES. The reason for that is given as the development of a Marine Pollution Contingency Plan (MPCP), which will form part of a wider CPEMMP. The CPEMMP is provided for under Co111. A similar approach to screening out the effect has not been applied to the RIAA, in response to comments received from Natural England (**Table 1**).

11.3.3.23 It is noted that the above plans are included through Co111 (**Table 3**) and secured in the DCO through Schedule 11, Part 2 - Condition 13(1)(d) and Schedule 12, Part 2 - Condition 13(1)(d). Licence conditions for preventing accidental pollution are a standard requirement for all other plans and projects which may act in-combinaiton with Hornsea Four. There is therefore no potential for Hornsea Four to contribute in any meaningful way to any in-combination effect.

11.3.3.24 The implementation of the CPEMMP, produced in consultation with relevant bodies, and provided for in the DCO as above, enables the conclusion that there is, therefore, no AEoI to marine mammals in relation to accidental pollution from Hornsea Four alone and/ or in-combination and therefore, subject to natural change, the marine mammal feature will be maintained in the long term with respect to the potential for accidental pollution.

11.4 Offshore Ornithology

11.4.1.1 A description of the significance of project level effects upon the receptors grouped under 'offshore ornithology', as relevant to the designated sites and their associated features screened in for LSE is provided below.

11.4.2 Construction and Decommissioning

11.4.2.1 Following the HRA Screening process undertaken for this RIAA, no potential effects were considered to require further assessment during the construction or decommissioning phase in-combination with other plans or projects. This is due to Hornsea Four having no proposed overlap with other projects within a reasonable distance which would result in a possible in-combination impact based on expert judgement at the same time, on the same features of designated sites reviewed for this RIAA. It is also due to the assessment alone for red-throated diver and common scoter at the Greater Wash SPA, gannet, guillemot, razorbill and puffin at FFC SPA, puffin at Coquet SPA, guillemot and puffin at the Farne Islands SPA as well as guillemot and puffin at the Northumberland Marine SPA alone assessments (summarised in **Table 38**) concluding potential for only a trivial and inconsequential effect that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect could occur.

Table 38: Summary of the sites and features considered for a disturbance and displacement assessment during construction and decommissioning phases for Hornsea Four in combination.

Site	Feature	Considered in-combination?
Greater Wash SPA	Red-throated diver during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Common scoter during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Flamborough and Filey Coast SPA	Gannet during breeding and non-breeding bio-season	No – no proposed overlap with other projects within a reasonable distance based on expert judgement that would result in a possible in-combination impact, based on expert judgement and species foraging range (woodward et al. 2019), would be considered to occur at the same time on the same features of designated sites reviewed for this RIAA.
	Guillemot during breeding and non-breeding bio-season	No – no proposed overlap with other projects within a reasonable distance based on expert judgement that would result in a possible in-combination impact, based on expert judgement and species foraging range (woodward et al. 2019), would be considered to occur at the same time on the same features of designated sites reviewed for this RIAA.
	Razorbill during breeding and non-breeding bio-season	No – no proposed overlap with other projects within a reasonable distance based on expert judgement that would result in a possible in-combination impact, based on expert judgement and species foraging range (woodward et al. 2019), would be considered to occur at the same time on the same features of designated sites reviewed for this RIAA.
	Puffin during breeding and non-breeding bio-season	No – no proposed overlap with other projects within a reasonable distance based on expert judgement that would result in a possible in-combination impact, based on expert judgement and species foraging range (woodward et al. 2019), would be considered to occur at the same time on the same features of designated sites reviewed for this RIAA.
Coquet Island SPA	Puffin during breeding and non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Farne Islands SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within

Site	Feature	Considered in-combination?
		the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during breeding and non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Northumberland Marine SPA	Guillemot during breeding and non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.

11.4.3 Operation and maintenance

Direct disturbance and displacement

11.4.3.1 The potential for offshore wind farms direct disturbance and displacement to result in an AEoI in-combination with Hornsea Four relates to the following designated site and the relevant features:

- Flamborough and Filey Coast SPA; gannet, guillemot, razorbill and puffin.

11.4.3.2 The remaining sites and features screened in for potential LSE during operation and maintenance phase are as follows:

- Greater Wash SPA; red-throated diver and common scoter during the non-breeding bio-season
- Coquet Island SPA; puffin during the breeding and non-breeding bio-seasons;
- Farne Islands SPA; guillemot during the non-breeding bio-season and puffin during the breeding and non-breeding bio-seasons;
- Northumberland Marine SPA; guillemot during the non-breeding bio-season and puffin during the breeding and non-breeding bio-seasons;
- St Abb's Head SPA; guillemot and razorbill during the non-breeding bio-season;
- Forth Islands (UK) SPA; guillemot, razorbill and puffin during the non-breeding bio-season;
- Outer Firth of Forth and St Andrew's Complex pSPA; guillemot and puffin during the non-breeding bio-season;
- Fowlsheugh SPA; guillemot and razorbill during the non-breeding bio-season;
- Buchan Ness to Collieston Coast SPA; guillemot during the non-breeding bio-season;

- Troup, Pennan and Lion's Heads SPA; guillemot and razorbill during the non-breeding bio-season;
- East Caithness Cliffs SPA; guillemot and razorbill during the non-breeding bio-season;
- North Caithness Cliffs SPA; guillemot, razorbill and puffin during the non-breeding bio-season;
- Copinsay SPA; guillemot during the non-breeding bio-season;
- Hoy SPA; guillemot and puffin during the non-breeding bio-season;
- Marwick Head SPA; guillemot during the non-breeding bio-season;
- Rousay SPA; guillemot during the non-breeding bio-season;
- Calf of Eday SPA; guillemot during the non-breeding bio-season;
- West Westray; guillemot and razorbill during the non-breeding bio-season;
- Fair Isle SPA; guillemot, razorbill and puffin during the non-breeding bio-season;
- Sumburgh Head SPA; guillemot during the non-breeding bio-season;
- Noss SPA; guillemot and puffin during the non-breeding bio-season;
- Foula SPA; guillemot, razorbill and puffin during the non-breeding bio-season; and
- Hermaness, Saxa, Vord and Valla Field SPA; guillemot and puffin during the non-breeding bio-season; guillemot and puffin during the non-breeding bio-season.

11.4.3.3 For the assessment alone for red-throated diver and common scoter at the Greater Wash SPA and all remaining seabirds (excepting FFC SPA, see below), as described in **Section 10.4.4** onwards and presented in **Table 39**, the alone assessments concluded potential for only a trivial and inconsequential effect or no material contribution to baseline mortality as a result of Hornsea Four would result and therefore no potential for any contribution to any in-combination effect could occur.

11.4.3.4 There is, therefore, no potential for an AEoI to the conservation objectives of the red-throated diver and common scoter features of the Greater Wash SPA, or the seabird features of the remaining SPAs listed above under **paragraph 11.4.3.2** in relation to disturbance and displacement effects in the operation and maintenance phase from Hornsea Four in-combination and therefore, subject to natural change, all these bird features will be maintained as a feature(s) in the long term with respect to the potential for adverse effects from disturbance and displacement.

11.4.3.5 For FFC SPA, the relevant interest features identified were screened in for LSE for the project 'alone' and the attribution of the predicted displacement mortality. With the project 'alone' displacement and attribution having been completed the assessment of potential in-combination impacts can be carried out on a quantitative basis.

11.4.3.6 For all other SPA, pSPA or Ramsar sites quantitatively assessed for displacement alone, in the bullet points referred to in **paragraph 11.4.3.2**, Hornsea Four does not make a material contribution to in-combination displacement mortality rates. Therefore, an AEoI in-combination can be ruled out.

Table 39: Summary of the sites and features considered for a disturbance and displacement assessment during the operation and maintenance phase for Hornsea Four alone.

Site	Feature	Considered in-combination?
Greater Wash SPA	Red-throated diver during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Common scoter during non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Flamborough and Filey Coast SPA	Gannet during breeding and non-breeding bio-season	Yes.
	Guillemot during breeding and non-breeding bio-season	Yes.
	Razorbill during breeding and non-breeding bio-season	Yes.
	Puffin during breeding and non-breeding bioseason	Yes.
Coquet Island SPA	Puffin during breeding and non-breeding bioseason	No – Due to the distance of Coquet Island from the Hornsea Four Array Area (167 km), it is highly improbable that breeding adults from this SPA would regularly forage out to the Hornsea Four Array Area and it is highly unlikely that any further refinement of the apportionment of mortality attributed to the FFC SPA would add up to a single breeding individual which could be attributed to Coquet Island SPA. In the non-breeding bio-season, as the Hornsea Four array area is highly unlikely to represent an important area for this species the application of the evidence-led displacement mortality rates (applying 50% displacement with 1% mortality) alongside the evidence-led apportionment is most appropriate. Therefore, the predicted consequent mortality is less than a single (0.09) breeding adults per non-breeding season. The predicted increase in baseline mortality is under 0.01% in the non-breeding bio-season per annum. This will not be noticeable in the natural population fluctuation at the site and will not affect the achievement of the conservation objectives for the SPA from Hornsea Four alone. This level of impact will not provide any meaningful contribution to any in-combination effects, therefore the potential for an AEoI in relation to in-combination effects can be ruled out.
Farne Islands SPA	Guillemot during the non-breeding bio-season	In the non-breeding bio-season, as the Hornsea Four array area is highly unlikely to represent an important area for this species the application of the evidence-led

Site	Feature	Considered in-combination?
		displacement mortality rates (applying 50% displacement with 1% mortality) alongside the evidence-led apportionment is most appropriate. Therefore, the predicted consequent mortality is three (3.18) breeding adults per non-breeding season. The predicted increase in baseline mortality is under 0.1% in the non-breeding bio-season per annum. This will not be noticeable in the natural population fluctuation at the site and will not affect the achievement of the conservation objectives for the SPA from Hornsea Four alone. This level of impact will not provide any meaningful contribution to any in-combination effects, therefore the potential for an AEoI in relation to in-combination effects can be ruled out.
	Puffin during breeding and non-breeding bioseason	No – Due to the distance of the Farnes Islands from the Hornsea Four Array Area (198 km), it is highly improbable that breeding adults from this SPA would regularly forage out to the Hornsea Four Array Area and it is highly unlikely that any further refinement of the apportionment of mortality attributed to the FFC SPA would add up to a single breeding individual which could be attributed to the Farne Islands SPA. In the non-breeding bio-season, as the Hornsea Four array area is highly unlikely to represent an important area for this species the application of the evidence-led displacement mortality rates (applying 50% displacement with 1% mortality) alongside the evidence-led apportionment is most appropriate. Therefore, the predicted consequent mortality is less than one (0.30) breeding adults per non-breeding season. The predicted increase in baseline mortality is under 0.01% in the non-breeding bio-season per annum. This will not be noticeable in the natural population fluctuation at the site and will not affect the achievement of the conservation objectives for the SPA from Hornsea Four alone. This level of impact will not provide any meaningful contribution to any in-combination effects, therefore the potential for an AEoI in relation to in-combination effects can be ruled out.
Northumberland Marine SPA	Guillemot during the non-breeding bio-season	In the non-breeding bio-season, as the Hornsea Four array area is highly unlikely to represent an important area for this species the application of the evidence-led displacement mortality rates (applying 50% displacement with 1% mortality) alongside the evidence-led apportionment is most appropriate. Therefore, the predicted consequent mortality is three (3.18) breeding adults per non-breeding season. The predicted increase in baseline mortality is under 0.1% in the non-breeding bio-

Site	Feature	Considered in-combination?
		season per annum. This will not be noticeable in the natural population fluctuation at the site and will not affect the achievement of the conservation objectives for the SPA from Hornsea Four alone. This level of impact will not provide any meaningful contribution to any in-combination effects, therefore the potential for an AEoI in relation to in-combination effects can be ruled out.
	Puffin during breeding and non-breeding bioseason	No – Due to the distance of the Northumberland Marine SPA from the Hornsea Four Array Area (187 km), it is highly improbable that breeding adults from this SPA would regularly forage out to the Hornsea Four Array Area and it is highly unlikely that any further refinement of the apportionment of mortality attributed to the FFC SPA would add up to a single breeding individual which could be attributed to the Northumberland Marine SPA. In the non-breeding bio-season, as the Hornsea Four array area is highly unlikely to represent an important area for this species the application of the evidence-led displacement mortality rates (applying 50% displacement with 1% mortality) alongside the evidence-led apportionment is most appropriate. Therefore, the predicted consequent mortality is less than one (0.39) breeding adults per non-breeding season. The predicted increase in baseline mortality is under 0.01% in the non-breeding bio-season per annum. This will not be noticeable in the natural population fluctuation at the site and will not affect the achievement of the conservation objectives for the SPA from Hornsea Four alone. This level of impact will not provide any meaningful contribution to any in-combination effects, therefore the potential for an AEoI in relation to in-combination effects can be ruled out.
St Abb's Head SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Forth Islands (UK) SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within

Site	Feature	Considered in-combination?
		the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Outer Firth of Forth and St Andrews Complex SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Fowlsheugh SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Buchan Ness to Collieston Coast SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Troup, Pennan and Lion's Heads SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
East Caithness Cliffs SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
North Caithness Cliffs SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.

Site	Feature	Considered in-combination?
	Razorbill during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Copinsay SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Hoy SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Marwick Head SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Rousay SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Calf of Eday SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
West Westray SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Fair Isle SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within

Site	Feature	Considered in-combination?
		the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Sumburgh Head SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Noss SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Foula SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Razorbill during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Hermaness, Saxa, Vord and Valla Field SPA	Guillemot during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Puffin during the non-breeding bioseason	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.

Gannet

11.4.3.7 Gannets show a low level of sensitivity to ship and helicopter traffic (Garthe and Hüppop, 2004 and Furness & Wade, 2012). A study by Krijgsveld et al. (2011) using radar and visual observations to monitor the post-construction effects of the Offshore Windpark Egmond aan Zee (OWEZ) established that 64% of gannets avoided entering the wind farm (macro-avoidance). The results of the post-consent monitoring surveys for Thanet offshore wind farm found that gannet densities reduced within the site in the third year, but the report did not quantify this (Royal HaskoningDHV 2013). For the purpose of the in-combination assessment the level of displacement considered during the non-migratory breeding bio-season is between 60% to 70% within offshore wind farm array areas and 2 km buffers. A more recent study by APEM (APEM 2014) provided evidence that during their migration most gannets would avoid flying into areas with operational WTGs (macro-avoidance), with the estimated macro avoidance being 95%. For the purpose of this assessment the level of displacement considered across all bio-seasons and offshore wind farms is between 60% to 80%, accepted by Natural England as appropriate rates for assessment purposes (OFF-ORN-2.43 **B1.1.1 Evidence Plan**).

11.4.3.8 A mortality rate of 1% was selected for the in-combination assessment, based on expert judgement supported by additional evidence that suggests that gannet have a large mean max (315 km) and maximum (709 km) foraging range (Woodward et al. 2019) and feed on a variety of different prey items that provide sufficient alternative foraging opportunities.

Auk species

11.4.3.9 Auk species (guillemot, razorbill and puffin) show a medium level of sensitivity to ship and helicopter traffic (Garthe and Hüppop 2004; Furness and Wade 2012; Langston 2010; and Bradbury et al. 2014). Studies on auk displacement in response to OWFs have previously been summarised by Dierschke et al. (2016). This review summarises evidence of auk displacement obtained from studies of twelve different European offshore wind farm sites that compared changes in seabird abundance between baseline and post-construction. Since the publication of this review, there have been a number of additional offsore wind farm sites which have reported displacement effects on auks (APEM 2017; Webb et al. 2017; Vanermen et al., 2019; Peschko et al. 2020). Furthermore, previously published datasets from three offshore wind farm sites have recently been re-analysed utilising a novel modelling approach, which has resulted in different displacement effects being concluded for some (R-INLA; Zuur 2018; Leopold et al. 2018).

11.4.3.10 A comparison of these post-construction monitoring studies is shown in **Table 12**, suggesting auk displacement effects vary considerably within different study sites showing attraction, no significant effect or a displacement effect. The studies included: one offshore wind farm with positive displacement effects, seven offshore wind farms with no significant effects or weak displacement effects, three with inferred displacement effects (but not statistically tested) and eight with negative displacement effects. The displacement effects from those studies which provided a defined displacement rate ranged from +112% to -75%.

11.4.3.11 As set out in detail in **Section 10.4.4** the causes for some of the significant variation in displacement rates reported appears to be due to the use of superceded modelling techniques and insufficient post-consent monitoring leading to inadequacies in statistical power to detect significant change, and instead displacement effects appear to be related to the importance of the respective area for auks with regard to breeding, migrating and moulting. For example, in an area of high auk density competition for food between birds is greater, and individual birds may become more tolerant of any real or perceived disturbance from an offshore wind farm. In locations of low auk density, birds select habitat with sufficient prey, but as competition for food between birds is reduced, they can also select areas where real or perceived disturbance is low. This may in part explain the highly variable displacement effects reported between offshore wind farm sites, especially in North Sea waters between the UK and mainland Europe. The data show no evidence that displacement effects are correlated to WTG density or size of the offshore wind farm, as suggested in earlier studies. Considering the significant variation in location within the North Sea, abundances within the offshore wind farms screened in for in-combination and the considerable distance of the majority of the offshore wind farms from the FFC SPA, it can be concluded that there is significant justification for the use of a 50% displacement rate for in-combination assessments as an upper limit, which is still considered as precautionary as this level of displacement is also applied to the 2 km buffer for all offshore wind farms.

Effects of Displacement on Auk Mortality

11.4.3.12 Current evidence suggests that the response of seabirds to OWFs varies depending on the species and of life stage of the individual birds. Birds that avoid OWFs may do so entirely, including an area considered to be a buffer around an OWF or do so partially. Avoidance of OWFs may be either on a spatial scale or temporally according to levels of competition outside the OWF or prey abundance within the OWF. Habitat loss is ultimately considered to be the consequence of these avoidance behaviours and therefore, a major challenge is understanding how displacement from OWF habitat may impact upon population processes.

11.4.3.13 Displacement effects may act at differing levels, including the individual, colony and population levels and are dependent on key factors:

- The importance of the area to be occupied by the OWF in context to the surrounding area;
- The fraction of the colony/population utilising the area of the OWF;
- The degree (number of birds and distance) of displacement by the OWF; and
- The consequences of habitat loss (in terms of the survival probability and productivity) as a result of the OWF.

11.4.3.14 Mortalities are likely to correlate strongly with the quality of the habitat lost; if key foraging habitat is lost and the remaining habitat is already close to carrying capacity, then the mortality rates of displaced birds may be considerably higher (Busche and Garthe, 2016).

11.4.3.15 The appropriateness of using mortality rates as high as 10% in assessments is unclear, given the lack of evidence, though UK SNCBs regularly advise the use of a range of 1–10% mortality based on expert opinion (Natural England, 2014) for guillemots and other auk species. In contrast, environmental consultants working on behalf of Developers have claimed that 1% or 2% mortality is more appropriate (Norfolk Boreas Limited, 2019; SPR, 2019; Orsted 2018), though these were also almost entirely based on expert judgement. The lack of robust evidence previously considered led to the 1-10% mortality rate range prediction continuing to be used despite it being a 'best guess' to allow for precaution. This was evident following consultation with seabird experts, such as stated by Allen (2013), in the JNCC expert statement on ornithological issues for East Anglia One OWF. At that time there was currently no data (even anecdotal) with which to support the reliable selection of mortality rates stemming from varying levels of displacement. However, since Natural England's interim advise on auk mortality rates was issued and updated in 2017 (SNCBs, 2017) there have been two detailed studies as detailed in **paragraph 10.4.4.17** and summarised below, with updates to predict the fate or population consequence of displaced seabirds, including auks, from OWFs (Searle et al., 2014 and 2018, and van Kooten et al., 2019), and an additional study with anecdotal evidence of implied low additional mortality rates from auk colony stability on Helgoland, where OWFs have been operating in the area since 2014 and auk displacement rates of 44-63% have been reported (Peschko et al., 2020).

11.4.3.16 The Van Kooten et al., (2019) study demonstrated that an additional 1% mortality for displaced auks is a more appropriate evidence-based rate that would still be considered precautionary considering the additional monthly mortality rates modelled by the study which translate to an additional non-breeding season mortality rate for displaced auks of 0.1 -0.4% (van Kooten et al., 2018) and that a 10% mortality rate is overly precautionary.

11.4.3.17 Searle et al., (2014) provides evidence that changes in time and energy budgets, in relation to guillemot and razorbill, as a result of displacement from OWFs has the potential to impact on the body condition, and future survival prospects. Such changes may also reduce breeding success if provisioning rate declines result in offspring starvation, or if the extended time required for foraging results in temporary unattendance of eggs or young, which increases the likelihood of mortality from predation or exposure. OWFs located on favoured foraging habitats that force birds to forage at greater densities in sub-optimal habitats were found to have the highest impact. However, studies using simulation models of time and energy budgets for auks during the breeding and non-breeding season conclude that these displacement effects, even at their highest impacts, are unlikely to exceed an additional 0.5% in mortality and that a 1% additional mortality rate based on available evidence, would offer precaution and encompass even scenarios with the highest impacts on demographics from displacement.

11.4.3.18 Considering the results of simulation models by Searle et al., (2014) and van Kooten et al., (2019) on the impacts of displacement on auk adult survival to be consistently less than 0.5%, it would suggest that additional mortality effects at a colony or population level would be negligible or undetectable under current monitoring conditions. However, an additional mortality level of 10% would likely be detectable after several years of monitoring, especially if continued moderate displacement from an OWF is occurring. Although published studies with empirical evidence to support this are lacking, impacts on demographic effects from OWF displacement can be inferred from colony population trends, where displacement effects on auk distributions have been reported. One such colony is that on Helgoland in the German North Sea in which displacement rates for auks have been predicted to be 44% during the breeding season and 63% during the non-breeding season (Peschko et al., 2020). OWFs of the Helgoland cluster have been in operation since 2014 allowing a substantial time for any correlation between operation of the OWFs and changes in colony demographics if significant additional mortality from displacement is occurring. This study provides strong supporting evidence that overly precautionary rates of mortality over 1% are not apparent, as the latest breeding population status on Helgoland shows a continued increase for both razorbill and guillemot over the latest five-year period, which has remained unchanged compared to long-term data (Gerlach et al., 2019).

11.4.3.19 The studies considered for this assessment (van Kooten et al., 2019, Searle et al., 2014, Peschko et al., 2020, and Gerlach et al., 2019) together provide the most comprehensive review of potential displacement consequences to auks during the breeding and non-breeding season. They all collectively conclude that any displacement effects, even when considering overly precautionary rates to increase potential impacts, are unlikely to exceed a mortality rate of 0.5%. Therefore, they support the use of a 1% mortality rate based on the best available evidence to offer an appropriate level of precaution that encompasses scenarios considering the highest impacts on demographics from displacement.

Precautionary Nature of Assessment

11.4.3.20 The assessments provided within this RIAA include a number of assumptions that contribute to the predicted impacts and potential effects being considered overly precautionary, including;

- The population within each bio-season for all of the offshore wind farms being the mean of the peaks from each survey year. This makes the assumption that such a high population is maintained for each of the months within each bio-season, whilst the actual abundance is likely to be less than this throughout the months making up each bio-season;
- The population within offshore wind farm array areas and / or buffers to the south of Hornsea Four is likely to include non-breeding and migratory auks moving north and south during the months considered as being included in the breeding bio-season for this assessment;
- All sites being considered within the maximum foraging range is very precautionary, considering that many of the offshore wind farm array areas and their buffers are beyond a reasonable distance to assume to be regularly used (if at all) by species during the breeding bio-season from the FFC SPA;
- The maximum extent of displacement considered for each species is likely to be greater than actually experienced within the array area and buffer;
- The maximum of 10% mortality of auks displaced during the non-migratory breeding bio-season is highly unlikely within all the offshore wind farms included within this assessment, as the species assessed in this RIAA are not solely dependant upon these area for all their foraging needs;
- Not 100% of adult birds within the offshore wind farms included within the in-combination assessment during the breeding bio-season will be from Flamborough and Filey Coast SPA;
- Not accounting for additional non-breeding adults within the North Sea that contribute to the population within the offshore wind farms considered within this in-combination assessment throughout the year; and
- That the layers of precaution that are provided within the most precautionary assessments within this RIAA (under Scenario 2 of relevant assessments) are highly unlikely to occur.

Flamborough and Filey Coast SPA – gannet

11.4.3.21 Gannet has been screened into the in-combination assessment of the O&M phase to assess the impacts from displacement from Hornsea Four in-combination with other projects in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

11.4.3.22 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- To maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts (Aitken et al. 2017).

11.4.3.23 The projects screened in are the proposed, consented, under-construction and operating offshore wind farms in the UK waters of the North Sea and English Channel (**Table 40**). They have been screened in on the basis of the species' sensitivity to the presence of the WTGs, the activities which will take place within those array areas during maintenance and the experience of the in-combination assessments carried out for offshore wind farms in recent years. The Hornsea Four array area and multiple other offshore wind farms are within the mean max foraging distance of 315.2 km to the FFC SPA and also within the mean max plus 1 SD foraging distance of 509.4 km (Woodward et al. 2019). Accordingly, multiple offshore wind farms are screened in for consideration for this species for assessment during the breeding bio-season. Outside of the breeding bio-season gannets are known to range more widely, so consideration is provided to offshore wind farms within the wider UK North Sea and English Channel BDMPS area. The different bio-seasons for consideration of assessing potential risk from displacement on gannets from FFC SPA from Hornsea Four in-combination with other offshore wind farms includes the migration-free breeding bio-season, defined as being the months of April to August by Furness (2015), the post-breeding migration bio-season of September to November and the return migration bio-season of December to March.

11.4.3.24 During the breeding bio-season it is considered that potential displacement impacts on gannets from FFC SPA may be attributed more highly to offshore wind farms within areas of sea within foraging distance from this breeding colony. In order to assess the potential in-combination impacts on gannet from multiple offshore wind farms, information was compiled on the seasonal abundance of gannets measured at each offshore wind farm site (plus 2 km buffer). The seasonal gannet abundances were then subjected to a process of attribution to FFC SPA.

11.4.3.25 Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during return migration and post-breeding migration bio-seasons were estimated to be 6.23% and 4.84%, respectively, which was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the evidence plan process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

11.4.3.26 The in-combination totals presented in **Table 40** for all consented and planned projects are derived from the in-combination tables presented at at Deadline XI for EA1N / EA2 (SPR, 2021) which are the most up to date in-combination disturbance and displacement tables for the FFC SPA at the time of this assessment. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (SPR, 2021) for assessments included within this report:

- Updated displacement values for Hornsea Four attributed to the FFC SPA as described within this report (**paragraph 10.4.4.44**);
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational; and
- Inclusion of Hornsea Three final Applicant's values as presented in the most recent update (Orsted, 2021a).

11.4.3.27 In order to assess the potential impact on gannet a displacement effect distance was determined of the array area and within a buffer out to 2 km in order to maintain consistency for all projects. Within that displacement effect area the percentage of birds displaced from the array area and 2 km buffer was set at between 60% and 80% during all bio-seasons. The level of mortality consequential of displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 11.4.3.7**.

11.4.3.28 Natural England consider displacement and any consequent mortality rates in the assessments of gannet should be made using a range of values. The displacement matrix in Table 41 provides a displacement matrix for the annual total of gannets apportioned to FFC SPA predicted to be at risk of displacement from the Hornsea Four array area plus 2 km buffer when applying any value of displacement or mortality.

11.4.3.29 **Table 40** below sets out the abundance of gannets as attributed to FFC SPA within all other offshore wind farms and their 2 km buffers for consideration in this in-combination assessment. It should be noted that these values are highly likely to be overly precautionary, as they are based on seasonal mean peaks added into an annual total.

Table 40: Seasonal mean peak abundances of gannets attributed to the FFC SPA from OWFs used to determine in-combination displacement.

Project	Migration-free breeding	Post-breeding migration (Autumn)	Return migration (Spring)	Annual total	Tier
Beatrice	0	0	0	0	1a

Project	Migration-free breeding	Post-breeding migration (Autumn)	Return migration (Spring)	Annual total	Tier
Blyth Demonstration Site	-	-	-	-	1a
Dudgeon	53	1	1	55	1a
East Anglia One	161	175	5	340	1a
EOWDC	0	0	0	0	1a
Galloper	0	44	17	61	1a
Greater Gabbard	0	3	7	10	1a
Gunfleet Sands	0	1	1	1	1a
Hornsea Project One	671	33	16	720	1a
Humber Gateway	-	-	-	-	1a
Hywind 2 Demonstration	0	0	0	0	1a
Kentish Flats	-	-	-	-	1a
Kentish Flats Extension	0	1	0	1	1a
Lincs	-	-	-	-	1a
London Array	-	-	-	-	1a
Lynn and Inner Dowsing	-	-	-	-	1a
Methil	0	0	0	0	1a
Race Bank	92	2	2	95	1a
Rampion	0	28	0	28	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	47	2	0	49	1a
Teesside	1	0	0	1	1a
Thanet	-	-	-	-	1a
Westermost Rough	-	-	-	-	1a
Kincardine	0	0	0	0	1a
Hornsea Project Two	457	55	8	519	1b
Moray East	0	14	2	16	1b
Neart na Gaoithe	0	27	17	44	1b
Seagreen Alpha	0	14	9	23	1b
Seagreen Bravo	0	18	12	30	1b
Triton Knoll	211	1	2	213	1b
Dogger Bank A	259	44	11	314	1c
Dogger Bank B	319	54	14	386	1c
Dogger Bank C	484	18	14	516	1c
East Anglia Three	412	61	33	505	1c
Hornsea Three	539	47	33	619	1c
Inch Cape	0	34	13	47	1c

Project	Migration-free breeding	Post-breeding migration (Autumn)	Return migration (Spring)	Annual total	Tier
Moray West	0	21	9	30	1c
Sofia	641	24	15	680	1c
East Anglia ONE North	149	23	3	174	1d
East Anglia TWO	192	43	12	247	1d
Norfolk Boreas	1,229	83	33	1,344	1d
Norfolk Vanguard	271	118	27	416	1d
Hornsea Four	484	41	15	540	1d
Dudgeon Extension Project	361	16	3	380	2
Sheringham Shoal Extension Project	40	14	0	54	2
All Projects Total	**7,072**	**1,057**	**329**	**8,458**	

11.4.3.30 To these in-combination totals the displacement and consequential mortality scenarios are applied as follows:

Breeding Season

11.4.3.31 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, in the breeding bio-season is between 4,243 (4,243.20) and 5658 (5657.60) breeding adults (applying displacement rates of between 60% and 80%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at between 42 (42.43) and 57 (56.58) breeding adults in total.

11.4.3.32 When considering the potential impact of this loss to the FFC SPA (classified gannet population of 16,938 breeding adults, with an annual background mortality of this number of adult birds being 1,372 individuals), then using this prediction of 42 and 57 breeding adults suffering displacement consequent mortality would represent a 3.09% to 4.12% increase in baseline mortality, of which Hornsea Four alone contributes an increase of three to four predicted breeding adult mortalies equating to an increase of 0.21% to 0.28% in baseline mortality. As the population of gannets has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 13,392 apparently occupied nests (or 26,784 breeding adults). On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of this number of adult birds being 2,170 breeding individuals) then this prediction of 42 and 57 breeding adults suffering displacement consequent mortality would represent a 1.96% to 2.61% increase in baseline mortality, of which Hornsea Four alone contributes an increase of three to four predicted breeding adult mortalies equating to an increase of 0.13% to 0.18% in baseline mortality.

Non-breeding season

11.4.3.33 The in-combination number predicted to be displaced from the offshore wind farms assessed, including Hornsea Four, that has been apportioned to FFC SPA in the two non-breeding bio-seasons is between 197 (197.40) and 263 (263.2) breeding adults in the return migration bio-season and between 634 (634.20) and 846 (845.60) breeding adults in post-breeding migration bio-season (applying displacement rates of between 60% and 80%). The predicted consequent mortality from being displaced is estimated at between two (1.97) and three (2.63) in the return migration and between six (6.34) and eight (8.46) breeding adults in post-breeding migration bio-season (applying a mortality rate of 1%). This equates to a total consequent mortality from being displaced across the whole non-breeding bio-season of between eight (8.32) and 11 (11.09) breeding adult birds per annum.

11.4.3.34 When considering the potential impact of this loss to the FFC SPA citation population, then using this prediction of between eight and 11 breeding adults suffering displacement consequent mortality would represent a 0.61% to 0.81% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.02% in baseline mortality. When considering the potential impact of this loss to the more recent 2017 colony count for gannet, then this prediction of between eight and 11 breeding adult birds suffering displacement consequent mortality would represent a 0.38% to 0.51% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.01% to 0.02% in baseline mortality.

Table 41: In-combination annual displacement matrix for gannet attributed to the FFC SPA values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	2	3	3	4	8	17	25	34	42	51	59	68	76	85
10	8	17	25	34	42	85	169	254	338	423	507	592	677	761	846
20	17	34	51	68	85	169	338	507	677	846	1,015	1,184	1,353	1,522	1,692
30	25	51	76	101	127	254	507	761	1,015	1,269	1,522	1,776	2,030	2,284	2,537
40	34	68	101	135	169	338	677	1,015	1,353	1,692	2,030	2,368	2,707	3,045	3,383
50	42	85	127	169	211	423	846	1,269	1,692	2,114	2,537	2,960	3,383	3,806	4,229
60	51	101	152	203	254	507	1,015	1,522	2,030	2,537	3,045	3,552	4,060	4,567	5,075
70	59	118	178	237	296	592	1,184	1,776	2,368	2,960	3,552	4,144	4,736	5,328	5,921
80	68	135	203	271	338	677	1,353	2,030	2,707	3,383	4,060	4,736	5,413	6,090	6,766
90	76	152	228	304	381	761	1,522	2,284	3,045	3,806	4,567	5,328	6,090	6,851	7,612
100	85	169	254	338	423	846	1,692	2,537	3,383	4,229	5,075	5,921	6,766	7,612	8,458

Annual Total

11.4.3.35 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, is a prediction of consequent mortality of between 42 and 57 breeding adults from the SPA in the breeding bio-season and between eight and 11 breeding adults in the non-breeding bio-season equating to between 51 (50.75) and 68 (67.66) breeding adults across all bio-seasons per annum. The predicted consequent baseline mortality increase of the citation population is estimated at between 3.70% and 4.93% across all bio-seasons per annum (Hornsea Four alone contributes an increase of three to four predicted breeding adult mortalities equating to an increase of 0.24% to 0.31% in baseline mortality per annum across all bio-seasons). The predicted consequent baseline mortality increase of the more recent 2017 colony count is estimated at between 2.34% and 3.12% across all bio-seasons per annum (Hornsea Four alone contributes an increase of three to four predicted breeding adult mortalities equating to an increase of 0.15% to 0.20% in baseline mortality per annum across all bio-seasons). Due to the increase in baseline mortality from displacement impacts in-combination exceeding a 1% increase further consideration of the impact is required.

Gannet Displacement PVA Results

11.4.3.36 Further consideration of the potential displacement and consequent mortality to the gannet feature of the FFC SPA from Hornsea Four in combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. The potential in-combination impacts have been assessed against the latest 2017 colony count population size of 26,784 breeding adults as agreed with Natural England (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**. The results of the PVA in relation to in-combination disturbance and displacement impacts are presented in **Table 42**.

Table 42: Population modelling results using the Natural England Seabird PVA Tool for potential gannet displacement mortality rate for Hornsea Four in-combination with all other projects attributed to the FFC SPA.

Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (after 35 years)	Reduction in growth rate (per annum)
In-combination total using 60% Displacement, 1% Mortality	51	0.998	0.22%
In-combination total using 80% Displacement, 1% Mortality	68	0.997	0.30%

Table 43: Average annual colony growth rate for gannets colony at Flamborough Head and Bempton Cliffs SPA between 1969 – 2017.

Species	Colony Annual Compound Growth Rate			
	1969 - 2017 (FH & BC SPA)	1987 - 2017 (FH & BC SPA)	2000 - 2017 (FH & BC SPA)	2008 - 2017 (FH & BC SPA)
Gannet	14.40%	9.94%	10.24%	8.58%

11.4.3.37 The average annual colony growth rates for gannet presented in **Table 43** are derived from the colony counts presented in the 2019 FFC SPA seabird monitoring programme (Lloyd et al. 2019). Over the nearly 50-year period presented, the gannet population has grown annually by just over 14%, when considering the population growth over the last 20 years the average annual growth rate was still calculated as over 8%, despite multiple OWFs being operational within the North Sea over that period. Although it's impossible to know what the growth rate of the gannet feature will be over the 35 year project lifespan of Hornsea Four, the current colony growth rates would suggest that the colony is likely to still increase in size on its current trajectory, although it's likely the growth rate will reduce over the next 35 years as competition for nesting ledges increases and viability of prey resources may be limiting factors.

11.4.3.38 With respect to future plausible growth rates, Natural England provided advice on the matter to Norfolk Boreas in relation to the gannet feature of the FFC SPA, suggesting they believe that a range of plausible future growth rate scenarios between 1% to 5% should be considered (Natural England, 2020). This range of growth rates were based on a review of current gannet colony growth at 22 differing colonies across Britain, the Channel Islands and Ireland, from which Natural England concluded that:

'The Flamborough / Bempton gannet colony was founded in the late 1930s (Cramp et al. 1974) and so has been in existence now for about 80 years. Thus, by the end of 30 years of Vanguard it will be about 110 years in age. Given the analysis of trends in gannet colony growth rates amongst a suite of long-established colonies, it is highly likely that its annual growth rate averaged over the whole period since founding will drop from its current average of c 11% over the first 80 years. The highest annual colony growth rate calculated over a period of >100 years is 4.5% at Grassholm. The Flamborough colony is unlikely to achieve a higher annual growth rate than this. The average annual growth rate calculated over a period of >90 years across the 8 gannet colonies with records exceeding 90 years is 1.8%. Amongst these colonies the mean annual growth rate over the most recent years of their records (80+ years) has been just 1.2% per annum (or 1.3% excluding Sula Sgeir (as the growth rate here may be influenced adversely by an annual licenced harvest of young birds)) compared to an average rate of 2.0% per annum during the first 80 or so years of their existence.'

11.4.3.39 When considering the growth rate scenarios suggested by Natural England above and the in-combination displacement reduction in growth rates presented in **Table 42**, the colony growth rate would still remain positive even when considering the unlikely growth rate scenario of only 1% per annum.

11.4.3.40 As stated above an annual harvest of up to 2,000 chicks at the Sula Sgeir gannet colony off the coast of Scotland is currently licesensed by NatureScot. The colony at Sula Sgeir is of a similar size to the FFC SPA colony with a citation population of 10,400 pairs. Despite harvesting occurring annually at the colony between 2004 and 2014 the colony still increased annually at an average annual growth rate of 2.2%, therefore providing strong evidence that even when up to 2,000 chicks are removed from the population on an annual basis this species maintains a positive growth rate. In order to ensure the sustainability of the harvesting being undertaken at the colony, PVA was commissioned to ensure the long-term viability of the population would not be adversely affected. The results concluded categorically that although in the absence of harvesting the colony growth rate would likely be higher, it seemed proabable that a continued annual harvest of up to 3,500 chicks per annum would not lead to a decline in population growth (Trinder 2016). This provides additional evidence in support of the resilliance of gannet populations, reinforcing the fact that a maximum predicted mortality of up to 68 breeding gannets per annum is highly improbable to lead to adverse effect on the FFC SPA population.

11.4.3.41 When considering Natural England's conservative suggestion that they believe the annual colony growth rate to be higher than 1.3% over the next 30 years, the in-combination displacement mortality would not cause the growth rate to become negative. However, a reduction in growth rate to this extent is highly improbable as suggested from data at a colony of similar size at Sula Sgeir, where this species has demonstrated it can withstand harvesting at rates of 2,000 chicks per annum from the population on a regular basis without it significantly affecting the colony size or growth rate. This means the conservation objective of the gannet feature of the FFC SPA, to maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent, would still be met over the operational lifespan of Hornsea Four and an AEoI from in-combination dispalcement mortality impacts can be ruled out.

Flamborough and Filey Coast SPA – guillemot

11.4.3.42 Guillemot has been screened into the in-combination assessment of the O&M phase to assess the impacts from displacement from Hornsea Four in-combination with other projects in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

11.4.3.43 Based on the above the conservation objective for the FFC SPA the specific target for the guillemot feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level which is above 41,607 breeding pairs (83,214 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 121,754 breeding adults based on the most recent 2017 colony count

11.4.3.44 The projects screened in are the proposed, consented, under-construction and operating offshore wind farms in the UK waters of the North Sea and English Channel (**Table 44**). They have been screened in on the basis of the species' sensitivity to the presence of the WTGs, the activities which will take place within those array areas during maintenance and the experience of the in-combination assessments carried out for offshore wind farms in recent years. The Hornsea Four array area and multiple other offshore wind farms are within the mean max foraging distance of 73.2 km to the FFC SPA at 63 km distant and also within the mean max plus 1 SD foraging distance of 150.7 km (Woodward et al. 2019). Accordingly, multiple offshore wind farms are screened in for consideration for this species for assessment during the breeding bio-season. Outside of the breeding bio-season guillemots are known to range more widely, so consideration is provided to offshore wind farms within the wider UK North Sea and English Channel BDMPS area. The different bio-seasons for consideration of assessing potential risk from displacement on guillemots from FFC SPA from Hornsea Four in-combination with other offshore wind farms includes the breeding bio-season, defined as being the months of March to July by Furness (2015) and the non-breeding bio-season of August to February.

11.4.3.45 During the breeding bio-season it is considered that potential displacement impacts on guillemots from FFC SPA may be attributed more highly to offshore wind farms within areas of sea within foraging distance from this breeding colony. In order to assess the potential in-combination impacts on guillemot from multiple offshore wind farms, information was compiled on the seasonal abundance of guillemots measured at each offshore wind farm site (plus 2 km buffer). The seasonal guillemot abundances were then subjected to a process of attribution to FFC SPA.

11.4.3.46 Outside of the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach, the proportion of the BDMPS populations from FFC SPA during non-breeding bio-season of 4.41% was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the evidence plan process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

11.4.3.47 The in-combination totals presented in **Table 44** for all consented and planned projects are derived from the in-combination tables presented at Deadline XI for EA1N / EA2 (SPR, 2021) which are the most up to date in-combination disturbance and displacement tables for the FFC SPA at the time of this assessment in June 2021. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (SPR, 2021) for assessments included within this report:

- Updated displacement values for Hornsea Four attributed to the FFC SPA as described within this report (**Table 14**);
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational; and
- Inclusion of the Applicant's final values for Hornsea Three (Orsted, 2021a).

11.4.3.48 In order to assess the potential impact on guillemot a displacement effect distance was determined of the array area and within a buffer out to 2 km. Within that displacement effect area the percentage of birds displaced from the array area was set at 50% during all bio-seasons and within the 2 km buffer. The level of mortality consequential of displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 10.4.4.10**.

11.4.3.49 Natural England consider displacement and any consequent mortality rates in the assessments of guillemot should be made using a range of values. **Table 45** provides a displacement matrix for the in-combination annual total of guillemots apportioned to FFC SPA predicted to be at risk of displacement from all projects within the North Sea and English Channel (OFF-ORN-4.8 **B1.1.1 Evidence Plan**) when applying any value of displacement or mortality. Summary statements applying the lower end (a displacement rate of 30% and a mortality rate of 1%) and extreme upper end (a displacement rate of 70% and a mortality rate of 10%) of Natural England's range of displacement and consequent mortality rates are also considered within this assessment, though Natural England acknowledge that the use of displacement mortality rates from the upper end of the range are not likely (OFF-ORN-2.50 **B1.1.1 Evidence Plan**), particularly when considering that many of the offshore wind farms are not considered to be in important areas for guillemot from the FFC SPA.

11.4.3.50 For Hornsea Four, the detailed calculations of how guillemots have been apportioned to the FFC SPA are presented in **paragraph 10.4.4.57**. **Table 44** below sets out the abundance of guillemots as attributed to FFC SPA within all other offshore wind farms and their 2 km buffers for consideration in this in-combination assessment. It should be noted that these values are highly likely to be overly precautionary though, as they are based on seasonal mean peaks added into an annual total of birds displaced from OWF within the North Sea and English Channel attributed to the FFC SPA.

Table 44: In-combination displacement totals for guillemot attributed to the FFC SPA.

Project	Breeding	Non-breeding	Annual Total	Tier
Beatrice	0	121	121	1a
Blyth Demonstration Site	0	58	58	1a
Dudgeon	0	24	24	1a
East Anglia One	0	28	28	1a
EOWDC	0	10	10	1a
Galloper	0	26	26	1a
Greater Gabbard	0	24	24	1a
Gunfleet Sands	0	16	16	1a
Hornsea Project One	4,554	356	4,910	1a
Humber Gateway	99	6	105	1a
Hywind 2 Demonstration	0	94	94	1a
Kentish Flats	0	0	0	1a
Kentish Flats Extension	0	0	0	1a
Kincardine	0	0	0	1a

Project	Breeding	Non-breeding	Annual Total	Tier
Lincs, Lynn & Inner Dowsing	0	36	36	1a
London Array	0	17	17	1a
Methil	0	0	0	1a
Race Bank	0	31	31	1a
Rampion	0	684	684	1a
Scroby Sands	-	-	-	1a
Sheringham Shoal	0	32	32	1a
Teesside	267	40	307	1a
Thanet	0	6	6	1a
Westermost Rough	347	21	368	1a
Hornsea Project Two	3,581	579	4,161	1b
Moray East	0	24	24	1b
Neart na Gaoithe	0	166	166	1b
Seagreen Alpha	0	206	206	1b
Seagreen Bravo	0	181	181	1b
Triton Knoll	425	33	458	1b
Dogger Bank A	1,893	270	2,163	1c
Dogger Bank B	3,318	467	3,785	1c
Dogger Bank C	1,149	100	1,249	1c
East Anglia Three	0	126	126	1c
Hornsea Three	8,502	782	9,284	1c
Inch Cape	0	140	140	1c
Moray West	0	1,680	1,680	1c
Sofia	1,824	163	1,987	1c
East Anglia ONE North	0	83	83	1d
East Anglia TWO	0	74	74	1d
Norfolk Boreas	0	606	606	1d
Norfolk Vanguard	0	210	210	1d
Hornsea Four	4,773	2,238	7,011	1d
Dudgeon Extension Project	0	355	355	2
Sheringham Shoal Extension Project	0	27	27	2
All Projects Total	**30,731**	**10,139**	**40,870**	

11.4.3.51 To these in-combination totals the displacement and consequential mortality scenarios are applied as follows:

Breeding Season

11.4.3.52 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, in the breeding bio-season is 15,366 (15,365.50) breeding adults (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 154 (153.66) breeding adults.

11.4.3.53 When considering the potential impact of this loss to the FFC SPA (classified guillemot population of 83,214 breeding adults), with an annual background mortality of this number of breeding adult birds being 5,076 then using this prediction of 154 breeding adults suffering displacement consequent mortality would represent a 3.03% increase in baseline mortality, of which Hornsea Four alone contributes an increase of 24 predicted breeding adult mortalites equating to an increase of 0.47% in baseline mortality. As the population of guillemots has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 121,754 breeding individuals. On this basis, when considering the potential impact of this loss to the FFC SPA (with an annual background mortality of this number of breeding adult birds being 7,427 individuals) then this prediction of 154 breeding adult birds suffering displacement consequent mortality would represent a 2.07% increase in baseline mortality, of which Hornsea Four alone contributes an increase of 24 predicted breeding adult mortalites equating to an increase of 0.32% in baseline mortality.

11.4.3.54 Should Natural England's range of displacement and mortality rates (Applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the in-combination impact of displacement is a prediction of consequent mortality of between 92 (92.19) and 2,151 (2,151.19) breeding adult birds from the SPA in the breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 1.82% and 42.38% when considering the citation population (Hornsea Four alone contributes an increase of 14 to 334 predicted breeding adult mortalites equating to an increase of 0.28% to 6.58% in baseline mortality) or between 1.24% and 28.96% when considering the recent 2017 colony count (Hornsea Four alone contributes an increase of 14 to 334 predicted breeding adult mortalites equating to an increase of 0.19% to 4.50% in baseline mortality) in the breeding bio-season per annum. However, based on the evidence put forward for auk species in **paragraph 10.4.4.10** and **10.4.4.82** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.62**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Non-Breeding Season

11.4.3.55 Non-The number of guillemots predicted to be displaced from Hornsea Four in-combination with other OWFs that have been apportioned to FFC SPA, in the non-breeding bio-season is 5,070 (5,069.50) breeding adults (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 51 (50.70) breeding adults.

11.4.3.56 When considering the potential impact of this loss to the FFC SPA citation population, then using this prediction of 51 breeding adults suffering displacement consequent mortality would represent a 1.00% increase in baseline mortality, of which Hornsea Four contributes an increase of 11 predicted breeding adult mortalites equating to an increase of 0.22% in baseline mortality. When considering the potential impact of this loss to the more recent 2017 colony count for guillemot, then this prediction of 51 breeding adult birds suffering displacement consequent mortality would represent a 0.68% increase in baseline mortality, of which Hornsea Four alone contributes an increase of 11 predicted breeding adult mortalites equating to an increase of 0.15% in baseline mortality.

11.4.3.57 Should Natural England's range of displacement and mortality rates (Applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the in-combination impact of displacement is a prediction of consequent mortality of between 30 (30.42) and 710 (709.70) breeding adult birds from the SPA in the non-breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.60% and 13.98% when considering the citation population (Hornsea Four alone contributes an increase of seven to 157 predicted breeding adult mortalites equating to an increase of 0.13% to 3.09% in baseline mortality) or between 0.41% and 9.56% when considering the recent 2017 colony count (Hornsea Four alone contributes an increase of seven to 157 predicted breeding adult mortalites equating to an increase of 0.09% to 2.11% in baseline mortality) in the non-breeding bio-season per annum. However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10** and **10.4.4.82** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.62**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality) can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Annual Total

11.4.3.58 The number of guillemots predicted to be displaced from Hornsea Four in-combination with other offshore wind farms, is a prediction of consequent mortality of 154 breeding adult birds from the SPA in the breeding bio-season and 51 breeding adult birds in the non-breeding bio-season which equates to 204 (204.35) breeding adult birds across all bio-seasons per annum. The addition of 204 predicted mortalities increases the baseline mortality of the citation population or the 2017 colony count by 4.03% or 2.75% across all bio-seasons per annum respectively (Hornsea Four alone contributes an increase of 35 predicted breeding adult mortalites equating to an increase of 0.69% or 0.47% in baseline mortality across all bio-seasons per annum), results in an increase in the baseline mortality above 1%, and therefore further consideration of the impacts are required.

11.4.3.59 Should Natural England's range of displacement and mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the in-combination impact of displacement is a prediction of consequent mortality of between 123 (122.61) and 2,861 (2,860.89) breeding adult birds from the SPA across all bio-seasons. This predicted additional mortality would represent an increase in baseline mortality of between 2.42% and 56.36% when considering the citation population (Hornsea Four alone contributes an increase of 0.41% to 9.67% in baseline mortality across all bio-seasons per annum) or between 1.81% and 42.15% when considering the recent 2017 colony count per annum across all bio-seasons (Hornsea Four alone contributes an increase of 21 to 491 predicted breeding adult mortalites equating to an increase of 0.28% to 6.61% in baseline mortality across all bio-seasons per annum). However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10** and **10.4.4.82** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.62**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality) can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Table 45: In-combination annual displacement matrix for guillemot attributed to the FFC SPA values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	4	8	12	16	20	41	82	123	163	204	245	286	327	368	409
10	41	82	123	163	204	409	817	1,226	1,635	2,043	2,452	2,861	3,270	3,678	4,087
20	82	163	245	327	409	817	1,635	2,452	3,270	4,087	4,904	5,722	6,539	7,357	8,174
30	123	245	368	490	613	1,226	2,452	3,678	4,904	6,130	7,357	8,583	9,809	11,035	12,261
40	163	327	490	654	817	1,635	3,270	4,904	6,539	8,174	9,809	11,444	13,078	14,713	16,348
50	204	409	613	817	1,022	2,043	4,087	6,130	8,174	10,217	12,261	14,304	16,348	18,391	20,435
60	245	490	736	981	1,226	2,452	4,904	7,357	9,809	12,261	14,713	17,165	19,618	22,070	24,522
70	286	572	858	1,144	1,430	2,861	5,722	8,583	11,444	14,304	17,165	20,026	22,887	25,748	28,609
80	327	654	981	1,308	1,635	3,270	6,539	9,809	13,078	16,348	19,618	22,887	26,157	29,426	32,696
90	368	736	1,103	1,471	1,839	3,678	7,357	11,035	14,713	18,391	22,070	25,748	29,426	33,105	36,783
100	409	817	1,226	1,635	2,043	4,087	8,174	12,261	16,348	20,435	24,522	28,609	32,696	36,783	40,870

Guillemot Displacement PVA Results

11.4.3.60 Further consideration of the potential displacement and consequent mortality to the guillemot feature of the FFC SPA from Hornsea Four in combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. The potential in-combination impacts have been assessed against the latest 2017 colony count population size of 121,754 breeding adults as agreed with Natural England (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**. The results of the PVA runs for guillemot displacement impacts from Hornsea Four in combination with all other projects attributed to the FFC SPA colony are summarised in **Table 46**. PVA has been undertaken for a wide range of displacement and mortality rate scenarios in order to better understand the level of risk involved with increasing levels of displacement resulting in mortality.

Table 46: Population modelling results using the Natural England Seabird PVA Tool for potential guillemot displacement mortality rate for Hornsea Four in-combination with all other projects attributed to the FFC SPA.

Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth rate (after 35 years)	Reduction in growth rate (per annum)
30% disp, 1% Mort	123	0.999	0.11%
50% disp, 1% Mort	204	0.998	0.19%
70% disp, 1% Mort	286	0.997	0.26%
30% disp, 2% Mort	245	0.998	0.23%
50% disp, 2% Mort	409	0.996	0.38%
70% disp, 2% Mort	572	0.995	0.53%
30% disp, 5% Mort	613	0.994	0.56%
50% disp, 5% Mort	1022	0.991	0.94%
70% disp, 5% Mort	1430	0.987	1.31%
30% disp, 10% Mort	1226	0.989	1.13%
50% disp, 10% Mort	2044	0.981	1.88%
70% disp, 10% Mort	2861	0.974	2.63%

Table 47: Average annual colony growth rate for guillemot colony at Flamborough Head and Bempton Cliffs SPA between 1969 – 2017.

	Colony Annual Compound Growth Rate			
Species	1969 - 2017 (FH & BC SPA)	1987 - 2017 (FH & BC SPA)	2000 - 2017 (FH & BC SPA)	2008 - 2017 (FH & BC SPA)
Guillemot	4.05%	3.23%	3.49%	3.93%

11.4.3.61 The average annual colony growth rates for guillemot presented in **Table 47** are derived from the colony counts presented in the 2019 FFC SPA seabird monitoring programme (Lloyd et al. 2019). Over the nearly 50-year period presented, the guillemot population has grown annually by just over 4%, when considering the population growth over the last 20 years the average annual growth rate was still calculated as over 3% per annum, despite multiple OWFs being operational within the North Sea over that period. Although it is impossible to know exactly what the growth rate of the guillemot feature will be over the 35 year project lifespan of Hornsea Four, the current colony growth rates would suggest that the colony is likely to still increase in size, even when applying the reduction in annual growth rates presented in **Table 46**.

11.4.3.62 As stated previously, Natural England do not consider a single displacement and mortality rate for auks, instead preferring a range-based approach to impact assessments. With respect to interpreting the most likely impacts of a range-based approach for auks at the FFC SPA, Natural England provided Norfolk Boreas (Natural England, 2020) with the following advice:

'*While there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of guillemot density during both the breeding (where relevant) and non-breeding seasons (Seabird Sensitivity Mapping Tool), it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from less good areas would be lower than displacement from optimal/important areas. Therefore, we do not expect mortality rates to be at the top of the range considered.*'

11.4.3.63 The above statement provided to Norfolk Boreas by Natural England is considered of equal relevance in relation to in-combination assessments for Hornsea Four, as the sites screened in for both projects are the same. Furthermore, Natural England have stated that for the assessment of auk species, the Applicant should refer to the advice provided to Norfolk Boreas at Deadline 4 (Natural England 2020), as stated in Table 1. In that instance the upper range of 70% displacement and 10% mortality can be ruled out for assessment when considering all the offshore wind farms in-combination. The most recent advice provided by Natural England to EA1N and EA2 during their PINS Examination, at Deadline 12, makes it clear that the same advice provided to Norfolk Boreas remains in place and continues to be the most up to date on this topic regarding auk in-combination assessments for the FFC SPA (Natural England, 2021b).

11.4.3.64 Considering the latest evidence, compiled and presented for this assessment in **paragraphs 10.4.4.10** and **10.4.4.82**, it is clear that the use of a 50% displacement rate alongside a 1% mortality rate still offers a precautionary assessment for auks, regardless of the location of offshore wind farms in relation to auks. That evidence provides greater certainty that more extreme upper rates of displacement and mortality associated with Natural England's range-based approach are overly precautionary, most likely due to relying on historic data from limited studies available at the time it was issued in 2017 (SNCBs, 2017) that used older data collection and modelling methods for analysis.

11.4.3.65 It must also be noted that assessments of displacement in-combination incorporate multiple layers of precaution, which intensify as more offshore wind farms are added together. This is demonstrated through considering each individual offshore wind farm assessment for displacement is based the mean peak for each bio-season (i.e. the largest two abundances within the same seasons in two different years) and that when these values are added together at a cumulative level a highly unlikely total abundance of birds is estimated within all these array areas and 2 km buffers. In this instance, for guillemot, the total in-combination abundances in **Table 44** are derived from the cumulative data presented in Section 5.12 of **Volume A5, Chapter 5: Offshore and Intertidal Ornithology**. These cumulative data represent almost 25% of the entire North Sea and English Channel BDMPS population, whilst the area covered by the combined array areas and 2 km buffers of all those offshore wind farms contributing to that total and used to apportion to the FFC SPA in this displacement in-combination assessment would be well under 5% of the area. Therefore, by adding together seasonal mean peaks in this manner the overall assessment for cumulative displacement is considered to be highly precautionary.

11.4.3.66 Based on the points stated above, more robust evidence in relation to displacement and consequent mortality rates from OWFs as detailed in **Section 10.4.4**, the statement from Natural England that the majority of OWFs included within this in-combination assessment do not lie in areas of high importance to guillemots, it is therefore highly unlikely that for all OWFs an average displacement of over 50% with a mortalilty rate of over 1% would occur in-combination. Natural England have previously stated that a maximum reduction in the growth rate of 0.4% would not cause an AEoI of the guillemot feature of the FFC SPA (Natural England, 2021b), although when considering that the actual annual growth rate over the past 50 years has been over 3% annually it's highly plausible that a higher reduction in growth rate would still not lead to a reduction in the population or, therefore, an AEoI. Nevertheless, the results of the PVA for scenarios up to 50% Displacement and a 2% mortality rate, which equates to a twofold increase in predicted mortalities when compared to the realistic predicted mortality form 50% displacement and 1% mortality, would not exceed a reduction in growth rate of over 0.4%, therefore, even considering this more precautionary approach to assessing the in-combination impacts (even when considering up to an overly precuationary 50% Displacement and a 2% mortality rate) the target for the guillemot feature to maintain the size of the breeding population at a level which is above 41,607 breeding pairs (83,214 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent would still be met for over the operational lifespan of Hornsea Four. There is, therefore, no potential for an AEoI to the conservation objectives of the guillemot feature of FFC SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four in-combination and therefore, subject to natural change, guillemot will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – razorbill

11.4.3.67 Razorbill has been screened into the in-combination assessment of the Hornsea Four O&M phase to assess the impacts from displacement from Hornsea Four in-combination with other projects in relation to the following conservation objectives for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

11.4.3.68 Based on the above the conservation objective for the FFC SPA the specific target for the razorbill feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level which is above 10,570 breeding pairs (21,140 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest colony population estimate is 40,506 breeding adults based on the most recent 2017 colony count.

11.4.3.69 The projects screened in are the proposed and operating offshore wind farms in the UK waters of the North Sea and English Channel. They have been screened in on the basis of the species' sensitivity to the presence of the WTGs, the activities which will take place within the array area during maintenance and the experience of the in-combination assessments carried out for offshore wind farms in recent years. The Hornsea Four array area is within the mean max foraging distance of 88.7 km to the FFC SPA at 63 km distant and also within the mean max plus 1 SD foraging distance of 164.6 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding seasons. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the return migration bio-season defined as the months of January to March, the migration-free breeding bio-season defined as being the months of April to July, the post-breeding migration bio-season defined as the months of August to October and the migration-free winter bio-season defined as the months of November and December by Furness (2015).

11.4.3.70 Following this approach, the proportion of the BDMPS populations from FFC SPA during migration bio-seasons of 3.38% and during the winter bio-season of 2.74% was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the evidence plan process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

11.4.3.71 The in-combination totals presented in **Table 48** for all consented and planned projects are derived from the in-combination tables presented at at Deadline XI for EA1N / EA2 (SPR, 2021) which are the most up to date in-combination disturbance and displacement tables for the FFC SPA at the time of this assessment. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (SPR, 2021) for assessments included within this report:

- Updated displacement values for Hornsea Four attributed to the FFC SPA as described within this report (Table 16);
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational; and
- Inclusion of Hornsea Three final Applicant's values as presented in (Orsted, 2021a).

11.4.3.72 In order to assess the potential impact on razorbill a displacement effect distance was determined of the array area and within a buffer out to 2 km. Within that displacement effect area the percentage of birds displaced from the array area was set at 50% during all bio-seasons and within the 2 km buffer. The level of mortality consequential of displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **Section 10.4.4.10.**

11.4.3.73 Natural England consider displacement and any consequent mortality rates in the assessments of razorbill should be made using a range of values. The displacement matrix in **Table 49** provides a displacement matrix for the in-combination annual total of razorbills apportioned to FFC SPA predicted to be at risk of displacement from all projects within the North Sea and English Channel (OFF-ORN-4.8 **B1.1.1 Evidence Plan**) when applying any value of displacement or mortality. Summary statements applying the lower end (a displacement rate of 30% and a mortality rate of 1%) and extreme upper end (a displacement rate of 70% and a mortality rate of 10%) of Natural England's range of displacement and consequent mortality rates are also considered within this assessment, though Natural England acknowledge that the use of displacement mortality rates from the upper end of the range are not likely (OFF-ORN-2.50 **B1.1.1 Evidence Plan**).

11.4.3.74 For Hornsea Four, the detailed calculations of how razorbills have been apportioned to the FFC SPA are presented in **Section 10.4.4.92**. **Table 48** below sets out the in-combination total of birds displaced from OWF within the North Sea and English Channel attributed to the FFC SPA.

Table 48: In-combination displacement totals for razorbill attributed to the FFC SPA.

Project	Migration-free breeding	Post-breeding migration	Migration-free winter	Return migration	Annual total	Tier
Beatrice	0	28	15	28	72	1a
Blyth Demonstration Site	0	3	2	3	8	1a
Dudgeon	0	12	20	12	44	1a
East Anglia One	0	1	4	11	17	1a
EOWDC	0	2	0	1	3	1a
Galloper	0	2	3	13	18	1a
Greater Gabbard	0	0	11	3	13	1a
Gunfleet Sands	0	0	1	0	1	1a
Hornsea Project One	535	164	41	61	800	1a
Humber Gateway	0	1	0	1	2	1a
Hywind 2 Demonstration	0	24	0		25	1a
Kentish Flats Extension	-	-	-	-	-	1a
Kentish Flats I	-	-	-	-	-	1a
Kincardine	0	0	0	0	0	1a
Lincs, Lynn & Inner Dowsing	0	1	1	1	3	1a
London Array	0	1	0	1	2	1a
Methil	0	0	0	0	0	1a
Race Bank	0	1	1	1	4	1a

Project	Migration-free breeding	Post-breeding migration	Migration-free winter	Return migration	Annual total	Tier
Rampion	0	2	34	113	149	1a
Scroby Sands	-	-	-	-	-	1a
Sheringham Shoal	0	46	6	1	52	1a
Teesside	0	2	0	1	3	1a
Thanet	0	0	0	1	1	1a
Westermost Rough	91	4	4	3	102	1a
Hornsea Project Two	1,210	144	19	57	1,430	1b
Moray East	0	38	1	6	44	1b
Neart na Gaoithe	0	187	14	-	200	1b
Seagreen Alpha	0	0	30	-	30	1b
Seagreen Bravo	0	0	34	-	34	1b
Triton Knoll	0	9	23	4	36	1b
Dogger Bank A	375	54	47	141	616	1c
Dogger Bank B	461	71	58	174	765	1c
Dogger Bank C	250	11	26	65	352	1c
East Anglia Three	0	38	41	52	130	1c
Hornsea Three	516	69	99	72	756	1c
Inch Cape	0	98	18	-	115	1c
Moray West	0	121	5	122	247	1c
Sofia	346	20	39	100	505	1c
East Anglia ONE North	0	3	2	7	11	1d
East Anglia TWO	0	2	4	8	13	1d
Norfolk Boreas	0	9	29	12	49	1d
Norfolk Vanguard	0	30	23	31	84	1d
Hornsea Four	154	121	13	13	301	1d
Dudgeon Extension Project	0	124	19	9	153	2
Sheringham Shoal Extension Project	0	22	16	5	43	2
All Projects Total	**3,938**	**1,461**	**700**	**1,133**	**7,232**	

11.4.3.75 To these in-combination totals the displacement and consequential mortality scenarios are applied as follows:

Breeding Season

11.4.3.76 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, in the migration-free breeding bio-season is 1,969 breeding adults (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at 20 (19.69) breeding adults.

11.4.3.77 When considering the potential impact of this loss to the FFC SPA (classified razorbill population of 21,140 breeding adults), with an annual background mortality of 2,220 breeding adults, then this prediction of 20 breeding adults suffering displacement consequent mortality would represent a 0.89% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.03% in baseline mortality. As the population of razorbills has increased significantly since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 40,506 breeding individuals. On this basis if all the birds predicted to be displaced were breeding adult birds from the FFC SPA (with an annual background mortality of 4,253 breeding adults) then the prediction of 20 breeding adult birds suffering displacement consequent mortality would represent a 0.46% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.02% in baseline mortality.

11.4.3.78 Should Natural England's range of displacement and mortality rates (Applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the in-combination impact of displacement is a prediction of consequent mortality of between 12 (11.82) and 276 (275.69) breeding adult birds from the SPA in the migration-free breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.53% and 12.42% when considering the citation population (Hornsea Four alone contributes an increase of less than one to 11 predicted breeding adult mortalities equating to an increase of 0.02% to 0.49% in baseline mortality) or between 0.28% and 6.48% when considering the recent 2017 colony count (Hornsea Four alone contributes an increase of less than one to 11 predicted breeding adult mortalities equating to an increase of 0.01% to 0.25% in baseline mortality) in the migration-free breeding bio-season per annum. However, it is acknowledged by Natural England (see statement below **paragraph 11.4.3.87**) that on the basis that projects currently screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging, the upper range of displacement and mortality do not need to be considered.

Non-Breeding Season

11.4.3.79 Non-The in-combination number predicted to be displaced from the offshore wind farms assessed, including Hornsea Four, that has been apportioned to FFC SPA in the three non-breeding bio-seasons is 567 (566.50) breeding adults in the return migration, 731 (730.50) breeding adults in post-breeding migration and 350 breeding adults in the migration-free winter bio-season (applying a displacement rate of 50%). The predicted consequent mortality from being displaced is estimated respectively at 6 (5.66), 7 (7.31) and 4 (3.50) breeding adult birds (applying a mortality rate of 1%), this equates to a total consequent mortality from being displaced across the whole non-breeding bio-season of 16 (16.47) breeding adult birds.

11.4.3.80 When considering the potential impact of this loss to the FFC SPA citation population, then using this prediction of 16 breeding adults suffering displacement consequent mortality would represent a 0.74% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.03% in baseline mortality. when considering the potential impact of this loss to the more recent 2017 colony count for razorbill, then this prediction of 16 breeding adult birds suffering displacement consequent mortality would represent a 0.39% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.02% in baseline mortality.

11.4.3.81 Should Natural England's range of displacement and mortality rates (Applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the in-combination impact of displacement is a prediction of consequent mortality of between 10 (9.88) and 231 (230.52) breeding adult birds from the SPA across the whole non-breeding bio-season. This predicted additional mortality would represent an increase in baseline mortality of between 0.45% and 10.39% when considering the citation population count (Hornsea Four alone contributes an increase of less than one to 10 predicted breeding adult mortalities equating to an increase of 0.02% to 0.46% in baseline mortality) or between 0.23% and 5.42% when considering the recent 2017 colony count count (Hornsea Four alone contributes an increase of less than one to 10 predicted breeding adult mortalities equating to an increase of 0.01% to 0.24% in baseline mortality) in the non-breeding bio-season per annum. However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10** and **10.4.4.112** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.87**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality) can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Annual Total

11.4.3.82 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, is a prediction of consequent mortality of 20 breeding adult birds from the SPA in the breeding bio-season and 16 breeding adult birds in the non-breeding bio-seasons equates to 36 (36.16) breeding adult birds across all bio-seasons per annum. The predicted increase in baseline mortality of the citation population or 2017 colony count equates to 1.63% or 0.85% across all bio-seasons per annum respectively (Hornsea Four alone contributes an increase of less than two predicted breeding adult mortalities equating to an increase of 0.07% or 0.04% in baseline mortality across all bio-seasons per annum), results in an increase in the baseline mortality above 1%, and therefore further consideration of the impacts are required.

11.4.3.83 Should Natural England's range of displacement mortality rates (applying a range of 30% displacement with 1% mortality and 70% displacement with 10% mortality) be considered alongside the evidence-led apportionment then the in-combination impact of displacement is a prediction of consequent mortality of between 22 (21.70) and 506 (506.27) breeding adult birds from the SPA across all bio-seasons. This predicted additional mortality would represent an increase in baseline mortality ofbetween 0.98% and 22.81% when considering the citation population (Hornsea Four alone contributes an increase of less than one to 21 predicted breeding adult mortalities equating to an increase of 0.04% to 0.95% in baseline mortality across all bio-seasons per annum) or between 0.51% and 11.90% when considering the recent 2017 colony count per annum across all bio-seasons (Hornsea Four alone contributes an increase of less than one to 21 predicted breeding adult mortalities equating to an increase of 0.02% to 0.50% in baseline mortality across all bio-seasons per annum). However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10** and **10.4.4.112** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.87**). This means that using Natural England's upper ranges of displacement and mortality (over 50% displacement and over 1% mortality) for assessment can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Table 49: In-combination annual displacement matrix for razorbill attributed to the FFC SPA values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	1	1	2	3	4	7	14	22	29	36	43	51	58	65	72
10	7	14	22	29	36	72	145	217	289	362	434	506	579	651	723
20	14	29	43	58	72	145	289	434	579	723	868	1,012	1,157	1,302	1,446
30	22	43	65	87	108	217	434	651	868	1,085	1,302	1,519	1,736	1,953	2,169
40	29	58	87	116	145	289	579	868	1,157	1,446	1,736	2,025	2,314	2,603	2,893
50	36	72	108	145	181	362	723	1,085	1,446	1,808	2,169	2,531	2,893	3,254	3,616
60	43	87	130	174	217	434	868	1,302	1,736	2,169	2,603	3,037	3,471	3,905	4,339
70	51	101	152	202	253	506	1,012	1,519	2,025	2,531	3,037	3,543	4,050	4,556	5,062
80	58	116	174	231	289	579	1,157	1,736	2,314	2,893	3,471	4,050	4,628	5,207	5,785
90	65	130	195	260	325	651	1,302	1,953	2,603	3,254	3,905	4,556	5,207	5,858	6,508
100	72	145	217	289	362	723	1,446	2,169	2,893	3,616	4,339	5,062	5,785	6,508	7,232

Razorbill Displacement PVA Results

11.4.3.84 Further consideration of the potential displacement consequent mortality to the razorbill feature of the FFC SPA from Hornsea Four in combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. The potential in-combination impacts have been assessed against the latest 2017 colony count population size of 40,506 breeding adults (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Volume A5, Annex 5.4: Offshore Ornithology Population Viability Analysis**.

11.4.3.85 The results of the PVA runs for razorbill displacement impacts from Hornsea Four in-combination with all other projects attributed to the FFC SPA colony are summarised in **Table 50**. PVA has been undertaken for a wide range of displacement and mortality rate scenarios in order to better understand the level of risk involved with increasing levels of displacement resulting in mortality.

Table 50: Population modelling results using the Natural England Seabird PVA Tool for potential razorbill displacement mortality rate for Hornsea Four in-combination with all other projects attributed to the FFC SPA.

Scenario	Adult mortality (per annum)	Density-Independent counterfactual of population growth rate (after 35 years)	Reduction in growth rate (per annum)
30% disp, 1% Mort	22	0.999	0.06%
50% disp, 1% Mort	36	0.999	0.11%
70% disp, 1% Mort	51	0.999	0.15%
30% disp, 2% Mort	43	0.999	0.13%
50% disp, 2% Mort	72	0.998	0.21%
70% disp, 2% Mort	101	0.997	0.30%
30% disp, 5% Mort	108	0.997	0.32%
50% disp, 5% Mort	181	0.995	0.53%
70% disp, 5% Mort	253	0.993	0.74%
30% disp, 10% Mort	217	0.994	0.63%
50% disp, 10% Mort	362	0.989	1.05%
70% disp, 10% Mort	506	0.985	1.48%

Table 51: Average annual colony growth rate for razorbill colony at Flamborough Head and Bempton Cliffs SPA between 1969 – 2017.

Species	Colony Annual Compound Growth Rate			
	1969 - 2017 (FH & BC SPA)	1987 - 2017 (FH & BC SPA)	2000 - 2017 (FH & BC SPA)	2008 - 2017 (FH & BC SPA)
Razorbill	5.98%	4.40%	7.28%	7.20%

11.4.3.86 The average annual colony growth rates presented in **Table 51** are derived from the colony counts presented in the 2019 FFC SPA seabird monitoring programme (Lloyd et al. 2019). Over the nearly 50-year period presented, the razorbill population has grown annually by just under 6%, when considering the population growth over the last 20 years the average annual growth rate has further increased to over 7% per annum, despite multiple OWFs being operational within the North Sea over that period. Although it is impossible to know what the growth rate of the razorbill feature will be over the 35-year project lifespan of Hornsea Four, the current colony growth rates would suggest that the colony is likely to still increase, even when applying the reduction in growth rates presented in **Table 50**.

11.4.3.87 As stated previously, Natural England do not consider a single displacement and mortality rate for auks, instead preferring a range-based approach to impact assessments. With respect to interpreting the most likely impacts of a range-based approach for auks at the FFC SPA, Natural England provided Norfolk Boreas (Natural England 2020) with the following advice:

11.4.3.88 'While there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of razorbill density during both the breeding (where relevant) and non-breeding seasons (Seabird Sensitivity Mapping Tool), it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from less good areas would be lower than displacement from optimal/important areas.Therefore, we do not expect mortality rates to be at the top of the range considered.'

11.4.3.89 The above statement provided to Norfolk Boreas by Natural England is considered of equal relevance in relation to in-combination assessments for Hornsea Four, as the sites screened in for both projects are the same. Furthermore, Natural England have stated that for the assessment of auk species, the Applicant should refer to the advice provided to Norfolk Boreas at Deadline 4 (Natural England 2020), as stated in Table 5.1. In that instance the upper range of 70% displacement and 10% mortality was ruled out for assessment when considering all the offshore wind farms in-combination. The most recent advice provided by Natural England to EA1N and EA2 during their PINS Examination, at Deadline 12, makes it clear that the same advice provided to Norfolk Boreas remains in place and continues to be the most up to date on this topic regarding auk in-combination assessments for the FFC SPA (Natural England, 2021b).

11.4.3.90 Considering the latest evidence, compiled and presented for this assessment in Section 10.4.4, it is clear that the use of a 50% displacement rate alongside a 1% mortality rate still offers a precautionary assessment for auks, regardless of the location of offshore wind farms in relation to auks. That evidence provides greater certainty that more extreme upper rates of displacement and mortality associated with Natural England's range-based approach are overly precautionary, most likely due to relying on historic data from limited studies available at the time it was issued in 2017 (SNCBs, 2017) that used older data collection and modelling methods for analysis.

11.4.3.91 It must also be noted that assessments of displacement in-combination incorporate several layers of precaution which intensify as more offshore wind farms area added together. This is demonstrated through considering each individual offshore wind farm assessment for displacement is based the mean peak for each bio-season (i.e. the largest two abundances within the same seasons in two different years) and that when these values are added together at a cumulative level a highly unlikely total abundance of birds is estimated within all these array areas and 2 km buffers. In this instance, for razorbill, the total in-combination abundances in **Table 48** are derived from the cumulative data presented in Section 5.12 of **Volume A5, Chapter 5: Offshore and Intertidal Ornithology**. These cumulative data represent over 20% of the entire North Sea and English Channel BDMPS population, whilst the area covered by the combined array areas and 2 km buffers of all those offshore wind farms contributing to that total and used to apportion to the FFC SPA in this displacement in-combination assessment would be well under 5% of the area. Therefore, by adding together seasonal mean peaks in this manner the overall assessment for cumulative displacement is considered to be highly precautionary.

11.4.3.92 Based on the points stated above, more robust evidence in relation to displacement and consequent mortality rates from OWFs as detailed in **paragraph 10.4.4.10**, the statement from Natural England that the majority of OWFs included within this in-combination assessment do not lie in areas of high importance to razorbills, it is therefore highly unlikely that for all OWFs an average displacement of over 50% with a mortality rate of over 1% would occur in-combination. Natural England have previously stated that a maximum reduction in the growth rate of 0.5% would not cause an AEoI of the razorbill feature of the FFC SPA (Natural England, 2021b), although when considering the actual annual growth rate over the past 50 years has been just under 6% annually it's highly plausible that a higher reduction in growth rate would still not lead to a reduction in the population or, therefore, an AEoI. Nevertheless, the results of the PVA for scenarios up to 50% Displacement and a 5% mortality rate, which equates to over a fivefold increase in predicted mortalities when compared to the realistic predicted mortality form 50% displacement and 1% mortality, would not exceed a reduction in growth rate of over 0.5%, therefore, even considering this more precautionary approach to assessing the in-combination impacts (even when considering up to an overly precuationary 50% Displacement and a 5% mortality rate) the target for the razorbill feature to maintain the size of the breeding population at a level which is above 10,570 breeding pairs (21,140 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent would still be met for the FFC SPA over the operational lifespan of Hornsea Four. There is, therefore, no potential for an AEoI to the conservation objectives of the razorbill feature of FFC SPA in relation to disturbance and displacement effects in the O&M phase from Hornsea Four in-combination and therefore, subject to natural change, razorbill will be maintained as a feature in the long term.

Flamborough and Filey Coast SPA – puffin

11.4.3.93 Puffin has been screened into the in-combination assessment of the Hornsea Four O&M phase to assess the impacts from displacement from Hornsea Four in-combination with other projects in relation to the following conservation objective, as a component of the seabird assemblage:

- Maintain the population of each of the qualifying features.

11.4.3.94 Based on the above the conservation objective for the FFC SPA the specific target for the seabird assemblage of which puffin is a component is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the overall abundance of the assemblage at a level which is above 216,730 individuals whilst avoiding deterioration from its current level as indicated by the latest peak mean count or equivalent.

11.4.3.95 Although puffin is only a named feature of the seabird assemblage, for the purpose of this assessment it has been considered in a similar manner to qualifying species, though the conclusion is not whether an AEoI would result from Hornsea Four in-combination with other projects on puffin as a feature, but more as an important component of the seabird assemblage.

11.4.3.96 The projects screened in are the proposed and operating offshore wind farms in the UK waters of the North Sea and English Channel. They have been screened in on the basis of the species' sensitivity to the presence of the WTGs, the activities which will take place within the array area during maintenance and the experience of the in-combination assessments carried out for offshore wind farms in recent years. The Hornsea Four array area is within the mean maximum foraging distance of 137.1 km to the FFC SPA at 63 km distant and also within the mean maximum plus 1 SD foraging distance of 265.4 km (Woodward et al. 2019). Accordingly, this species is assessed for both the breeding and non-breeding bio-season. The different bio-seasons for consideration of assessing potential risk from displacement on birds from FFC SPA and other designated sites includes the breeding bio-season, defined as being the months of April to July by Furness (2015) and the non-breeding bio-season of August to March.

11.4.3.97 The potential for impact on the FFC SPA varies by season and accordingly the assessment is carried out on a seasonal basis. This is because the population of birds in the area in and around Hornsea Four during the breeding bio-season may contain a higher proportion of adult birds (and potentially up to 100%) that can be attributed to a nearby breeding colony SPA. Outside the breeding season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. In the breeding bio-season the mean max plus 1 SD from Woodward et al. (2019) determines which breeding colonies the birds may be coming from and the contribution of that population to the total displaced is calculated using the SNH apportionment tool (SNH 2018).

11.4.3.98 Outside the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach, the proportion of the BDMPS populations from FFC SPA during non-breeding bio-season of 0.41% was agreed as appropriate for other auk species by

Natural England for this project through the evidence plan process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

11.4.3.99 In order to assess the potential in-combination impact on this species, information was compiled on the abundances that were measured at each of the OWF projects included in the in-combination assessment. The in-combination totals presented in **Table 52** for all consented projects are derived from the in-combination tables submitted at Deadline VIII for Norfolk Vanguard (MacArthur Green 2019b), with the addition of Gunfleet Sands, Kentish Flats (and subsequent extension) Methil, Rampion and Scroby Sands at the request of Natural England (OFF-ORN-6.7 **B1.1.1 Evidence Plan**). For the remaining projects (Norfolk Boreas, Hornsea Three, EA1N, EA2, Sheringham Shoal Extension and Dudgeon Extension projects) the in-combination totals were derived from the latest relevant examination submissions. For Hornsea Four, the details of how the apportioned abundance to the FFC was calculated is presented in **paragraph 10.4.4.141**.

11.4.3.100 In order to assess the potential impact on puffin a displacement effect distance was determined of the array area and within a buffer out to 2 km. Within that displacement effect area the percentage of birds displaced from the array area was set at 50% during all bio-seasons and within the 2 km buffer. The level of mortality consequential of displacement was set at 1% during all bio-seasons. Further details on the derivation of the extent of displacement and of the consequential mortality are given in **paragraph 10.4.4.10**.

11.4.3.101 Natural England consider displacement and any consequent mortality rates in the assessments of puffin should be made using a range of values. The displacement matrix in **Table 53** provides a displacement matrix for the in-combination annual total of puffins apportioned to FFC SPA predicted to be at risk of displacement from all projects within the North Sea and English Channel (OFF-ORN-4.8 **B1.1.1 Evidence Plan**) when applying any value of displacement or mortality. Summary statements applying the lower end (a displacement rate of 30% and a mortality rate of 1%) and extreme upper end (a displacement rate of 70% and a mortality rate of 10%) of Natural England's range of displacement and consequent mortality rates are also considered within this assessment, though Natural England acknowledge that the use of displacement mortality rates from the upper end of the range are not likely (OFF-ORN-2.50 **B1.1.1 Evidence Plan**).

11.4.3.102 For Hornsea Four, the detailed calculations of how puffins have been apportioned to the FFC SPA are presented in **paragraph 10.4.4.141**. **Table 52** below sets out the in-combination total of birds displaced from OWF within the North Sea and English Channel attributed to the FFC SPA.

Table 52: In-combination displacement totals for puffin attributed to the FFC SPA.

Project	Breeding	Non-breeding	Annual total	Tier
Beatrice	0	10	10	1a
Blyth Demonstration Site	0	1	1	1a
Dudgeon	0	0	0	1a

Project	Breeding	Non-breeding	Annual total	Tier
East Anglia One	0	0	0	1a
EOWDC	0	0	0	1a
Galloper	0	0	0	1a
Greater Gabbard	0	0	0	1a
Gunfleet Sands	-	-	0	1a
Hornsea Project One	407	5	412	1a
Humber Gateway	15	0	15	1a
Hywind 2 Demonstration	0	0	0	1a
Kentish Flats	-	-	0	1a
Kentish Flats Extension	0	0	0	1a
Kincardine	0	0	0	1a
Lincs, Lynn and Inner Dowsing	0	0	0	1a
London Array	0	0	0	1a
Methil	0	0	0	1a
Race Bank	0	0	0	1a
Rampion	0	0	0	1a
Scroby Sands	-	-	0	1a
Sheringham Shoal	0	0	0	1a
Teesside	35	0	35	1a
Thanet	0	0	0	1a
Westermost Rough	61	0	61	1a
Hornsea Project Two	178	8	186	1b
Moray East	0	3	3	1b
Neart na Gaoithe	0	9	9	1b
Seagreen Alpha	0	6	6	1b
Seagreen Bravo	0	16	16	1b
Triton Knoll	23	0	23	1b
Dogger Bank A	11	1	12	1c
Dogger Bank B	31	3	34	1c
Dogger Bank C	10	1	11	1c
East Anglia Three	0	1	1	1c
Hornsea Three	20	1	21	1c
Inch Cape	0	11	11	1c
Moray West	0	16	16	1c
Sofia	11	1	12	1c
East Anglia One North	-	-	0	1d
East Anglia Two	0	0	0	1d

Project	Breeding	Non-breeding	Annual total	Tier
Norfolk Boreas	0	1	1	1d
Norfolk Vanguard	0	0	0	1d
Hornsea Four	137	2	139	1d
Dudgeon Extension Project	0	0	0	2
Sheringham Shoal Extension Project	0	0	0	2
All Projects Total	**938**	**98**	**1,036**	

11.4.3.103 To these in-combination totals the displacement and consequential mortality scenarios are applied as follows:

Breeding Season

11.4.3.104 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, in the breeding bio-season is 469 breeding adults (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at five (4.69) breeding adults.

11.4.3.105 When considering the potential impact of this loss to the FFC SPA of 3,759 puffins based on the mean of the 2017 & 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with an annual background mortality of this number of breeding adult birds being 336 then using this prediction of five breeding adults suffering displacement consequent mortality would represent a 1.39% increase in baseline mortality during the breeding bio-season, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.20% in baseline mortality.

11.4.3.106 Should Natural England's range of displacement mortality rates be considered alongside the evidence-led apportionment, then the potential impact of this loss to the FFC SPA population based on the 2017 / 2018 average count, using the lower end of the range (applying rates of 30% displacement and 1% mortality) a prediction of three (2.81) breeding adults suffering displacement consequent mortality would represent a 0.84% increase in baseline mortality during the breeding bio-season, of which Hornsea Four alone contributes less than one predicted breeding adult mortality equating to an increase of 0.12% in baseline mortality. When considering using the upper end of the range (applying rates of 70% displacement and 10% mortality) then this prediction of 66 (65.65) breeding adult birds suffering displacement consequent mortality would represent a 19.51% increase in baseline mortality during the breeding bio-season, of which Hornsea Four alone contributes 10 predicted breeding adult mortalities equating to an increase of 2.85% increase in baseline mortality. However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10, 10.4.4.82** and **10.4.4.112** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.115**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1%

mortality) can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Non-Breeding Season

11.4.3.107 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, in the non-breeding bio-season is 49 breeding adults (applying a displacement rate of 50%) and the predicted consequent mortality (applying a mortality rate of 1%) from being displaced is estimated at less than a single (0.49) breeding adult.

11.4.3.108 When considering the potential impact of this loss to the FFC SPA of 3,759 puffins based on the mean of the 2017 & 2018 colony counts (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), then using this prediction of less than one breeding adult suffering displacement consequent mortality would represent a 0.15% increase in baseline mortality during the non-breeding bio-season, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of less than 0.01% in baseline mortality.

11.4.3.109 Should Natural England's range of displacement mortality rates be considered alongside the evidence-led apportionment, then the potential impact of this loss to the FFC SPA population based on the 2017 / 2018 average count, using the lower end of the range (applying rates of 30% displacement and 1% mortality) a prediction of less than a single breeding adult (0.29) breeding adults suffering displacement consequent mortality would represent a 0.09% increase in baseline mortality during the non-breeding bio-season, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.00% in baseline mortality. When considering using the upper end of the range (applying rates of 70% displacement and 10% mortality) then this prediction of seven (6.87) breeding adult birds suffering displacement consequent mortality would represent a 2.04% increase in baseline mortality during the non-breeding bio-season, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortalities equating to an increase of 0.03% in baseline mortality. However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10, 10.4.4.82** and **10.4.4.112** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.115**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality) can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Annual Total

11.4.3.110 The in-combination number predicted to be displaced from the OWFs assessed, including Hornsea Four, is a prediction of consequent mortality of five breeding adult birds from the SPA in the breeding bio-season and less than a single breeding adult in the non-breeding bio-season equates to five (5.18) breeding adult birds across all bio-seasons per annum. The predicted annual increase in baseline mortality of the 2017 / 2018 average colony count baseline mortality equates to 1.54% across all bio-seasons per annum (Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.21% in baseline mortality across all bio-seasons per annum), results in an increase in the baseline mortality above 1%, and therefore further consideration of the impacts are required.

11.4.3.111 Should Natural England's range of displacement mortality rates be considered alongside the evidence-led apportionment, then the potential impact of this loss to the FFC SPA population based on the 2017 / 2018 average count, using the lower end of the range (applying rates of 30% displacement and 1% mortality) a prediction of three (3.11) breeding adults suffering displacement consequent mortality would represent a 0.92% increase in baseline mortality annually across all bio-seaons, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.12% in baseline mortality. When considering using the upper end of the range (applying rates of 70% displacement and 10% mortality) then this prediction of 73 (72.51) breeding adult birds suffering displacement consequent mortality would represent a 21.55% increase in baseline mortality annually across all bio-seaons, of which Hornsea Four alone contributes an increase of 10 predicted breeding adult mortalities equating to an increase of 2.88% in baseline mortality. However, based on the evidence put forward for auk species in **paragraphs 10.4.4.10, 10.4.4.82** and **10.4.4.112** for Hornsea Four and Natural England suggesting the other sites screened in for in-combination assessment reside in areas of the UK North Sea regarded as less important / desirable for foraging (see statement below **paragraph 11.4.3.115**), Natural England's upper ranges of displacement and mortality (over 50% discplacement and over 1% mortality) can be considered overly precautionary and unsuitable for the basis of disturbance and displacement assessment.

Table 53: In-combination annual displacement matrix for puffin attributed to the FFC SPA values in green represent the range-based values advocated by Natural England and the darker shade of green representing the Applicant's approach value.

Displacement Rate (%)	Mortality Rate (%)														
	1	2	3	4	5	10	20	30	40	50	60	70	80	90	100
1	0	0	0	0	1	1	2	3	4	5	6	7	8	9	10
10	1	2	3	4	5	10	21	31	41	52	62	73	83	93	104
20	2	4	6	8	10	21	41	62	83	104	124	145	166	186	207
30	3	6	9	12	16	31	62	93	124	155	186	218	249	280	311
40	4	8	12	17	21	41	83	124	166	207	249	290	331	373	414
50	5	10	16	21	26	52	104	155	207	259	311	363	414	466	518
60	6	12	19	25	31	62	124	186	249	311	373	435	497	559	621
70	7	15	22	29	36	73	145	218	290	363	435	508	580	653	725
80	8	17	25	33	41	83	166	249	331	414	497	580	663	746	829
90	9	19	28	37	47	93	186	280	373	466	559	653	746	839	932
100	10	21	31	41	52	104	207	311	414	518	621	725	829	932	1,036

Puffin Displacement PVA Results

11.4.3.112 Further consideration of the potential displacement consequent mortality to the puffin feature of the FFC SPA from Hornsea Four in combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. The potential in-combination impacts have been assessed against the average estimate of the 2017 / 2018 colony equating to 3,579 breeding adults (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**.

11.4.3.113 The results of the PVA runs for puffin displacement impacts from Hornsea Four in-combination with all other projects attributed to the FFC SPA colony are summarised in **Table 54**. PVA has been undertaken for a wide range of displacement and mortality rate scenarios in order to better understand the level of risk involved with increasing levels of displacement resulting in mortality.

Table 54: Population modelling results using the Natural England Seabird PVA Tool for potential puffin displacement mortality rate for Hornsea Four in-combination with all other projects attributed to the FFC SPA.

Scenario	Adult mortality (per annum)	Density-Independent Counterfactual of population growth rate(after 35 years)	Reduction in growth rate (per annum)
30% disp, 1% Mort	3	0.999	0.10%
50% disp, 1% Mort	5	0.998	0.17%
70% disp, 1% Mort	7	0.998	0.24%
30% disp, 2% Mort	6	0.998	0.21%
50% disp, 2% Mort	10	0.997	0.34%
70% disp, 2% Mort	15	0.995	0.48%
30% disp, 5% Mort	16	0.995	0.51%
50% disp, 5% Mort	26	0.991	0.85%
70% disp, 5% Mort	36	0.988	1.19%
30% disp, 10% Mort	31	0.990	1.02%
50% disp, 10% Mort	52	0.983	1.70%
70% disp, 10% Mort	73	0.976	2.38%

11.4.3.114 It has not been possible to calculate the annual compound colony growth rates for puffins at the FFC SPA due to lack of full colony counts completed for puffin (Lloyd et al. 2019). The last land based whole colony count was conducted in 2008 and recorded a total of 958 individuals, adjusted to 958 apparently occupied burrows (Seabird 2000). In recent years a different strategy has been implemented of counting puffins staging on the sea in the pre-breeding period. The results of the at sea surveys were 2,267, 2,879 and 4,279 from 2016 to 2018 resepctively (surveys could not be completed in 2019 and 2020). Despite the caveats associated with the accuracy of the at sea counts, the results would suggest that the puffin population of the FFC SPA are in favourable condition with significant annual growth highly probable based on the counts above.

11.4.3.115 As stated previously, Natural England do not consider a single displacement and mortality rate for auks, instead preferring a range-based approach to impact assessments. With respect to interpreting the most likely impacts of a range-based approach for auks at the FFC SPA, there hasn't been any recent specific advice offered by Natural England to delevopers on interpretation of puffin impacts attributed to the FFC SPA. However, the advice stated below by Natural England provided to Norfolk Boreas (Natural England 2020) in relation to guillemot and razorbill range-based interpretation is applicable to puffin due to having similar foraging behaviour:

'While there is some empirical evidence to support the displacement levels for auks we do not know what the likely mortality impacts of displacement are. We therefore consider it appropriate to consider a range of mortalities from 1-10%. However, on the basis that the projects that have been scoped into the assessment lie in areas of the North Sea that represent low to medium levels of guillemot (and razorbill) density during both the breeding (where relevant) and non-breeding seasons (Seabird Sensitivity Mapping Tool), it is assumed that areas of low/medium density will be less important/desirable feeding areas and therefore mortality impacts of displacement from less good areas would be lower than displacement from optimal/important areas. Therefore, we do not expect mortality rates to be at the top of the range considered.'

11.4.3.116 The above statement provided to Norfolk Boreas by Natural England is considered of equal relevance in relation to in-combination assessments for Hornsea Four, as the sites screened in for both projects are the same. Furthermore, Natural England have stated that for the assessment of auk species, the Applicant should refer to the advice provided to Norfolk Boreas at Deadline 4 (Natural England 2020), as stated in **Table 1**. In that instance the upper range of 70% displacement and 10% mortality was ruled out for assessment when considering all the offshore wind farms in-combination. The most recent advice provided by Natural England to EA1N and EA2 during their PINS Examination, at Deadline 12, makes it clear that the same advice provided to Norfolk Boreas remains in place and continues to be the most up to date on this topic regarding auk in-combination assessments for the FFC SPA (Natural England, 2021b).

11.4.3.117 Considering the latest evidence, compiled and presented for this assessment in **paragraph 10.4.4.10**, it is clear that the use of a 50% displacement rate alongside a 1% mortality rate still offers a precautionary assessment for auks, regardless of the location of offshore wind farms in relation to auks. That evidence provides greater certainty that more extreme upper rates of displacement and mortality associated with Natural England's range-based approach are overly precautionary, most likely due to relying on historic data from limited studies available at the time it was issued in 2017 (SNCBs, 2017) that used older data collection and modelling methods for analysis.

11.4.3.118 It must also be noted that assessments of displacement in-combination incorporate several layers of precaution which intensify as more offshore wind farms area added together. This is demonstrated when considering each individual offshore wind farm assessment for displacement is based the mean peak for each bio-season (i.e. the largest two abundances within the same seasons in two different years) and that when these values are added together at a cumulative level a highly unlikely total abundance of birds is estimated within all these array areas and 2 km buffers. In this instance, for puffin, the total in-combination abundances in **Table 52** are derived from the cumulative data presented in Section 5.12 of **Volume A5, Chapter 5: Offshore and Intertidal Ornithology**.

These cumulative data represent almost 20% of the entire North Sea and English Channel BDMPS population, whilst the area covered by the combined array areas and 2 km buffers of all those offshore wind farms contributing to that total and used to apportion to the FFC SPA in this displacement in-combination assessment would be well under 5% of the area. Therefore, by adding together seasonal mean peaks in this manner the overall assessment for cumulative displacement is considered to be highly precautionary.

11.4.3.119 Based on the points stated above, more robust evidence in relation to displacement and consequent mortality rates for OWFs as detailed in **paragraph 10.4.4.10**, the statement from Natural England that the majority of OWFs included within this in-combination assessment do not lie in areas of high importantace to auks, it is therefore highly unlikely that for all OWFs an average displacement of over 50% with a mortality rate of over 1% would occur in-combination. Therefore, when considering a maximum reduction of five breeding adult puffins from the FFC SPA colony this would be considered de minimis, the baseline mortality rate of this puffin population (336 breeding adults per annum) is highly likely to fluctuates on an annual basis by more than five birds in any case, so in reality the loss of such a small number would not be significant to the colony. The assessment of puffin, as a named species within the seabird assemblage, provides evidence that the conservation objective of the seabird assemblage feature of the FFC SPA would not be significantly adversely affected due to displacement of puffins as a consequence of Hornsea Four in-combination with other projects. The conservation objective to which is to maintain an overall seabird assemblage population level of all species at the FFC SPA of 216,730 individuals, therefore the loss of five birds is not considered to make any consequential difference to this being maintained. Therefore, the conservation objectives will still be met over the operational lifespan of Hornsea Four and an AEoI from in-combination displacement impacts can be ruled out on the seabird assemblage when considering puffin and other species.

Collision Risk

11.4.3.120 The potential for collision risk from offshore wind farms to result in an AEoI in-combination with Hornsea Four relates to the following designated site and the relevant features:

- Flamborough and Filey Coast SPA; gannet and kittiwake.

11.4.3.121 This site and the relevant interest features identified were screened in for LSE for the project 'alone' and the attribution of the predicted collision mortality. With the project 'alone' collision mortality and attribution having been completed the assessment of potential in-combination impacts can be carried out on a quantitative basis.

11.4.3.122 The remaining sites and features screened in for potential LSE as a consequence of collision risk during operation and maintenance are as follows:

- Flamborough and Filey Coast SPA (herring gull);
- Greater Wash SPA (little gull); (waterbirds and hen harrier);
- Humber Estuary Ramsar (waterbirds and hen harrier);
- Hornsea Mere SPA (Gadwall);
- Northumbria Coast SPA (Arctic tern);
- Teesmouth and Cleveland Coast SPA (Sandwich tern and common tern);

- Coquet Island SPA (kittiwake, common tern, Arctic tern, roseate tern, Sandwich tern);
- Farne Islands SPA (kittiwake, common tern, Arctic tern, Sandwich tern);
- Northumberland Marine SPA (kittiwake, common tern, Arctic tern, roseate tern, Sandwich tern);
- St Abbs Head SPA (kittiwake);
- Forth Islands SPA (gannet, kittiwake, common tern, Arctic tern, Sandwich tern)
- Outer Firth of Forth and St Andrews Complex pSPA (gannet, kittiwake);
- Fowlsheugh SPA (kittiwake);
- Buchan Ness to Collieston Coast SPA (kittiwake);
- Troup, Pennand and Lions Heads SPA (kittiwake);
- East Caithness Cliffs SPA (kittiwake);
- North Caithness Cliffs SPA (kittiwake);
- Copinsay SPA (kittiwake);
- Hoy SPA (Arctic skua, Great skua, kittiwake);
- Marwick Head SPA (kittiwake);
- Rousay SPA (Arctic skua, kittiwake, Arctic tern);
- Calf of Eday SPA (kittiwake, great black-backed gull);
- West Westray SPA (Arctic skua, kittiwake, Arctic tern);
- Fair Isle SPA (gannet, Arctic skua, Great skua, kittiwake, Arctic tern);
- Sumburgh Head SPA (kittiwake, Arctic tern);
- Noss SPA (gannet, great skua, kittiwake);
- Foula SPA (Arctic skua, great skua, kittiwake, Arctic term);
- Fetlar SPA (Arctic skua, great skua, Arctic tern); and
- Hermaness, Saxa Vord and Valla Field SPA (gannet, great skua, kittiwake).

11.4.3.123 For the assessment alone for herring gull from FFC SPA (see **paragraph 10.4.4.269**), Humber Estuary SPA and Ramsar (see **paragraph 10.4.4.280**), for gadwall from the Hornsea Mere SPA (see **paragraph 10.4.4.286**), for tern species associated with the Northumbria Coast SPA (Arctic tern) and Teesmouth and Cleveland Coast SPA (sandwich tern and common tern) (see **paragraph 10.4.4.320**), for kittiwake and terns at Coquet Island SPA (see **paragraphs 10.4.4.332** and **10.4.4.302**), kittiwake and terns at Farne Island SPA (see **paragraphs 10.4.4.341** and **10.4.4.302**), kittiwake and terns at the Northumberland Marine SPA (see **paragraphs 10.4.4.353** and **10.4.4.302**) and for various species at the more distant Scottish sites (see **paragraphs 10.4.4.291**, **10.4.4.302**, **10.4.4.309** and **10.4.4.320**, the latter including some English sites for terns) the conclusion drawn is of at most a very small and de minimis contribution to any increase in baseline mortality (typically less than one individual, with several species and/or features for particular sites considered not at risk at all) which is insufficient to result in a material contribution to any in-combination effect.

11.4.3.124 There is, therefore, no potential for an AEoI to the conservation objectives of the sites and associated features listed above in relation to collision risk in the operation and maintenance phase from Hornsea Four in-combination and therefore, subject to natural change, the features will be maintained in the long term with respect to the potential for adverse effects from disturbance and displacement.

Table 55: Summary of the sites and features considered for a collision risk assessment during the operation and maintenance phase for Hornsea Four alone.

Site	Feature	Considered in-combination?
Greater Wash SPA	Little gull during the non-breeding bio-season (migratory)	Yes
Flamborough and Filey Coast SPA	Gannet during the breeding and non-breeding bio-seasons	Yes
	Kittiwake during the breeding and non-breeding bio-seasons	Yes
	Herring gull during the breeding and non-breeding bio-seasons	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Humber Estuary SPA	Waterbirds and hen harrier during the non-breeding bio-season (migratory)	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Humber Estuary Ramsar	Waterbirds and hen harrier during the non-breeding bio-season (migratory)	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Hornsea Mere SPA	Gadwall during the non-breeding bio-season (migratory	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Northumbria Coast SPA	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Teesmouth and Cleveland Coast SPA	Sandwich tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Common tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Coquet Island SPA	Kittiwake during the non-breeding bio-season (migratory)	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Common tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.

Site	Feature	Considered in-combination?
	Roseate tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Sandwich tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Farne Islands SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Common tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Sandwich tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Northumberland Marine SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Common tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathwayfor a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Roseate tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Sandwich tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
St Abb's Head SPA	Kittiwake during the non-breeding bio-season (migratory)	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within

Site	Feature	Considered in-combination?
		the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Forth Islands (UK) SPA	Gannet during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Common tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Sandwich tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Outer Firth of Forth and St Andrew's Complex pSPA	Gannet during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Fowlsheugh SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Buchan Ness to Collieston Coast SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Troup, Pennan and Lion's Heads SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
East Caithness Cliffs SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
North Caithness Cliffs SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within

Site	Feature	Considered in-combination?
		the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Copinsay SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Hoy SPA	Arctic skua during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great skua during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Marwick Head SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
Rousay SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Arctic skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Calf of Eday SP	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great black-backed gull during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
West Westray SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Arctic skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.

Site	Feature	Considered in-combination?
Fair Isle SPA	Gannet during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great skua during the non-breeding bio-season (migratory	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Sumburgh Head SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Noss SPA	Gannet during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Foula SPA	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.

Site	Feature	Considered in-combination?
Fetlar SPA	Arctic skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Arctic tern during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
Hermaness, Saxa, Vord and Valla Field SPA	Gannet during the non-breeding bio-season	No - assessment alone concluded potential for a trivial and inconsequential level of effect, that would be well within the error margins of the assessment, and therefore no potential for any contribution for an in-combination effect.
	Kittiwake during the non-breeding bio-season	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.
	Great skua during the non-breeding bio-season (migratory)	No - assessment alone concluded no potential impact pathway and therefore no potential for any contribution for an in-combination effect.

11.4.3.125 The assessments provided within this RIAA for the remaining site and features to be assessed for collision risk in-combination (FFC SPA, gannet and kittiwake as well as Greater Wash, little gull) include a number of assumptions that contribute to the predicted impacts and potential effects being considered overly precautionary, including:

- The population within other offshore wind farm array areas and / or buffers are likely to include non-breeding and migratory birds moving north and south during the months considered as being included in the breeding bio-season for this assessment;
- All sites being considered within the maximum foraging range is very precautionary, considering that many of offshore wind farm array areas and their buffers are beyond a reasonable distance to assume to be regularly used (if at all) by kittiwakes and gannets during the breeding bio-season from the FFC SPA;
- Not 100% of adult birds within the offshore wind farms included within the in-combination assessment during the breeding bio-season will be from Flamborough and Filey Coast SPA; and
- Not accounting for additional non-breeding adults within the North Sea that contribute to the population within the offshore wind farms considered within this in-combination assessment throughout the year.

<u>Flamborough and Filey Coast SPA – gannet</u>

11.4.3.126 Gannet has been screened into the in-combination assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four in-combination with other projects in relation to the following conservation objective for this species, as a feature of the FFC SPA:

- Maintain the population of each of the qualifying features.

11.4.3.127 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts (Aitken et al. 2017).

11.4.3.128 The projects screened in are the proposed, consented, under-construction and operating offshore wind farms in the UK waters of the North Sea and English Channel (**Table 56**). They have been screened in on the basis of this species' flight behaviour that places it at risk of collision with the turning blades of the WTGs and the experience of the in-combination assessments carried out for other offshore wind farms in recent years. Collisions may occur when birds fly through operational offshore wind farms whilst foraging for food, commuting between breeding sites and foraging areas, or during migration. The Hornsea Four array area and multiple other offshore wind farms are within the mean max foraging distance of 315.2 km to the FFC SPA and also within the mean max plus 1 SD foraging distance of 509.4 km (Woodward et al. 2019). Accordingly, multiple offshore wind farms are screened in for consideration for this species for assessment during the breeding bio-season. Outside of the breeding bio-season gannets are known to range more widely, so consideration is provided to offshore wind farms within the wider UK North Sea and English Channel BDMPS area. The different bio-seasons for consideration of assessing potential risk from collision for gannets from FFC SPA from Hornsea Four in-combination with other offshore wind farms includes the migration-free breeding bio-season, defined as being the months of April to August by Furness (2015), the post-breeding migration bio-season of September to November the return migration bio-season of December to March.

11.4.3.129 During the breeding bio-season it is considered that potential collision mortality suffered by gannets from FFC SPA may be attributed more highly to offshore wind farms within areas of sea within foraging distance from this breeding colony.

11.4.3.130 Outside the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during return migration and post-breeding migration bio-seasons were estimated to be 6.23% and 4.84%, respectively, which was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the evidence plan process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

11.4.3.131 In order to assess the potential in-combination impact on this species, information was compiled on the predicted collision mortality for each of the OWF projects included in the in-combination assessment. The in-combination collision mortality totals presented in **Table 56** for all consented projects are derived from the latest in-combination collision risk values presented at at Deadline XI for EA1N / EA2 (SPR, 2021) which are the most up to date in-combination collision tables for the FFC SPA at the time of this assessment. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (SPR, 2021) for assessments included within this report:

- Updated collision values for Hornsea Four attributed to the FFC SPA as described within this report (**paragraph 10.4.4.232**);
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational; and
- Inclusion of Hornsea Three final Applicant's values as presented in (Orsted, 2021a).

11.4.3.132 For Hornsea Four, the detailed calculations of how gannets have been apportioned to the FFC SPA are presented in **paragraph 10.4.4.232**. **Table 56** below sets out the in-combination predicted collision totals from offshore wind farms within the North Sea and English Channel attributed to the FFC SPA.

Table 56: Attribution of gannet numbers to the FFC SPA for three bio-seasons for each offshore wind farm included in the in-combination assessment.

Project	Migration-free breeding	Post-breeding migration	Return migration	Annual total	Tier
Beatrice	0.0	2.3	0.6	2.9	1a
Blyth Demonstration Site	0.0	0.1	0.2	0.3	1a
Dudgeon	22.3	1.9	1.2	25.3	1a
East Anglia One	3.4	6.3	0.4	10.1	1a
EOWDC	0.0	0.3	0.0	0.3	1a
Galloper	0.0	1.5	0.8	2.3	1a
Greater Gabbard	0.0	0.4	0.3	0.7	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	11.5	1.5	1.4	14.4	1a
Humber Gateway	1.9	0.1	0.1	2.0	1a
Hywind 2 Demonstration	0.0	0.0	0.1	0.1	1a
Kentish Flats	0.0	0.0	0.1	0.1	1a
Kentish Flats Extension	-	-	-	-	1a
Kincardine	0.0	0.0	0.0	0.0	1a
Lincs, Lynn & Inner Dowsing	2.3	0.07	0.1	2.5	1a
London Array	0.0	0.07	0.1	0.2	1a
Methil	0.0	0.0	0.0	0.0	1a
Race Bank	33.7	0.6	0.3	34.5	1a
Rampion	0.0	3.1	0.1	3.2	1a

Project	Migration-free breeding	Post-breeding migration	Return migration	Annual total	Tier
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	14.1	0.2	0.0	14.3	1a
Teesside	2.4	0.1	0.0	2.5	1a
Thanet	0.0	0.0	0.0	0.0	1a
Westermost Rough	0.2	0.0	0.0	0.2	1a
Hornsea Project Two	7	0.7	0.4	8.0	1b
Moray East	0.0	1.7	0.6	2.3	1b
Neart na Gaoithe	0.0	2.3	1.4	3.7	1b
Seagreen Alpha & Bravo	0.0	2.4	4.1	6.4	1b
Triton Knoll	26.8	3.1	1.9	31.7	1b
Dogger Bank A & B	40.6	4.0	3.4	47.9	1c
Dogger Bank C & Sofia	7.4	0.5	0.7	8.5	1c
East Anglia Three	4.8	1.4	0.5	6.7	1c
Hornsea Three	1.0	0.0	0.0	1.0	1c
Inch Cape	0.0	1.4	0.3	1.7	1c
Moray West	0.0	0.1	0.1	0.2	1c
East Anglia ONE North	12.4	0.5	0.1	13.0	1d
East Anglia TWO	12.5	1.1	0.2	13.8	1d
Norfolk Boreas	14.2	0.6	0.2	15.1	1d
Norfolk Vanguard	8.2	0.9	0.3	9.4	1d
Hornsea Four	8.2	0.2	0.1	8.5	1d
Dudgeon Extension Project	3.6	0.2	0.0	3.9	2
Sheringham Shoal Extension Project	0.3	0.1	0.0	0.4	2
All Projects Total	**238.8**	**39.6**	**19.9**	**298.1**	

Breeding Season

11.4.3.133 The number of gannets from FFC SPA predicted to be subject to collision resultant mortality, from Hornsea Four in-combination with all other projects, in the migration-free breeding bio-season from the operating, consented and proposed OWFs, including Hornsea Four, is 239 (238.78) breeding adult birds.

11.4.3.134 When considering the potential impact of this loss to the FFC SPA (classified gannet population of 16,938 breeding adults), with an annual background mortality of 1,372 breeding adult birds, then using this prediction of 239 breeding adults suffering collision consequent mortality would represent a 17.40% increase in baseline mortality, of which Hornsea Four alone contributes an increase of eight predicted breeding adult mortalities equating to an increase of 0.60% in baseline mortality.On this basis, when considering the potential impact of this loss to the FFC SPA with an annual background mortality of 2,170 breeding adults, then this prediction of 239 breeding adult birds suffering collision consequent mortality would represent a 11.01% increase in baseline mortality, of which

Hornsea Four alone contributes an increase of eight predicted breeding adult mortalities equating to an increase of 0.38% in baseline mortality.

Non-Breeding Season

11.4.3.135 The number of gannets from FFC SPA predicted to be subject to collision resultant mortality, from Hornsea Four and all other projects, in the return migration bio-season is 20 (19.85) breeding adult birds and in the post-breeding migration bio-season is 40 (39.57) breeding adults (there is no migration free winter bio-season). In total 59 (59.42) breeding adults, attributed to the FFC SPA are predicted to suffer collision related mortality during the non-breeding bio-seasons.

11.4.3.136 When considering the potential impact of this loss to the FFC SPA citation population, then using this prediction of 59 breeding adults suffering consequent mortality in the non-breeding bio-season would represent a 4.33% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.03% in baseline mortality. When considering the potential impact of this loss to the more recent 2017 colony count for gannet, then this prediction of 59 breeding adult birds suffering consequent mortality would represent a 2.74% increase in baseline mortality, of which Hornsea Four alone contributes an increase of less than one predicted breeding adult mortality equating to an increase of 0.02% in baseline mortality.

Annual Total

11.4.3.137 The total number of gannets from FFC SPA predicted to be subject to collision mortality per annum from Hornsea Four and all other projects is a prediction of consequent mortality of 298 (298.06) breeding adults across all bio-seasons. The predicted consequent baseline mortality increase of the citation population is estimated at 21.72% across all bio-seasons per annum, of which Hornsea Four alone contributes an increase of nine predicted breeding adult mortalities equating to an increase of 0.62% in baseline mortality per annum across all bio-seasons. The predicted consequent baseline mortality increase of the more recent 2017 colony count is estimated at 13.74% across all bio-seasons per annum, of which Hornsea Four alone contributes an increase of nine predicted breeding adult mortalities equating to an increase of 0.39% in baseline mortality per annum across all bio-seasons. Due to the increase in baseline mortality from collision impacts in-combination exceeding a 1% increase further consideration of the impact is required.

Gannet CRM PVA Results

11.4.3.138 Further consideration of the potential collision risk consequent mortality to the gannet feature of the FFC SPA from Hornsea Four in-combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. The potential impacts have been assessed against the latest 2017 colony count population size of 26,784 breeding adults as agreed with Natural England (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**.

11.4.3.139 The results of the PVA run for gannet collision impacts from Hornsea Four in-combination with all other projects attributed to the FFC SPA colony is presented in **Table 57.**

Table 57: Population modelling results using the Natural England Seabird PVA Tool for potential gannet collision mortality rate for Hornsea Four and all other projects attributed to the FFC SPA.

Scenario	Adult mortality	Density-Independent counterfactual of population growth rate (after 35 years)	Reduction in the growth rate (per annum)
In-combination total Collision Risk	298	0.987	1.36%

11.4.3.140 The average annual colony growth rates for gannet presented in **Table 43** are derived from the colony counts presented in the 2019 FFC SPA seabird monitoring programme (Lloyd et al. 2019). Over the nearly 50-year period presented, the gannet population has grown annually by just over 14%, when considering the population growth over the last 20 years the average annual growth rate was still calculated as over 8%, despite multiple OWFs being operational within the North Sea over that period. Although it is impossible to know what the growth rate of the gannet feature will be over the 35 year project lifespan of Hornsea Four, the current colony growth rates would suggest that the colony is likely to still increase in size on its current trajectory, although it's likely the growth rate will reduce over the next 35 years as competition for nesting ledges increases and viability of prey resources may be limiting factors.

11.4.3.141 With respect to future plausible growth rates, Natural England provided advice on the matter to Norfolk Boreas in relation to the gannet feature of the FFC SPA, suggesting they believe that a range of plausible future growth rate scenarios between 1% to 5% should be considered (Natural England 2020). This range of growth rates were based on a review of current gannet colony growth at 22 differing colonies across Britain, the Channel Islands and Ireland, from which Natural England (Natural England 2020) concluded that:

11.4.3.142 'The Flamborough / Bempton gannet colony was founded in the late 1930s (Cramp et al. 1974) and so has been in existence now for about 80 years. Thus, by the end of 30 years of Vanguard it will be about 110 years in age. Given the analysis of trends in gannet colony growth rates amongst a suite of long-established colonies, it is highly likely that its annual growth rate averaged over the whole period since founding will drop from its current average of c 11% over the first 80 years. The highest annual colony growth rate calculated over a period of >100 years is 4.5% at Grassholm. The Flamborough colony is unlikely to achieve a higher annual growth rate than this. The average annual growth rate calculated over a period of >90 years across the 8 gannet colonies with records exceeding 90 years is 1.8%. Amongst these colonies the mean annual growth rate over the most recent years of their records (80+ years) has been just 1.2% per annum (or 1.3% excluding Sula Sgeir (as the growth rate here may be influenced adversely by an annual licenced harvest of young birds)) compared to an average rate of 2.0% per annum during the first 80 or so years of their existence.'

11.4.3.143 When considering the growth rate scenario range suggested by Natural England and applying the maximum reduction in growth rate of 1.36% presented in **Table 57**, the colony would still maintain a positive growth rate under any scenario from 2% to 5% or more, and would therefore continue to grow maintaining the conservation objectives of the gannet feature of the FFC SPA. Furthermore, Natural England suggested to Norfolk Boreas (Natural England 2020) in relation to the outcomes of their in-combination collision mortality impacts:

11.4.3.144 'If the colony were to experience an annual growth rate of 2% or more per annum over the next 30 or so years, then the integrity of the site for this feature is high, with high rates for self-repair, and self-renewal under dynamic conditions with minimal external management. Therefore, the FFC gannet population is believed to be robust enough to allow the conservation objective to maintain the population at (or above) designation levels and sustain additional alone and in-combination mortalities from the offshore wind farms. Our justification for this position is we consider it to be highly unlikely that the FFC annual growth rate would be as low as 1%, and from the analysis of gannet colony growth rates we have conducted the current annual growth rate of c 11% appears to be relatively high for a colony of this age and so the colony is likely to do better than a 1.3 % annual growth rate in the foreseeable future.'

11.4.3.145 As stated above an annual harvest of up to 2,000 chicks at the Sula Sgeir gannet colony off the coast of Scotland is currently licensed by NatureScot. The colony at Sula Sgeir is of a similar size to the FFC SPA colony with a citation population of 10,400 pairs. Despite harvesting occurring annually at the colony between 2004 and 2014 the colony still increased annually at an average annual growth rate of 2.2%, therefore providing strong evidence that even when up to 2,000 chicks are removed from the population on an annual basis this species maintains a positive growth rate. In order to ensure the sustainability of the harvesting being undertaken at the colony, PVA was commissioned to ensure the long-term viability of the population would not be adversely affected. The results concluded categorically that although in the absence of harvesting the colony growth rate would likely be higher, it seemed proabable that a continued annual harvest of up to 3,500 chicks per annum would not lead to a decline in population growth (Trinder, 2016). This provides additional evidence in support of the resilliance of gannet populations, reinforcing the fact that a maximum predicted mortality of up to 298 breeding gannets per annum is highly improbable to lead to adverse effect on the FFC SPA population.

11.4.3.146 When considering Natural England's conservative suggestion that they believe the annual colony growth rate to be higher than 1.3% over the next 30 years, the in-combination collision risk mortality would not cause the growth rate to become negative. However, a reduction in growth rate to this extent is highly improbable as suggested from data at a colony of similar size at Sula Sgeir, where this species has demonstrated it can withstand harvesting at rates of 2,000 chicks per annum from the population on a regular basis without it significantly affecting the colony size or growth rate. This means the conservation objective of the gannet feature of the FFC SPA, to maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent, would still be met over the operational lifespan of Hornsea Four and an AEoI from in-combination collision mortality impacts can be ruled out.

Flamborough and Filey Coast SPA – kittiwake

11.4.3.147 Kittiwake has been screened into the in-combination assessment of the Hornsea Four O&M phase to assess the impacts from collision from Hornsea Four in-combination with other projects in relation to the following conservation objective for this species, as a feature of the FFC SPA:

- Restore the population of each of the qualifying features.

11.4.3.148 Based on the above the conservation objective for the FFC SPA the specific target for the kittiwake feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- Restore the size of the breeding population at a level which is above 83,700 breeding pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent.

11.4.3.149 The projects screened in are the proposed, consented, under-construction and operating offshore wind farms in the UK waters of the North Sea and English Channel (**Table 58**). They have been screened in on the basis of this species' flight behaviour that places it at risk of collision with the turning blades of the WTGs and the experience of the in-combination assessments carried out for other offshore wind farms in recent years. Collisions may occur when birds fly through operational offshore wind farms whilst foraging for food, commuting between breeding sites and foraging areas, or during migration. The Hornsea Four array area and multiple other offshore wind farms are within the mean max foraging distance of 156.1 km to the FFC SPA and also within the mean max plus 1 SD foraging distance of 300.6 km (Woodward et al. 2019). Accordingly, multiple offshore wind farms are screened in for consideration for this species for assessment during the breeding bio-season. Outside of the breeding bio-season kittiwakes are known to range more widely, so consideration is provided to offshore wind farms within the wider UK North Sea and English Channel BDMPS area. The different bio-seasons for consideration of assessing potential risk from collision for kittiwakes from FFC SPA from Hornsea Four in-combination with other offshore wind farms includes the migration-free breeding bio-season, defined as being the months of May to July by Furness (2015), the post-breeding migration bio-season of August to December and the return migration bio-season of January to April.

11.4.3.150 It is acknowledged that within the consent approval of Hornsea Three in December 2020 the Secretary of State referred back to previous statements issued in a "minded to" letter in July 2020 that he could not rule out an AEoI on the kittiwake feature of the FFC SPA from Hornsea Three in-combination with other projects (BEIS 2020a) following the evidence and modelling results at that time and in part due to compensation measures for that impact not having been secured. However, having considered the further evidence provided by Hornsea Three and responses to that evidence from other Interested Parties, he then considered that there was, on balance, a reasonable prospect of Hornsea Three being able to secure appropriate compensatory measures (BEIS 2020b) to ensure that the overall coherence of the network of European sites, including FFC SPA, is maintained.

11.4.3.151 In association with the consent decision for Hornsea Three it was stipulated that the decision was granted subject to the provision of compensatory measures as the Secretary of State found he could not rule out AEoI on kittiwake at FFC SPA in-combination with other offshore wind farms. Compensation measures for kittiwakes were subsequently submitted for Hornsea Three (Orsted, 2021b) and agreed with

Natural England as appropriate for this species in association with the FFC SPA (Natural England, 2021b). Natural England also agreed that as all potential collision risk to kittiwake from FFC SPA as a consequence of Hornsea Three is now completely compensated for the associated collision mortality rates no longer need to be considered or included within in-combination assessments (Natural England, 2021b).

11.4.3.152 Since the assessments contained within the Hornsea Three submissions on kittiwake for FFC SPA were undertaken a number of updates are apparent that provide more certainty on the conclusions able to be made in this RIAA for Hornsea Four in-combination. These include:

- Improvements to the methods to estimate collision risk through the use of the sCRM, developed by Marine Scotland Science (Donovan, 2018) to provide more accurate collision mortality estimates through the use of this tool deterministically. The use of the sCRM was only agreed Natural England as being suitable to use deterministically in 2020 (OFF-ORN-2.26 **B1.1.1 Evidence Plan**) following substantial testing by APEM in consultation with Natural England, the RSPB and DMPStats (the developers of the model);
- A number of OWFs submitting revised collision mortality totals following mitigation design changes (for instance from raising the air gap) following their consent decisions reducing the overall risk to kittiwakes from FFC SPA through lower mortality rates;
- The removal of Hornsea Three kittiwake mortality rate from in-combination assessments due to being fully compensated for;
- The introduction of population modelling through the Natural England developed Seabird PVA tool (Natural England, 2019), that provides the most up to date methods to estimate potential effects at the colony level for kittiwake at the FFC SPA; and
- Additional supporting evidence on the latest FFC SPA colony growth rates of relevance to assessing the potential for an AEoI (Aitken et al, 2017).

11.4.3.153 Through consideration, inclusion and interpretation of the above an assessment of the potential impacts from Hornsea Four in-combination with other plans and projects has been able to be undertaken without prejudice of decisions prior to this RIAA. The Applicant therefore, undertook the assessments following the latest guidance and using the most up-to-date tools available to assess potential impacts to kittiwake from the FFC SPA and consider that this RIAA has allowed for a transparent and updated assessment to be provided that is appropriate for decision makers to understand the risk to this species at this site.

11.4.3.154 During the breeding bio-season it is considered that potential collision mortality suffered by kittiwakes from FFC SPA may be attributed more highly to offshore wind farms within areas of sea within foraging distance from this breeding colony.

11.4.3.155 Outside the breeding bio-season, when the population contains a mix of birds from UK breeding colonies and breeding colonies from further away, then a much lower percentage of birds can be attributed to any particular breeding colony SPA population. This apportionment is based on calculating the proportion of the breeding adults within the UK North Sea and English Channel BDMPS population that can be attributed to the FFC SPA as defined by Furness (2015), based on the data within that report. Following this approach to apportionment the proportion of the BDMPS populations from FFC SPA during return migration and post-breeding migration bio-seasons were estimated to be 7.19% and 5.44%, respectively, which was agreed as appropriate by Natural England during the Norfolk Boreas examination (Natural England 2020) and for this project through the evidence plan process (OFF-ORN-6.13 **B1.1.1 Evidence Plan**).

11.4.3.156 In order to assess the potential in-combination impact on this species, information was compiled on the predicted collision mortality for each of the OWF projects included in the in-combination assessment. The in-combination collision mortality totals presented in **Table 58** for all consented projects are derived from the latest in-combination collision risk values presented at at Deadline XI for EA1N / EA2 (SPR, 2021) which are the most up to date in-combination collision tables for the FFC SPA at the time of this assessment. The following amendments were made to the values published at Deadline XI for EA1N / EA2 (SPR, 2021) for assessments included within this report:

- Updated collision mortality values for Hornsea Four attributed to the FFC SPA as described within this report (**paragraph 10.4.4.249**); and
- Removal of Beatrice Demonstrator as the project will be decommissioned by the time Hornsea Four is predicted to be operational.

11.4.3.157 For Hornsea Four, the detailed calculations of how kittiwakes have been apportioned to the FFC SPA are presented in **paragraph 10.4.4.249**. The results of that apportionment process are presented in **Table 58**, which sets out the in-combination predicted collision totals from OWFs within the North Sea and English Channel attributed to the FFC SPA. It should also be noted that the apportionment process included only kittiwake colonies associated with coastal locations along the east coast of England. However, recent evidence compiled for consideration within the Hornsea Three and Hornsea Four compensation and derogation cases has identified that a substantial number of oil and gas platforms within the southern North Sea host colonies of kittiwakes that are also within mean max (and mean max plus 1SD) foraging range from Hornsea Four (APEM, 2021b and Niras, 2021). The significance of this is that future apportionment may consider such additional colonies with more accurate numbers of the breeding pairs to which impacts may be spread across. This in turn, would contribute towards potential impacts on kittiwakes during the breeding bio-season being lower at the FFC SPA colony and therefore provide further evidence in support of the apportionment values in **Table 58** being overly precautionary.

Table 58: Attribution of kittiwake numbers to the FFC SPA for three bio-seasons for each offshore wind farm included in the in-combination assessment.

Project	Migration-free breeding	Post-breeding migration	Return Migration	Annual Total	Tier
Beatrice	0.0	0.6	2.9	3.5	1a
Blyth Demonstration Site	0.0	0.1	0.1	0.2	1a
Dudgeon	-	-	-	-	1a
East Anglia One	0.0	8.7	3.4	12.0	1a
EOWDC	0.0	0.3	0.1	0.4	1a
Galloper	0.0	1.5	2.3	3.8	1a

Project	Migration-free breeding	Post-breeding migration	Return Migration	Annual Total	Tier
Greater Gabbard	0.0	0.8	0.8	1.6	1a
Gunfleet Sands	-	-	-	-	1a
Hornsea Project One	36.5	3	1.5	41.0	1a
Humber Gateway	1.9	0.2	0.1	2.2	1a
Hywind 2 Demonstration	0.0	0.1	0.1	0.1	1a
Kentish Flats	0.0	0.1	0.1	0.1	1a
Kentish Flats Extension	0.0	0	0.2	0.2	1a
Kincardine	0.0	0.5	0.1	0.6	1a
Lincs, Lynn & Inner Dowsing	0.7	0.1	0.1	0.8	1a
London Array	0.0	0.1	0.1	0.3	1a
Methil	0.0	0.0	0.0	0.0	1a
Race Bank	1.9	1.3	0.4	3.6	1a
Rampion	0.0	2	2.1	4.2	1a
Scroby Sands	-	-	-	-	1a
Sheringham Shoal	-	-	-	-	1a
Teesside	0.0	1.3	0.2	1.5	1a
Thanet	0.0	0	0	0.1	1a
Westermost Rough	0.1	0	0	0.1	1a
Hornsea Project Two	13.3	0.5	0.2	14	1b
Moray East	0.0	0.1	1.4	1.5	1b
Neart na Gaoithe	0.0	3	0.3	3.4	1b
Seagreen Alpha & Bravo	0.0	16.9	17.8	34.7	1b
Triton Knoll	24.6	7.5	3.3	35.4	1b
Dogger Bank A & B	55.8	7.3	21.3	84.3	1c
Dogger Bank C & Sofia	26.4	4.9	15.6	46.9	1c
East Anglia Three	0.0	3.1	2.2	5.3	1c
Hornsea Three	0.0	0.0	0.0	0.0	1c
Inch Cape	0.0	12.1	4.6	16.7	1c
Moray West	0.0	1.3	0.5	1.8	1c
East Anglia ONE North	0.0	0.4	0.3	0.7	1d
East Anglia TWO	0.0	0.3	0.5	0.8	1d
Norfolk Boreas	11.4	1.7	0.9	14	1d
Norfolk Vanguard	18.7	0.9	1.4	21.0	1d
Hornsea Four	17.3	2.1	1.8	21.2	1d
Dudgeon Extension Project	17.2	0.5	0.2	17.9	2
Sheringham Shoal Extension Project	0.9	0.1	0.0	1.0	2
All Projects Total	**226.8**	**83.4**	**86.8**	**396.9**	

Breeding Season

11.4.3.158 The number of kittiwakes from FFC SPA predicted to be subject to collision resultant mortality, from Hornsea Four in-combination with all other projects, in the migration-free breeding bio-season from the operating, consented and proposed OWFs, including Hornsea Four, is 227 (226.76) breeding adult birds.

11.4.3.159 When considering the potential impact of this loss to the FFC SPA (the kittiwake citiation population classified as 167,400 breeding adults), with an annual background mortality of 24,440 breeding adult birds, then using this prediction of 227 breeding adults suffering collision consequent mortality would represent a 0.93% increase in baseline mortality, of which Hornsea Four alone contributes an increase of 17 predicted breeding adult mortalities equating to an increase of 0.07% in baseline mortality. As the population of kittiwakes has changed since the citation population count the potential impact on the population is more reasonably assessed against the latest population count undertaken in 2017, which was of 51,535 apparently occupied nests (or 103,070 breeding adults). On this basis, when considering the potential impact of this loss to the FFC SPA with an annual background mortality of 15,048 breeding adults, then this prediction of 289 breeding adult birds suffering collision consequent mortality would represent a 1.11% increase in baseline mortality, of which Hornsea Four alone contributes an increase of 17 predicted breeding adult mortalities equating to an increase of 0.12% in baseline mortality.

Non-Breeding Season

11.4.3.160 The number of kittiwakes from FFC SPA predicted to be subject to collision resultant mortality, from Hornsea Four and all other projects, in the return migration bio-season is 87 (86.81) breeding adult birds and in the post-breeding migration bio-season is 85 (85.27) breeding adults (there is no migration free winter bio-season). In total 170 (170.19) breeding adults, attributed to the FFC SPA are predicted to suffer collision related mortality during the non-breeding bio-season.

11.4.3.161 When considering the potential impact of this loss to the FFC SPA citation population, then using this prediction of 170 breeding adults suffering consequent mortality in the non-breeding bio-seasons would represent a 0.70% increase in baseline mortality, of which Hornsea Four alone contributes an increase of four predicted breeding adult mortalities equating to an increase of 0.02% in baseline mortality. when considering the potential impact of this loss to the more recent 2017 colony count for kittiwake, then this prediction of 170 breeding adult birds suffering consequent mortality would represent a 1.13% increase in baseline mortality, of which Hornsea Four alone contributes an increase of four predicted breeding adult mortalities equating to an increase of 0.03% in baseline mortality per annum across all bio-seasons.

Annual Total

11.4.3.162 The total number of kittiwakes from FFC SPA predicted to be subject to collision mortality per annum from Hornsea Four and all other projects is a prediction of consequent mortality of 397 (396.87) breeding adults across all bio-seasons. The predicted consequent baseline mortality increase of the citation population is estimated at 1.62% across all bio-seasons per annum, of which Hornsea Four alone contributes an increase of 21 predicted breeding adult mortalities equating to an increase of 0.09% in baseline mortality per annum across all bio-seasons. The predicted consequent baseline mortality increase of the more recent 2017 colony count is estimated at 2.64% across all bio-seasons per annum, of which Hornsea Four alone contributes an increase of 21 predicted breeding adult mortalities equating to an increase of 0.14% in baseline mortality per annum across all bio-seasons. Due to the increase in baseline mortality from collision impacts in-combination exceeding a 1% increase further consideration of the impact is required.

Kittiwake CRM PVA Results

11.4.3.163 Further consideration of the potential collision risk consequent mortality to the kittiwake feature of the FFC SPA from Hornsea Four in-combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. The potential impacts have been assessed against the latest 2017 colony count population size of 103,070 breeding adults as agreed with Natural England (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology, input parameters and details on how to interpret the PVA results below can be found in **Appendix H**. The results of the PVA runs for kittiwake collision impacts from Hornsea Four in-combination with all other projects attributed to the FFC SPA colony are presented in **Table 59**.

Table 59: Population modelling results using the Natural England Seabird PVA Tool for potential kittiwake collision mortality rate for Hornsea Four and all other projects attributed to the FFC SPA.

Scenario	Adult mortality (per annum)	Density-independent Counterfactual of population growth rate (after 35 years)	Reduction in growth rate (per annum)
Total in-combination up to and including Hornsea 2 collision risk (the point at which Natural England last agreed no AEoI)	351	0.996	0.42%
Total in-combination up to and including Hornsea Four collision risk	397	0.995	0.48%

Table 60: Kittiwake average annual colony growth rate for Flamborough Head and Bempton Cliffs SPA between 1969 – 2017.

Species	Colony Annual Compound Growth Rate			
	1969 - 2017 (FH & BC SPA)	1987 - 2017 (FH & BC SPA)	2000 - 2017 (FH & BC SPA)	2008 - 2017 (FH & BC SPA)
Kittiwake	0.82%	-2.08%	0.39%	2.14%

11.4.3.164 The average annual colony growth rates presented in **Table 60** are derived from the colony counts presented in the 2019 FFC SPA seabird monitoring programme (Lloyd et al. 2019).

11.4.3.165 The FFC SPA colony of kittiwakes seemingly increased in size from 30,800 to 83,000 pairs or by 169.5% between 1969 and 1979, respectively. However, this increase is widely disputed by seabird experts, including Coulson (Coulson 2011 and 2017) and McArthur Green (2015). These expert's opinions on these kittiwake data relate to a likely error in the colony counts undertaken in 1979, when recorders at that time are considered to have recorded the number of individual birds present (83,000 individual breeding kittiwakes) as being the number of breeding pairs, hence artificially inflating the colony population to double the value (to 166,000 individual breeding kittiwakes). No accurate counts were made of the colony in the years between 1979 and 1986, whilst the 1986 data (Lloyd et al., 1991) is an estimate made on the basis that the colony had remained at similar or slightly higher levels, hence the limited increase in the population being recorded as 83,700 pairs, which forms the basis of the designated SPA citation population value that underpins the conservation objectives of the FFC SPA.

11.4.3.166 Should these population values be considered further then following the more accurate colony count in 2000, undertaken for the national Seabird 2000 project (Mitchell et al. 2004), it would appear that a decrease in the colony size from 83,700 to 42,659 pairs, representing a reduction by 50%, occurred between 1987 and 2000. Should such a dramatic population change have occurred, then this would have to be linked to changes from other elements such as changes in available food resources, such as the biomass of sandeels, which are the main food source of kittiwakes. Shortages of this food source for kittiwakes are recognised as being a likely direct cause of declines in kittiwake breeding success at other colonies, as waters within their natural foraging range contain a lack of alternative prey species to substitute such losses when sandeels have years of low abundance (Coulson 2017; Frederiksen et al. 2004; Wanless et al. 2007). A further study conducted by Carroll et al. (2017) further highlights this relationship, at the FFC SPA in particular, with modelling results showing increases in sandeel biomass at the Dogger Bank area having a positive association with the FFC SPA kittiwake colony productivity rates.

11.4.3.167 It is also noted that the productivity rates recorded during the period of decline reported, between 1987 and 2000, do not correlate with such a dramatic population decline. The average productivity during this period is recorded as a relatively high mean value of 1.06 young fledged per pair, which should have caused the population to remain stable or increase, but not cause such a severe decline (Coulson 2011; 2017). Therefore, either there were other unknown elements at work on the colony or the data on colony counts are less accurate than reported.

11.4.3.168 Despite the relationship between sandeels and kittiwakes being evident and for productivity rates to have remained at positive levels, these are not considered to be the reasons for such a potentially dramatic increase and decrease to the FFC SPA kittiwake colony between 1979 and 1986, the circumstances for which may never be known. However, as kittiwake are one of the most numerous gull species in the world (JNCC 2020) and known to colonise and desert suitable nesting colonies in other locations in short periods of time it is not beyond the realms of science that should these data (between 1979 and 1986) be accepted as accurate that such an incident could not occur once more in the future again.

11.4.3.169 Following more regular monitoring work at the FFC SPA colony since 2000, it is apparent that in the last 20 years the kittiwake population has steadily increased by 0.39% per annum. A further increase of 2.14% per annum is evident in the last 10 years to achieve a population of just over 51,535 pairs in 2017, despite multiple OWFs being operational within the North Sea over that period, providing further evidence of the FFC SPA kittiwake colony being stable and maintaining a population of the long-term mean of between 40,000 to 50,000 breeding pairs. It is also acknowledged in the 2017 FFC pSPA seabird monitoring report (Aitken et al. 2017) that based off the whole colony count and study plot count the kittiwake population was considered stable.

11.4.3.170 Reference to the potential 170% increase between 1969 and 1979 and then 50% decrease 1987 and 2000 are considered a contentious subject (Coulson 2011; McArthur Green, 2015), as explained above. Considering these data as erroneous would better fit with the long-term colony trend of maintaining a steady increase from approximately 30,000 breeding pairs in the 1960s to over 50,000 breeding pairs in the 2020s, therefore providing evidence that this colony has a continuously increasing trend. Therefore, when considering the overall long-term population trend from 1969 of 30,800 pairs until the most recent accurate counts in 2017 of 51,535 pairs, the population shows a steady increase in the growth rate of 0.82% per annum.

11.4.3.171 The output of the newly developed NE PVA Tool presented in **Table 59**, predicted that the in-combination collision risk to kittiwakes of the FFC SPA may cause a maximum reduction in the population growth rate by 0. 48% per annum. When assessing against the long-term and most recent colony growth rates, the in-combination collision risk mortality would not negatively impact the colony growth rate to the point of causing an adverse population effect, only slow the rate of growth. Furthermore, as mentioned the productivity of the FFC SPA colony is known to be associated with the availability of sandeels within foraging range, therefore if in the future there is an increase in sandeel biomass it is likely the kittiwake growth rate could further increase beyond the long-term average of 0.82% per annum.

11.4.3.172 Therefore, as the long-term health of the FFC SPA colony of kittiwakes is steadily on the increase it is reasonable to assume that this long-term trend is the more appropriate to gauge potential impacts against and use to predict whether the effects of collision risk impacts from Hornsea Four in-combination with other offshore wind farms on the kittiwake feature of the FFC SPA.

11.4.3.173 Following this evidence led approach to consider an in-combination adult mortality rate of 397 against the most appropriate FFC SPA kittiwake colony short and long-term growth rates the maximum reduction in the population growth rate of 0.48% (using the density independent model) would not result in the growth rate becoming negative. The kittiwake feature of the FFC SPA would therefore remain in a favourable condition and continue to increase in population after 35 years. This would enable the conservation objective to maintain the kittiwake feature of the FFC SPA without deterioration from its current level would still be met over the operational lifespan of Hornsea Four and an AEoI from in-combination collision mortality impacts can be ruled out. This would also mean that the conservation objective to restore the kittiwake feature of the FFC SPA to the disputed level within the citation could also still be met over a longer period of time and an AEoI from in-combination collision mortality impacts can be ruled out.

Collision Risk: Greater Wash SPA – Little Gull

11.4.3.174 Little gull has been screened into the in-combination assessment of the O&M phase to assess the impacts from collision from Hornsea Four in-combination with other projects in relation to the following conservation objective for this species, as a feature of the SPA:

- Maintain the population of the qualifying feature in the long term.

11.4.3.175 Little gull has been screened into the in-combination assessment of the O&M phase on a precautionary basis as a result of the proximity of the Greater Wash SPA and its flight behaviour that places it at risk of collision with the turning blades of the WTGs. It has been screened in for the migratory non-breeding bio-seasons.

11.4.3.176 The 24 months of aerial digital surveys for Hornsea Four recorded little gull flying across the array area on only two occasions. In October 2016, with an estimated abundance of 50 birds, and in July 2017 with an estimated abundance of 40 birds (further details are given in **Volume A5, Annex 5.1: Offshore and Intertidal Ornithology Baseline Characterisation Report**). This is typical of data collected from other offshore wind farms in the southern North Sea, that have few records of little gulls within their array areas.

11.4.3.177 As the number of little gulls that migrate through the North Sea has not been assessed by Furness (2015) or Musgrove et al. (2013); the standard sources used for population estimates APEM undertook a desk study to understand the potential population following consultation with with Natural England and the RSPB. A subsequent population estimate for little gull using the UK waters of the North Sea has been prepared from a review of the literature and available databases relating to north-west Europe. This has considered both breeding populations from which the number of non-breeding individuals can be derived and non-breeding individuals recorded using particular sites or on migration along the coast. A copy of the literature review can be found in Appendix C of **Volume A5, Chapter 5: Annex 5.5: Offshore Ornithology Migratory Birds Report**. The findings of the literature review proposed an estimate of the autumn migration BDMPS for use in assessments of offshore wind farms (OWFs) occurring in English waters of the North Sea as 30,500 individuals (with a range of between 23,500 and 37,500 individuals).

11.4.3.178 Another assessment of little gull migration undertaken by WWT and MacArthur Green (2013) concluded that the majority of UK little gull migrate within 20 km from the UK coastline based on observations from coastal watches and offshore surveys.

11.4.3.179 The resultant apportionment of the migratory population for this assessment considered that 6,148 little gulls may potentially fly over the Hornsea Four array area during their autumn migration. Subsequent collision risk modelling for little gull provided an estimate of under one individual (under 0.1 individuals per annum) likely to be subject to mortality per annum as a consequence of Hornsea Four. Other offshore wind farm projects in the southern North Sea have undertaken similar assessments of the potential for little gull to be subject to collision risk, including:

- Triton Knoll - 26 collisions using 99.2% avoidance rate (corrected from 65 collisions using 98% avoidance rate);

- Race Bank - 21 collisions using 99.2% avoidance rate (corrected from 52 collisions using 98% avoidance rate);
- Sherringham Shoal - Three collisions using 99.2% avoidance rate (corrected from eight collisions using 98% avoidance rate);
- Hornsea Projects One - Four collisions using 99.2% avoidance rate (corrected from 10 collisions using 98% avoidance rate);
- Hornsea Project Two - 0.5 collisions using 99.2% avoidance rate (corrected from one collision using 98% avoidance rate);
- Hornsea Project Three - 0.5 collisions using 99.2% avoidance rate;
- Norfolk Vanguard - 8.3 collisions using 99.2% avoidance rate;
- Norfolk Boreas - 3.9 collisions using 99.2% avoidance rate; and
- Total collision mortality rate of 67 individuals.

11.4.3.180 As the North Sea migratory population is estimated at 30,500 individuals (with a range of between 23,500 and 37,500 individuals) then the Greater Wash population is 4.1% of the total individuals (with a range of between 5.3% and 3.3%, to the lower and upper population estimates). Therefore, of the 67 individuals subject to collision mortality from all other offshore wind farms only three individuals (2.7 birds) per annum may be attributed to being lost from the Greater Wash SPA population, which would be inconsequential.

11.4.3.181 Given the limited risk of collision to this species of three individuals (2.7 birds per annum) and the SPA population of 1,255 individuals, the contribution of risk of an adverse effect on the population is extremely low and hence a prediction that Hornsea Four in-combination with all other offshore wind farms will not affect the achievement of the conservation objectives for the SPA and as a result will not have an adverse effect on the integrity of the SPA.

11.4.3.182 There is, therefore, no potential for an AEoI to the conservation objectives of the little gull feature of the Greater Wash SPA in relation to collision mortality effects in the O&M phase from Hornsea Four in-combination with all other offshore wind farms and therefore, subject to natural change, little gull will be maintained as a feature in the long term with respect to the potential for adverse effects from collision mortality.

Collision Risk and Displacement: Flamborough and Filey Coast SPA – Gannet

11.4.3.183 Gannet has been screened into the in-combination assessment of the O&M phase to assess the impacts from both displacement and collision combined from Hornsea Four in-combination with other projects in relation to the following conservation objective for this species, as a feature of the SPA:

- Maintain the population of each of the qualifying features.

11.4.3.184 Based on the above the conservation objective for the FFC SPA the specific target for the gannet feature is as follows based on Naural England's case-specific advice (Natural England 2021a):

- To maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 counts.

11.4.3.185 Previous sections have concluded no AEOI from either collision risk or displacement acting alone; however, the combined impact of both collision risk and displacement will be greater than either one acting alone. Further consideration of both impacts acting together is therefore required.

11.4.3.186 Further consideration of the potential for combining the collision risk consequent additional mortality with the displacement consequent mortality to the gannet feature of the FFC SPA from Hornsea Four in-combination with all other projects has been undertaken in the form of assessment at the population scale through a PVA. Impacts have been assessed against the latest 2017 colony count population size of 26,784 breeding adults as agreed with Natural England (OFF-ORN-2.30 **B1.1.1 Evidence Plan**), with further details of the PVA methodology and input parameters used for the analysis found in **Appendix H**.

11.4.3.187 The results of the PVA runs for combined collision and displacement impacts from Hornsea Four and all other projects in-combination attributed to the FFC SPA colony are presented in **Table 61.**

Table 61: Population modelling results using the Natural England Seabird PVA Tool for potential gannet collision and displacement mortality rate for Hornsea Four in-combination with all other projects attributed to the FFC SPA.

Scenario	Adult mortality (per annum)	Density-independent counterfactual of population growth (after 35 years)	Reduction in growth rate (per annum)
In-combination total using 60% Displacement, 1% Mortality and CRM results	349	0.985	1.54%
In-combination total using 80% Displacement, 1% Mortality and CRM results	366	0.984	1.61%

11.4.3.188 The average annual colony growth rates for gannet presented in **Table 43** are derived from the colony counts presented in the 2019 FFC SPA seabird monitoring programme (Lloyd et al. 2019). Over the nearly 50-year period presented, the gannet population has grown annually by just over 14%, when considering the population growth over the last 20 years the average annual growth rate was still calculated as over 8% despite multiple OWFs being operational within the North Sea over that period. Although it's impossible to know what the growth rate of the gannet feature will be over the 35 year project lifespan of Hornsea Four, the current colony growth rates would suggest that the colony is likely to still increase in size on its current trajectory, although it's likely the growth rate will reduce over the next 35 years as competition for nesting ledges increases and viability of prey resources may be limiting factors.

11.4.3.189 The conservation objective for the gannet feature of the FFC SPA is to maintain the size of the breeding population at a level which is above 8,469 breeding pairs (16,938 breeding adults), whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent. The latest mean count is 24,594 adults based on the mean of the 2012, 2015 and 2017 countsWith respect to future plausible growth rates, Natural England provided advice on the matter to Norfolk Boreas in relation to the gannet feature of the FFC SPA, suggesting they believe that a range of plausible future growth rate scenarios between 1% to 5% should be considered (Natural England 2020). This range of growth rates were based on a review of current gannet colony growth at 22 differing colonies across Britain, the Channel Islands and Ireland, from which Natural England concluded that:

'The Flamborough / Bempton gannet colony was founded in the late 1930s (Cramp et al. 1974) and so has been in existence now for about 80 years. Thus, by the end of 30 years of Vanguard it will be about 110 years in age. Given the analysis of trends in gannet colony growth rates amongst a suite of long-established colonies, it is highly likely that its annual growth rate averaged over the whole period since founding will drop from its current average of c 11% over the first 80 years. The highest annual colony growth rate calculated over a period of >100 years is 4.5% at Grassholm. The Flamborough colony is unlikely to achieve a higher annual growth rate than this. The average annual growth rate calculated over a period of >90 years across the 8 gannet colonies with records exceeding 90 years is 1.8%. Amongst these colonies the mean annual growth rate over the most recent years of their records (80+ years) has been just 1.2% per annum (or 1.3% excluding Sula Sgeir (as the growth rate here may be influenced adversely by an annual licenced harvest of young birds)) compared to an average rate of 2.0% per annum during the first 80 or so years of their existence.'

11.4.3.190 When considering the growth rate scenario range suggested by Natural England and applying the maximum reduction in growth rate of 1.63% presented in **Table 61**, the colony would still maintain a positive growth rate under any scenario from 2% to 5%. Furthermore, Natural England suggested to Norfolk Boreas (Natural England, 2020) in relation to the outcomes of their in-combination impacts:

'If the colony were to experience an annual growth rate of 2% or more per annum over the next 30 or so years, then the integrity of the site for this feature is high, with high rates for self-repair, and self-renewal under dynamic conditions with minimal external management. Therefore, the FFC gannet population is believed to be robust enough to allow the conservation objective to maintain the population at (or above) designation levels and sustain additional alone and in-combination mortalities from the offshore wind farms. Our justification for this position is we consider it to be highly unlikely that the FFC annual growth rate would be as low as 1%, and from the analysis of gannet colony growth rates we have conducted the current annual growth rate of c 11% appears to be relatively high for a colony of this age and so the colony is likely to do better than a 1.3 % annual growth rate in the foreseeable future.'

11.4.3.191 As stated above an annual harvest of up to 2,000 chicks at the Sula Sgeir gannet colony off the coast of Scotland is currently licensed by NatureScot. The colony at Sula Sgeir is of a similar size to the FFC SPA colony with a citation population of 10,400 pairs. Despite harvesting occurring annually at the colony between 2004 and 2014 the colony still increased annually at an average annual growth rate of 2.2%, therefore providing strong evidence that even when up to 2,000 chicks are removed from the population on an annual basis this species maintains a positive growth rate. In order to ensure the sustainability of the harvesting being undertaken at the colony, PVA was commissioned to ensure the long-term viability of the population would not be adversely affected. The results concluded categorically that although in the absence of harvesting the colony growth rate would likely be higher, it seemed proabable that a continued annual harvest of up to 3,500 chicks per annum would not lead to a decline in population growth (Trinder, 2016). This provides additional evidence in support of the resilliance of gannet populations, reinforcing the fact that a maximum predicted mortality of up to 366 breeding gannets per annum is highly improbable to lead to adverse effect on the FFC SPA population.

11.4.3.192 When considering Natural England's conservative suggestion that they believe the annual colony growth rate to be higher than 1.3% over the next 30 years, the in-combination collision and displacement mortality would not cause the growth rate to become negative if it remains above 1.61%. However, a reduction in growth rate to this extent is highly improbable as suggested from data at a colony of similar size at Sula Sgeir, where this species has demonstrated it can withstand harvesting at rates of 2,000 chicks per annum from the population on a regular basis without it significantly affecting the colony size or growth rate. This means the conservation objective of the gannet feature of the FFC SPA, to maintain the size of the breeding population at a level which is above 8,469 pairs, whilst avoiding deterioration from its current level as indicated by the latest mean peak count or equivalent, would still be met over the operational lifespan of Hornsea Four and an AEoI from in-combination collision and displacement combined impacts can be ruled out.

11.5 Onshore Ecology

11.5.1.1 All potential adverse effects alone that are related to onshore ecology have been screened out, as confirmed with Stakeholders within Hornsea Four Screening Report (**Appendix A**) and as presented within **Section 8** and the screening matrices supporting this RIAA (**Appendix B**).

11.5.1.2 The CEA has been based on information available on each potential project (e.g. as set out on the ERYC planning portal or in an attendant, available ES) and it is noted that the project details available may change in the period up to construction or may not be available in detail at all. The assessment presented within **Volume A3, Chapter 3: Ecology and Nature Conservation** is therefore considered to be conservative, with the level of impacts expected to be reduced compared to those presented here.

11.5.1.3 The CEA has not identified any potential impacts that are considered to be of any greater significance than those identified in isolation and no cumulative effects of significance are forecast. Therefore no in-combination effects have been identified.

11.6 Migratory Fish

11.6.1.1 As all potential effects related to migratory have been screened out for alone and in-combination, as confirmed within the Screening Report and Screening Matrix (**Appendix A** and **Appendix B**), and therefore no assessment is presented with regard to migratory fish. Full details on impacts and effects related to fish ecology is presented within **Volume A2, Chapter 3: Fish and Shellfish Ecology**.

12 Transboundary statement

12.1.1.1 The Screening process has identified twelve transboundary sites for assessment, with these sites being as follows (including the relevant designated species screened in):

- Doggersbank (Netherlands) SAC (grey seal and harbour seal);
- Klaverbank (Netherlands) SAC (grey seal and harbour seal);
- Bancs des Flandres (France) SCI (grey seal);
- Vlaamse Banken SCI (Belgium) (grey seal);
- SBZ 1 SCI (Belgium) (grey seal);
- SBZ 2 SCI (Belgium) (grey seal);
- SBZ 3 SCI (Belgium) (grey seal);
- Vlakte van de Raan (Netherlands) SCI (grey seal);
- Westerschelde & Saeftinghe (Netherlands) SCI (grey seal);
- Voordelta (Netherlands) SCI (grey seal);
- Noordzeekustzone SCI (Netherlands) (grey seal); and
- Waddenzee SCI (Netherlands) (grey seal).

12.1.1.2 Consultation on Transboundary Screening was undertaken by PINS in October 2019[111], with the following countries notified:

- The Netherlands;
- Germany;
- Belgium;
- Denmark;
- Norway;
- France;
- Iceland;
- Republic of Ireland; and
- Sweden.

12.1.1.3 Therefore consultation has included all countries for which a designated site has been screened in. No transboundary comments have been received to date (December 2020).

12.1.1.4 Consideration of the potential for an AEoI alone has been addressed in **Section 10** for marine mammals, including in relation to the above sites where marine mammals are highlighted, with all conclusions being no AEoI. The assessment in-combination with other plans or projects (including transboundary projects) has been addressed in **Section 11** for marine mammals, with all conclusions similarly being no AEoI.

12.1.1.5 It can therefore be concluded that no AEoI exists for a transboundary effect from Hornsea Four alone and/ or in-combination.

13 Conclusion of the Assessment

13.1.1.1 A summary of the assessment is presented below, firstly identifying in **Table 62** the designated sites (together with the relevant feature(s)) screened in for effect in relation

[111] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010098/EN010098-000342-H4WF%20-%20Regulation%2032%20Transboundary%20Screening.pdf

to Hornsea Four alone, including the conclusion on AEoI. The determination of AEoI in-combination is summarised in **Table 63**.

Table 62: Summary of the Potential for Adverse Effect from Hornsea Four Alone.

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Sites primarily designated for subtidal and intertidal benthic ecology[112]					
Flamborough Head SAC	Reefs; and Submerged or partially submerged sea caves	Temporary increases in suspended sediment concentrations (SSC)/ smothering	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Invasive non-native species	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Accidental polution	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Reefs	Changes to physical processes	N/A	No potential for AEoI	N/A
Humber Estuary SAC	Atlantic saltmeadows; and *Salicornia* and other colonising species	Nitrogen deposition	No potential for AEoI	N/A	No potential for AEoI
Humber Estuary Ramsar	Saltmarsh	Nitrogen deposition	No potential for AEoI	N/A	No potential for AEoI
Sites primarily designated for Marine Mammals					
Southern North Sea SAC	Harbour porpoise	Underwater noise	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Accidental pollution	No potential for AEoI	No potential for AEoI	No potential for AEoI
Moray Firth SAC	Bottlenose dolphin	Underwater noise	No potential for AEoI	N/A	No potential for AEoI

[112] Where other features are relevant, these are addressed under the relevant receptor group

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
The Wash and North Norfolk Coast SAC	Harbour seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Humber Estuary SAC	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
Humber Estuary Ramsar	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
Berwickshire and North Northumberland Coast SAC	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
Doggersbank (Netherlands) SAC	Harbour seal; and Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Klaverbank SCI	Harbour seal; and Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Bancs de Flandres	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Vlaamse Banken	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
SBZ 1	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
SBZ 2	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
SBZ 3	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Vlakte van d Raan	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Westerschelde & Saeftinghe	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Voordelta	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Noordzeekustzone	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Waddenzee	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Sites primarily designated for Offshore Ornithology					
Greater Wash SPA	Little gull	Collision Risk	-	No potential for AEoI	-
	Red-throated diver Common scoter	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
Flamborough and Filey Coast SPA	Gannet	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Gannet Kittiwake Herring gull	Collision Risk	-	No potential for AEoI	-
	Guillemot Razorbill Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Guillemot Razorbill	Barrier effect	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Puffin				
Humber Estuary SPA	Avocet, Golden plover, Black-tailed godwit, Bar-tailed godwit, Ruff, Shelduck, Dunlin, Redshank, Knot, Hen harrier	Risk of Collision	-	No potential for AEoI	-
Humber Estuary Ramsar	Golden plover, Black-tailed godwit, Bar-tailed godwit, Shelduck, Dunlin, Redshank, Knot, hen harrier, dark-bellied brent goose, teal, wigeon, goldeneye, avocet, oystercatcher, ringed plover, grey plover, lapwing, sanderling, curlew, whimbrel, turnstone	Risk of Collision	-	No potential for AEoI	-
Hornsea Mere SPA	Gadwall	Risk of Collision	-	No potential for AEoI	
Northumbria Coast SPA	Arctic tern	Risk of Collision	-	No potential for AEoI	-
Teemouth and Cleveland Coast SPA	Sandwich tern Common tern	Risk of Collision	-	No potential for AEoI	
Coquet Island SPA	Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Kittiwake, Common tern, Arctic tern,	Risk of Collision	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Roseate tern, Sandwich tern				
Farne Islands SPA	Guillemot Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Kittiwake, Common tern, Arctic tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
Northumberland Marine SPA	Guillemot Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Kittiwake, Common tern, Arctic tern, Roseate tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
St Abb's SPA	Kittiwake	Risk of Collision	-	No potential for AEoI	-
	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
Forth Islands (UK) SPA	Guillemot, Razorbill, Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet, Kittiwake, Common tern, Arctic tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
Outer Firth of Forth and St. Andrew's Complex pSPA	Guillemot, Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Kittiwake	Risk of Collision	-	No potential for AEoI	-
Fowlsheugh SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Buchan Ness to Collieston Coast SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
Troup, Pennan and Lion's Heads SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
East Caithness Cliffs SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
North Caithness Cliffs SPA	Guillemot Razorbill Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
Copinsay SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
Hoy SPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Marwick Head SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Rousay SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Calf of Eday SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake Great black-backed gull	Risk of Collision	-	No potential for AEoI	-
West Westray SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Fair Isle SPA	Guillemot Razorbill Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Arctic skua Great skua Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Sumburgh Head SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Noss SPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Gannet Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Foula SPA	Guillemot Razorbill Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Great skua Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Fetlar SPA	Arctic skua Great skua Arctic tern	Risk of Collision	-	No potential for AEoI	-
Hermaness, Saxa Vord and Valla Field SPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Sites primarily designated for Onshore Ecology and Migratory Fish					
All potential effects alone that are related to onshore ecology and migratory fish have been screened out, as confirmed by Natural England following the updated Hornsea Four Screening Report (see Appendix A).					

Table 63: Summary of the Potential for Adverse Effect from Hornsea Four In-combination.

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Sites primarily designated for subtidal and intertidal benthic ecology					
Flamborough Head SAC	Reefs; and Submerged or partially submerged sea caves	Temporary increases in suspended sediment concentrations (SSC)/ smothering	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Invasive non-native species	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Accidental polution	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Reefs	Changes to physical processes	N/A	No potential for AEoI	N/A
Humber Estuary SAC	Atlantic saltmeadows; and *Salicornia* and other colonising species	Nitrogen deposition	No potential for AEoI	N/A	No potential for AEoI
Humber Estuary Ramsar	Saltmarsh	Nitrogen deposition	No potential for AEoI	N/A	No potential for AEoI
Sites primarily designated for Marine Mammals					
Southern North Sea SAC	Harbour porpoise	Underwater noise	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Accidental pollution	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Habitat loss	N/A	No potential for AEoI	N/A
Moray Firth SAC	Bottlenose dolphin	Underwater noise	No potential for AEoI	N/A	No potential for AEoI

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
The Wash and North Norfolk Coast SAC	Harbour seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Humber Estuary SAC	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
Humber Estuary Ramsar	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
Berwickshire and North Northumberland Coast SAC	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
		Vessel collision risk	No potential for AEoI	No potential for AEoI	No potential for AEoI
Doggersbank (Netherlands) SAC	Harbour seal; and Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Klaverbank SCI	Harbour seal; and Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Bancs de Flandres	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Vlaamse Banken	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
SBZ 1	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
SBZ 2	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
SBZ 3	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Vlakte van d Raan	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Westerschelde & Saeftinghe	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Voordelta	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Noordzeekustzone	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Waddenzee	Grey seal	Underwater noise	No potential for AEoI	N/A	No potential for AEoI
		Vessel disturbance	No potential for AEoI	No potential for AEoI	No potential for AEoI
Sites primarily designated for Offshore Ornithology					
Greater Wash SPA	Little gull	Collision Risk	-	No potential for AEoI	-
	Red-throated diver Common scoter	Disturbance and Displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
Flamborough and Filey Coast SPA	Gannet Kittiwake Herring gull	Collision Risk	-	No potential for AEoI	-
	Guillemot Razorbill Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
Humber Estuary SPA	Avocet, Golden plover, Black-tailed godwit, Bar-tailed godwit, Ruff, Shelduck, Dunlin,	Risk of Collision	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Redshank, Knot, Hen harrier				
Humber Estuary Ramsar	Golden plover, Black-tailed godwit, Bar-tailed godwit, Shelduck, Dunlin, Redshank, Knot, hen harrier, dark-bellied brent goose, teal, wigeon, goldeneye, avocet, oystercatcher, ringed plover, grey plover, lapwing, sanderling, curlew, whimbrel, turnstone	Risk of Collision	-	No potential for AEoI	-
Hornsea Mere SPA	Gadwall	Risk of Collision	-	No potential for AEoI	
Northumbria Coast SPA	Arctic tern	Risk of Collision	-	No potential for AEoI	-
Teemouth and Cleveland Coast SPA	Sandwich tern Common tern	Risk of Collision	-	No potential for AEoI	
Coquet Island SPA	Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Kittiwake, Common tern, Arctic tern, Roseate tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
Farne Islands SPA	Guillemot Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Kittiwake, Common tern, Arctic tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
Northumberland Marine SPA	Guillemot Puffin	Disturbance and displacement	No potential for AEoI	No potential for AEoI	No potential for AEoI
	Kittiwake, Common tern, Arctic tern, Roseate tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
St Abb's SPA	Kittiwake	Risk of Collision	-	No potential for AEoI	-
	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
Forth Islands (UK) SPA	Guillemot, Razorbill, Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet, Kittiwake, Common tern, Arctic tern, Sandwich tern	Risk of Collision	-	No potential for AEoI	-
Outer Firth of Forth and St. Andrew's Complex pSPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Kittiwake	Risk of Collision	-	No potential for AEoI	-
Fowlsheugh SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
Buchan Ness to Collieston Coast SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
Troup, Pennan and Lion's Heads SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
East Caithness Cliffs SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
North Caithness Cliffs SPA	Guillemot Razorbill Puffin	Disturbance and displacement	-	No potential for AEoI	-
Copinsay SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
Hoy SPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Marwick Head SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake	Risk of Collision	-	No potential for AEoI	-
Rousay SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Calf of Eday SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Kittiwake Great black-backed gull	Risk of Collision	-	No potential for AEoI	-
West Westray SPA	Guillemot Razorbill	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Fair Isle SPA	Guillemot Razorbill Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Arctic skua Great skua Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Sumburgh Head SPA	Guillemot	Disturbance and displacement	-	No potential for AEoI	-
	Kittiwake Arctic tern	Risk of Collision	-	No potential for AEoI	-
Noss SPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Foula SPA	Guillemot Razorbill Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Arctic skua Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-

Designated Site	Relevant Features	Potential for Effect	Conclusion on Adverse Effect		
			Construction	Operation	Decommissioning
	Arctic tern				
Fetlar SPA	Arctic skua Great skua Arctic tern	Risk of Collision	-	No potential for AEoI	-
Hermaness, Saxa Vord and Valla Field SPA	Guillemot Puffin	Disturbance and displacement	-	No potential for AEoI	-
	Gannet Great skua Kittiwake	Risk of Collision	-	No potential for AEoI	-
Sites designated for migratory fish					
All potential effects in-combination that are related to migratory fish have been screened out, as confirmed by Natural England following the updated Hornsea Four Screening Report (see Appendix A).					
Sites primarily designated for Onshore Ecology					
All potential effects in-combination that are related to onshore ecology have been screened out, as confirmed by Natural England following the updated Hornsea Four Screening Report (see Appendix A).					

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