

Hornsea Project Three
Offshore Wind Farm



Hornsea Project Three Offshore Wind Farm

Preliminary Environmental Information Report:
Chapter 12 - Inter-related Effects (Offshore)

Date: July 2017

Hornsea 3
Offshore Wind Farm

DONG
energy

Environmental Impact Assessment
Preliminary Environmental Information Report

Volume 2
Chapter 12 – Inter-related Effects (Offshore)

Liability

This report has been prepared by RPS, with all reasonable skill, care and diligence within the terms of their contracts with DONG Energy Power (UK) Ltd.

Report Number: P6.2.12

Version: Final

Date: July 2017

This report is also downloadable from the Hornsea Project Three offshore wind farm website at:
www.dongenergy.co.uk/hornseaproject3

DONG Energy Power (UK) Ltd.

5 Howick Place,

London, SW1P 1WG

© DONG Energy Power (UK) Ltd, 2017. All rights reserved

Front cover picture: Kite surfer near one of DONG Energy's UK offshore wind farms © DONG Energy Hornsea Project Three (UK) Ltd., 2016.

Prepared by: RPS

Checked by: Julian Carolan

Accepted by: Sophie Banham

Approved by: Stuart Livesey

Table of Contents

12. Inter-related Effects (Offshore)	1
12.1 Introduction	1
12.2 Purpose of this chapter	1
12.3 Study area	1
12.4 Planning policy context	1
12.5 Consultation	2
12.6 Data sources	4
12.7 Impact assessment	4
12.8 Summary	35
12.9 Conclusion	35
12.10 References	36

List of Tables

Table 12.1: Summary of key consultation issues raised during consultation activities undertaken for Hornsea Three relevant to inter-related effects (offshore)	3
Table 12.2: Summary of staged approach to the inter-related effects assessment for Hornsea Three	4
Table 12.3: PEIR topics not included in the Hornsea Three inter-related effects assessment	5
Table 12.4: Definitions of project lifetime and receptor-led inter-related effects	6
Table 12.5: Summary of potential inter-related effects on adjacent UK coastlines (to Hornsea Three) from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	8
Table 12.6: Summary of potential inter-related effects on benthic subtidal and intertidal ecology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	10
Table 12.7: Summary of potential inter-related effects on fish and shellfish ecology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	13
Table 12.8: Summary of potential inter-related effects on marine mammals from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	16
Table 12.9: Summary of potential inter-related effects on offshore ornithology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	19
Table 12.10: Summary of potential inter-related effects on commercial fisheries from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	21
Table 12.11: Summary of potential inter-related effects on shipping and navigation from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	24
Table 12.12: Summary of potential inter-related effects on Aviation, Military and Communication from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	26
Table 12.13: Summary of potential inter-related effects on marine archaeology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	29
Table 12.14: Summary of potential inter-related effects on seascape and visual resources from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	31
Table 12.15: Summary of potential inter-related effects on infrastructure and other users from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects)	33

Glossary

Term	Definition
Helicopter Main Route (HMR)	Routes which are established to facilitate safe helicopter flights in Instrument Flight Rules (IFR) conditions (i.e., when flight cannot be completed in visual conditions).
High Voltage Alternating Current	High voltage alternating current is the bulk transmission of electricity by alternating current (AC), whereby the flow of electric charge periodically reverses direction.
Hydrodynamic	Of or relating to the motion of fluids and the forces acting on solid bodies immersed in fluids and in motion relative to them.
Inter-related effects	Multiple effects on the same receptor arising from Hornsea Three. These occur either where a single effect acts on a receptor over time to produce a potential additive effect or where a number of separate effects, such as noise and habitat loss, affect a single receptor, for example marine mammals.
Intertidal	An area of a seashore that is covered at high tide and uncovered at low tide.
Nursery habitat	Habitats where high numbers of juveniles of a species occur, having a greater level of productivity per unit area than other juvenile habitats.
Morphological	Of or relating to the form, shape and structure of landforms
Safety Zone	A marine zone demarcated for the purposes of safety around a possibly hazardous installation or works/ construction area.
Seascape character	The distinct and recognisable pattern of elements that occurs consistently in a particular type of seascape and how this is perceived by people and it reflects particular combinations of current sea use and human activity. It creates the particular sense of place of different areas of the seascape.
Sediment transport	The movement of a mass of sedimentary material by the forces of currents and waves. The sediment in motion can comprise fine material (silts and muds), sands and gravels. Potential sediment transport is the full amount of sediment that could be expected to move under a given combination of waves and currents, i.e. not supply limited.
Seismic Survey	The technique involves releasing pulses of acoustic energy along designated lines, the energy penetrates the sub-surface rocks and is reflected back to the surface where it can be detected by acoustic transducers and relayed to a recording vessel.
Spawning	The release or deposition of eggs and sperm, usually into water, by aquatic animals.

Acronyms

Acronym	Description
AEZ	Archaeological Exclusion Zone
AfL	Agreement for Lease
ATC	Air Traffic Control
CoCP	Code of Construction Practice
DCO	Development Consent Order
DEPONS	Disturbance Effects on the Harbour Porpoise Population in the North Sea
EIA	Environmental Impact Assessment
EMF	Electromagnetic Fields
ERCoP	Emergency Response Cooperation Plan
FLO	Fisheries Liaison Officer
HMR	Helicopter Main Route
HVAC	High Voltage Alternating Current
IMC	Instrument Meteorological Conditions
JNCC	Joint Nature Conservation Committee
MMO	Marine Management Organisation
MPS	Marine Policy Statement
NPS	National Policy Statement
NPS EN-1	Overarching National Policy Statement for Energy
NPS EN-3	National Policy Statement for Renewable Energy Infrastructure
NPS EN-5	National Policy Statement for Electricity Networks Infrastructure
NTM	Notice to Mariners
PEMMP	Project Environmental Management and Monitoring Plan
PINS	Planning Inspectorate
REWS	Radar Early Warning System
SAR	Search and Rescue
SoS	Secretary of State

Acronym	Description
SSC	Suspended Sediment Concentrations
VOR	Valued Ornithological Receptor

Units

Unit	Description
km	kilometre
m	metre

12. Inter-related Effects (Offshore)

12.1 Introduction

12.1.1.1 This chapter of the Preliminary Environmental Information Report (PEIR) presents the findings to date of the Environmental Impact Assessment (EIA) for the potential impacts of the Hornsea Project Three offshore wind farm (hereafter referred to as Hornsea Three) in relation to inter-related effects (offshore). Specifically, this chapter considers the potential impacts of Hornsea Three seaward of Mean High Water Springs (MHWS) during its construction, operation and maintenance and decommissioning phases. The assessment of inter-related effects on onshore receptors is presented in volume 3, chapter 11 Inter-related Effects (Onshore).

12.1.1.2 The detailed technical information which underpins the impact assessments presented in this chapter is contained within volume 1, chapter 3: project description, volume 2, chapters 1 to 11 and their supporting annexes. These chapters provide a detailed characterisation of the physical, biological and human environment of Hornsea Three and the wider southern North Sea, based on existing literature sources, surveys of the former Hornsea Zone and specifically of Hornsea Three, and includes information on receptors of importance and of conservation value.

12.2 Purpose of this chapter

12.2.1.1 The primary purpose of the Environmental Statement is to support the Development Consent Order (DCO) application for Hornsea Three under the Planning Act 2008 (the 2008 Act). This PEIR constitutes the Preliminary Environmental Information for Hornsea Three and sets out the findings of the EIA to date to support pre-application consultation activities required under the 2008 Act. The EIA will be finalised following completion of pre-application consultation and the Environmental Statement will accompany the application to the Secretary of State for Development Consent.

12.2.1.2 The PEIR will form the basis for Phase 2 Consultation which will commence on 27 July and conclude on 20 September 2017. At this point, comments received on the PEIR will be reviewed and incorporated (where appropriate) into the Environmental Statement, which will be submitted in support of the application for Development Consent scheduled for the second quarter of 2018.

12.2.1.3 In particular, this PEIR chapter:

- Presents the receptor groups considered within the inter-related assessment;
- Presents the potential for effects on receptor groups across the three key project phases (construction, operation and maintenance and decommissioning); and
- Presents the potential for multiple effects on a receptor group, as presented within the topic specific chapter, to interact to create inter-related effects.

12.2.1.4 The impact assessment presented within this chapter has taken into account other relevant impact assessments and Annexes in this PEIR including:

- Volume 2, chapter 1: Marine Processes;
- Volume 2, chapter 2: Benthic Subtidal and Intertidal Ecology;
- Volume 2, chapter 3: Fish and Shellfish Ecology;
- Volume 2, chapter 4: Marine Mammals;
- Volume 2, chapter 5: Offshore Ornithology;
- Volume 2, chapter 6: Commercial Fisheries;
- Volume 2, chapter 7: Shipping and Navigation;
- Volume 2, chapter 8: Aviation, Military and Communication;
- Volume 2, chapter 9: Marine Archaeology;
- Volume 2, chapter 10: Seascape and Visual Resources; and
- Volume 2, chapter 11: Infrastructure and Other Users.

12.3 Study area

12.3.1.1 Due to the differing spatial extent of effects experienced by different offshore receptors, the study area for potential inter-related effects (offshore) varies according to topic and receptor. The potential inter-related effects (offshore) considered in this chapter are, therefore, also limited to the study areas defined in each of the topic specific chapters outlined in paragraph 12.2.1.4. The rationale for the exclusion of other topics from further inter-related effects assessment is presented in section 12.7 (see Table 12.3).

12.4 Planning policy context

12.4.1.1 Guidance on the issues to be assessed for offshore renewable energy developments is contained in Overarching National Policy Statement (NPS) for Energy (NPS EN-1; DECC, 2011a), the NPS for Renewable Energy Infrastructure (NPS EN-3, DECC, 2011b), the NPS for Electricity Networks Infrastructure (NPS EN-5, DECC, 2011c), and the Marine Policy Statement (MPS; HM Government, 2011).

12.4.1.2 This chapter of the PEIR has been compiled following advice from PINS on the need to ensure that inter-related effects are fully addressed in any Environmental Statement accompanying a DCO application. This advice was outlined in Advice Note 9 issued by PINS in April 2012 (PINS, 2012a), which states the following in paragraph 3 of page 7:

"The Environmental Statement should not be a series of separate unrelated topic reports. The interrelationship between aspects of the proposed development should be assessed and careful consideration should be given by the developer to explain how interrelationships have been assessed in order to address the environmental impacts of the proposal as a whole. It need not necessarily follow that the maximum adverse impact in terms of any one topic impact would automatically result in the maximum potential impact when a number of topic impacts are considered collectively. In addition, individual impacts may not be significant but could become significant when their inter-relationship is assessed. It will be for the developer to demonstrate that the likely significant impacts of the project have been properly assessed."

12.4.1.3 Section 4.2.6 of NPS EN-1 also states that:

"The Infrastructure Planning Commission (IPC) should consider how the accumulation of, and interrelationship between, effects might affect the environment, economy and community as a whole, even though they may be acceptable when considered on an individual basis with mitigation measures in place."

12.5 Consultation

12.5.1.1 A summary of the key issues raised during consultation specific to inter-related effects (offshore) is outlined in Table 12.1 below, together with how these issues have been considered in the production of this PEIR.

Table 12.1: Summary of key consultation issues raised during consultation activities undertaken for Hornsea Three relevant to inter-related effects (offshore).

Date	Consultee and type of response	Issues raised	Response to issue raised and/or where considered in this chapter
December 2016	PINS – Scoping Opinion	The Secretary of State recommends that in order to assist the decision making process, the Applicant may wish to consider the use of tables to identify and collate the residual impacts after mitigation on the basis of specialist topics, inter-relationships and cumulative impacts and to demonstrate how the assessment has taken account of this Opinion and other responses to consultation.	The inter-related assessments for the defined receptor groups are presented in Table 12.5 to Table 12.15
December 2016	PINS – Scoping Opinion	The EIA Regulations state that information submitted within the ES includes a description of the development, including a description of the aspects of the environment likely to be significantly affected by the development, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the interrelationship between the above factors.	The inter-related assessments for the defined receptor groups are presented in Table 12.5 to Table 12.15.
December 2016	PINS – Scoping Opinion	The Secretary of State considers it is imperative for the ES to define the meaning of 'significant' in the context of each of the specialist topics and for significant impacts to be clearly identified. The Secretary of State recommends that the criteria should be set out fully and that the ES should set out clearly the interpretation of 'significant' in terms of each of the EIA topics. Quantitative criteria should be used where available. The Secretary of State considers that this should also apply to the consideration of cumulative impacts and impact inter-relationships.	The approach adopted has been to provide a descriptive assessment of the scope for these individual effects to combine, incorporating qualitative and, where reasonably possible, quantitative assessments to potentially create additional effects that may be of greater significance than the individual effects acting in isolation on a given receptor. In practice, quantitative assessment of how individual impacts may interact has not always been possible due to the lack of a clear, proven method for doing this. Therefore, in most instances a qualitative assessment has been undertaken based on the knowledge and experience of the authors. In terms of the definition of 'significant' this has been defined in the relevant topic chapters that have been utilised in undertaking the Inter-related effects assessment. The definitions for each specialist EIA topic can be found within chapters 1 to 11 of volume 2.
December 2016	PINS – Scoping Opinion	The inter-relationship between aspects of the environments likely to be significantly affected is a requirement of the EIA Regulations (see Schedule 4 Part 1 of the EIA Regulations). These occur where a number of separate impacts, e.g. noise and air quality, affect a single receptor such as fauna.	The inter-related assessments for the defined receptor groups are presented in Table 12.5 to Table 12.15.
December 2016	PINS – Scoping Opinion	The Secretary of State considers that the inter-relationships between factors must be assessed in order to address the environmental impacts of the proposal as a whole. This will help to ensure that the ES is not a series of separate reports collated into one document, but rather a comprehensive assessment drawing together the environmental impacts of the proposed development. This is particularly important when considering impacts in terms of any permutations or parameters to the proposed development.	This chapter presents this information in section 12.7.2. Onshore inter-related effects are presented in volume 3, chapter 11. The inter-related assessments for the defined receptor groups are presented in Table 12.5 to Table 12.15.
December 2016	PINS – Scoping Opinion	The Secretary of State considers that the ES should not be a series of disparate reports and stresses the importance of considering inter-relationships between factors and cumulative impacts.	This chapter presents this information in section 12.7.2. Onshore inter-related effects are presented in volume 3, chapter 11: Inter-related Effects (Onshore)
November 2016	Natural England – Scoping Opinion	We note that EIA should consider the environment as a whole, and not as a discrete set of individually sensitive receptors. Within the scoping report there is a section (5.6) on inter-related effects where the Applicant has outlined suggestions regarding the assessment of linkages between receptors, and how impacts on one receptor may influence others e.g. such as impacts to fish which may be important as prey species for birds and marine mammals. We consider that such inter-relationships are likely to be key in interpreting the environmental impacts of the development and welcome the applicant's intention to integrate these aspects as part of the EIA process.	Linkages between receptors are acknowledged and where such linked relationships arise these have been assessed within the individual topic chapters (see section 12.7.1) and for completeness are summarised for each receptor group, where applicable, in Section 12.7.2 of this chapter

12.6 Data sources

12.6.1.1 The baseline environments for the receptor groups considered in this chapter are specific to each receptor group and are, therefore, set out in the relevant topic specific chapters. This chapter draws on the conclusions made within the individual chapters for the assessment of impacts acting in isolation on the receptor groups. The relevant sections drawn upon in this inter-related effects (offshore) assessment are presented in the following sections of the PEIR chapters:

- Chapter 1: Marine Processes (sections 1.7 and 1.11);
- Chapter 2: Benthic Subtidal and Intertidal Ecology (sections 2.7 and 2.11);
- Chapter 3: Fish and Shellfish Ecology (sections 3.7 and 3.11);
- Chapter 4: Marine Mammals (sections 4.7 and 4.11);
- Chapter 5: Ornithology (sections 5.7 and 5.11);
- Chapter 6: Commercial Fisheries (sections 6.7 and 6.11);
- Chapter 7: Shipping and Navigation (sections 7.7 and 7.11);
- Chapter 8: Aviation, Military and Communication (sections 1.11 and 1.16);
- Chapter 9: Marine Archaeology and Ordnance (sections 9.7 and 9.10);
- Chapter 10: Seascape and Visual Resources (sections 10.7 and 10.8); and
- Chapter 11: Infrastructure and Other Users (sections 11.7 and 11.11).

12.7 Impact assessment

12.7.1 Impact assessment methodology

12.7.1.1 The following sections present the approach for the inter-related effects (offshore) assessment for Hornsea Three, which is also described in volume 1, chapter 5: Environmental Impact Assessment Methodology. The following definition of inter-related effects has been applied throughout this chapter:

"Multiple effects upon the same receptor arising from Hornsea Three. These occur either where a single effect acts upon a receptor over time to produce a potential additive effect or where a number of separate effects, such as underwater noise and collision risk, affect a single receptor, for example marine mammals."

Guidance

12.7.1.2 The approach to the inter-related effects assessment has been developed with specific regard to the following text (footnote 11, page 7) from PINS Advice Note 9 (PINS, 2012):

"Inter-relationships consider impacts of the proposals on the same receptor. These occur where a number of separate impacts, e.g., noise and air quality, affect a single receptor such as fauna."

12.7.1.3 The approach also serves to accommodate PINS Advice Note 9 (and Scoping Opinion; PINS, 2016) regarding the need to consider the assessment as a whole and not as a series of unconnected specialist reports.

Approach to assessment

12.7.1.4 The approach to assessing inter-related effects within this chapter has followed a four stage process, as summarised in Table 12.2 and outlined below. More details of the approach summarised above and used to develop this chapter are presented in volume 1, chapter 3: Environmental Impact Assessment Methodology.

Table 12.2: Summary of staged approach to the inter-related effects assessment for Hornsea Three.

Stage	Description
1	Assessment of effects undertaken for individual Environmental Impact Assessment (EIA) topic areas within chapters 1 to 11.
2	Review of assessments undertaken within chapters 1 to 11 to identify 'receptor groups' requiring assessment.
3	Identification of potential inter-related (offshore) effects on receptor groups through review of the topic specific assessments in the PEIR chapters.
4	Assessment undertaken on how individual effects may combine to create inter-related effects on each receptor group for: <ul style="list-style-type: none"> • 'Project lifetime effects', i.e. during construction, operational and decommissioning phases; and • 'Receptor-led effects', i.e. multiple effects on a single receptor.

Stage 1: Topic specific assessments

12.7.1.5 The first stage of the assessment of inter-related (offshore) effects is presented in each of the individual offshore EIA topic chapters and comprises the individual assessments of effects on receptors across the construction, operation and maintenance and decommissioning of Hornsea Three.

Stage 2: Identification of receptor group

12.7.1.6 Stage 2 involved a review of the assessments undertaken in the topic specific chapters to identify 'receptor groups' requiring assessment within the inter-related effects assessment. The term 'receptor group' is used to highlight that the approach taken for the inter-related effects assessment will not assess every individual receptor assessed at the EIA stage, but rather potentially sensitive groups of receptors. The receptor groups assessed can be broadly categorised as those relating to the physical environment, the biological environment and the human environment, as follows:

- Physical environment:
 - Marine Processes.
- Biological environment:
 - Benthic subtidal and intertidal ecology;
 - Fish and shellfish ecology;
 - Marine mammals; and
 - Offshore ornithology.
- Human environment:
 - Commercial fisheries;
 - Shipping and navigation;
 - Aviation, military and communication;
 - Marine archaeology;
 - Seascape and visual resources; and
 - Infrastructure and other users.

12.7.1.7 It is important to note that the significance of effects on different receptors in the same receptor group (i.e. different species of birds in 'offshore ornithology') may vary according to the sensitivity of receptors. Therefore, where a number of species have been considered within the assessments in this chapter, a range is provided for significance of effect.

12.7.1.8 For some other individual topic chapters, an assessment of potential inter-related effects is inherent within the chapter itself and as such, is not covered in this inter-related effect assessment. The topics where this applies are shown below in Table 12.3.

Table 12.3: PEIR topics not included in the Hornsea Three inter-related effects assessment.

Topic ^a	Definition
Marine Nature Conservation Sites	The assessment of inter-related effects is central to the assessment of potential effects on the integrity of designated sites and, as such, has already been assessed within the topic specific chapter and within the Draft Report to Inform Appropriate Assessment. No additional levels of effect are therefore considered to occur at the site level beyond those identified in the individual chapters and the Draft Report to Inform Appropriate Assessment.
Radio communications and television	The assessment presented in chapter 8: Aviation, Military and Communication, includes the consideration of all potential impact pathways on radio and television broadcast and reception infrastructure. Therefore, no additional inter-related effects are considered likely to occur beyond those identified in the specific assessment in chapter 8: Aviation, Military and Communication.

a Items listed in the topic column do not necessarily correspond to a specific PEIR chapter. The topic name presented refers to individual topics or receptors within a chapter.

Stage 3: Identification of potential inter-related effects on receptor groups

12.7.1.9 Following the identification of receptor groups the potential inter-related effects on these receptor groups were identified via review of the impact assessment sections for each topic chapter. The judgement as to which impacts may result in inter-related effects upon receptors associated with Hornsea Three was based on the professional judgement and experience of the project team.

Linked receptor groups

12.7.1.10 It is important to recognise potential linkages between the topic-specific chapters within this PEIR, whereby effects assessed in each chapter have the potential for secondary effects on any number of other receptors. Examples include:

- Chapter 2: Benthic Subtidal and Intertidal Ecology addresses effects on benthic habitats and species arising from changes to the physical environment (as described in chapter 1: Marine Processes);
- Chapter 4: Marine Mammals assesses the effects on marine mammal receptors arising from potential changes in the distribution of fish, which form their principal prey (as described in chapter 3: Fish and Shellfish Ecology);
- Chapter 6: Commercial Fisheries assesses the effects on commercial fisheries receptors arising from potential impacts on commercial species of fish and shellfish as a result of a combination of effects caused by EMF, suspended sediments, habitat alteration/loss and underwater noise impacts; and
- Chapter 11: Infrastructure and Other Users assesses the effects on aggregate extraction areas arising from potential impacts on aggregate resource as a result of potential increase in suspended sediment concentrations (SSC) and deposition and effects on sediment transport pathways (as described in chapter 1: Marine Processes).

12.7.1.11 Where such linked relationships arise these have been fully assessed within the individual topic chapters. This chapter on inter-related effects (offshore) therefore summarises the consideration of these inter-related effects on linked receptors already set out in the preceding, topic specific chapters.

12.7.1.12 It should be noted that it is not considered that there are likely to be any receptor led effects from combined onshore and offshore activities and as a result this has not been considered further in this offshore inter-related effects chapter or the onshore inter-related effects chapter (volume 3, chapter 12).

Stage 4: Assessment of inter-related effects on each receptor group

12.7.1.13 Individual effects on each of the key receptors were identified across the three project phases (i.e. project lifetime effects) as well as the interaction of multiple effects on a receptor (i.e. receptor-led effects), as defined in Table 12.4. This information has been presented within the assessment tables in this chapter (see Table 12.5 to Table 12.15).

12.7.1.14 It is important to note that the inter-related effects assessment considers only effects produced by Hornsea Three and not from other projects which are considered within the cumulative impact assessment sections of each topic chapter.

Table 12.4: Definitions of project lifetime and receptor-led inter-related effects.

Effect Type	Definition
Project lifetime effects	Assessment of the scope for effects that occur throughout more than one phase of the project, (construction, operation and maintenance and decommissioning) to interact to potentially create a more significant effect on a receptor than if just assessed in isolation in these three key project stages (e.g. underwater noise effects from construction piling, operational turbines, vessels and decommissioning).
Receptor-led effects	Assessment of the scope for multiple effects to interact to create inter-related effects on a receptor. As an example, multiple effects on a given receptor such as benthic habitats (e.g. direct habitat loss or disturbance, sediment plumes, scour, jack-up vessel use etc.) may interact to produce a different or greater effect on this receptor than when the effects are considered in isolation. Receptor-led effects might be short term, temporary or transient effects, or incorporate longer term effects.

12.7.1.15 The significance of the individual effects, as defined in the topic specific chapters, is presented in the assessment tables for each receptor group (all conclusions for significance of effect for impacts defined in the topic chapters assume successful implementation of mitigation measures where appropriate, i.e. the residual effect has been used). A descriptive assessment of the scope for these individual effects to interact to create a different or greater effect is then undertaken (see Table 12.5 to Table 12.15). This assessment incorporates qualitative and, where reasonably possible, quantitative assessments. The assignment of significance of effect to any such inter-related effect is not undertaken, rather, any inter-related effects that may be of greater significance than the individual effects acting in isolation on a given receptor are identified and discussed within this chapter.

12.7.1.16 The inter-related effects assessment presents and utilises the maximum significant adverse effects for the project (i.e. the maximum design scenarios including successful implementation of mitigation measures where appropriate), noting that individual effects may not be significant at the topic-specific level but could become significant when their inter-related effect is assessed. Effects of negligible significance or greater (minor, moderate, major) may occur in only one phase of the project life-cycle (e.g. during construction but not operation and maintenance or decommissioning). Where this is the case, it has been made clear that, as a result, there will be no inter-related effects across the project phases. Effects of negligible significance identified in the individual topic assessments have been included since there is the potential for inter-related effects to increase the level (significance) of effect when considered with other sources.

12.7.2 Assessment of inter-related effects

12.7.2.1 For each of the receptor groups listed above, the scope for impacts to these receptors to create project lifetime effects over all the project phases and/or receptor-led effects through interacting together on the receptor group in question has been explored and discussed in the following sections.

Physical environment

Marine processes

12.7.2.2 With respect to physical processes, the only receptor group identified with the potential for inter-related effects is the adjacent UK coastlines. The following potential impacts have been considered within the inter-related effects assessments:

- Changes to the wave regime, with associated potential impacts to sandbanks and along adjacent shorelines; and
- Changes to hydrodynamics, sediment transport and beach morphology at the landfall.

12.7.2.3 Table 12.5 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance and decommissioning of Hornsea Three, and the inter-related effects (receptor-led effects) that are predicted to arise for adjacent coastlines.

Summary of linked receptor group assessments

12.7.2.4 As noted in paragraph 12.7.1.10, effects on the sediment regime (i.e. from increases in SSC and sediment deposition above background levels or changes to sediment transport pathways), also have the potential to have secondary effects on other receptors which have been fully assessed in the topic-specific chapters. These receptors and effects are:

- Benthic subtidal and intertidal ecology:
 - potential increases in SSC and sediment deposition resulting in indirect effects on benthic ecology during construction and decommissioning of minor adverse significance (chapter 2: Benthic Subtidal and Intertidal Ecology);
 - effects on physical processes, including scour effects and changes in wave and tidal regimes resulting in indirect effects on benthic ecology during operation and maintenance of minor adverse significance (chapter 2: Benthic Subtidal and Intertidal Ecology);
- Fish and shellfish ecology:
 - potential increases in SSC and sediment deposition resulting in indirect effects of minor adverse significance during construction and decommissioning (chapter 3: Fish and Shellfish Ecology);
- Marine mammals:
 - potential increases in SSC resulting in indirect effects on marine mammals (through reduction of foraging ability) during construction and decommissioning of negligible significance across all project phases (chapter 4: Marine Mammals);
- Marine archaeology:
 - Sediment deposition resulting in indirect effects on heritage assets during construction of negligible significance;
- Infrastructure and other users:
 - Potential increase in SSC and deposition resulting in indirect effects of negligible significance during construction and decommissioning on aggregate extraction areas (chapter 11: Infrastructure and other users); and
 - Effects on sediment transport pathways resulting in indirect effects of negligible significance during operation and maintenance on aggregate extraction areas (chapter 11: Infrastructure and other users).

Table 12.5: Summary of potential inter-related effects on adjacent UK coastlines (to Hornsea Three) from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Adjacent UK coastlines				
Impact type	Residual effect			Inter-related assessment
	Construction	Operation and maintenance	Decommissioning	Project lifetime effects
Changes to the wave regime, with associated potential impacts to sandbanks and along adjacent shorelines		Negligible		Potential impacts on adjacent UK shorelines due to changes in wave regime produced via the interaction of waves with installed project infrastructure (foundations) will only occur in the operation and maintenance phase of the project and as such, no inter-related effects across the project phases are predicted.
Changes to hydrodynamics, sediment transport and beach morphology at the landfall	Minor adverse	Negligible	Negligible	Potential impacts on the shoreline due to landfall works, such as disruption to sediment transport and changes to beach morphology, will initially arise in the construction phase and then in the decommissioning phase. There is also scope for additional impacts during the operation and maintenance phase. However, due to the mitigation measures proposed to bury the cable to sufficient depths to ensure the cable remains buried for the lifetime of the project, these effects have been assessed as negligible to minor adverse in isolation. The scope for a project lifetime inter-related effect is limited as these potential effects will occur as discrete events, of short duration, separated by large periods of time. Therefore, across the project lifetime, the effects on adjacent coastline are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Receptor-led effects				
<p>Potential exists for interactions to arise at shoreline in the immediate vicinity of the cable landfall site through a combination of changes in the wave regime due to the presence of offshore infrastructure and the changes in sediment transport and/or beach morphology due to cable installation.</p> <p>As described in volume 1, chapter 3 Project Description, Hornsea Three could be built out in multiple phases, up to a maximum of three phases each of which could involve an element of landfall works and foundation installation. As result of this phasing, there is potential that foundations may be present within the Hornsea Three array area (from an earlier construction phase) at the point at which landfall works take place (for a later construction phase). This leads to the potential for operation and maintenance phase changes to the wave regime to coincide with cable installation works at the landfall. However, given measurable changes to the wave regime due to Hornsea Three are not expected to extend to adjacent coastlines and given the short duration and localised nature of changes to SSC arising from the landfall works, it is not considered that there will be any greater impact on the shoreline than that assessed within the individual assessments presented above. As such, these potential effects are not likely to interact in a way that will result in an effect of any greater significance on the shoreline at the landfall site above that predicted for each individual effect (i.e. minor adverse significance).</p>				

Biological environment

Benthic subtidal and intertidal ecology

12.7.2.5 For benthic subtidal and intertidal ecology, the following potential impacts have been considered within the inter-related assessments:

- Temporary or long term loss or alteration of benthic habitat;
- Temporary increases in SSC and deposition may affect benthic ecology;
- Seabed disturbances leading to the release of sediment contaminants and resulting in potential effects on benthic ecology
- Accidental release of pollutants (e.g. from accidental spillage/leakage) may affect benthic ecology
- Introduction of invasive and non-native species;
- Alteration of seabed habitats from effects on physical processes, including scour effects and changes in wave and tidal regimes; and
- Seabed disturbance from maintenance operations.

12.7.2.6 Table 12.6 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise for benthic ecology receptors.

Summary of linked receptor group assessments

12.7.2.7 As noted in paragraph 12.7.1.10, effects on benthic subtidal and intertidal receptors also have the potential to have secondary effects on other receptors which are fully considered in the topic-specific chapters. These receptors and effects are:

- Fish and shellfish ecology:
 - temporary (during construction, operation and maintenance and decommissioning phase) or long term (during operation and maintenance phase only) habitat loss resulting in indirect effects on fish ecology of negligible to minor adverse significance (chapter 3: Fish and Shellfish Ecology);
- Ornithology:
 - changes in habitat and prey availability as a result of loss/alteration of subtidal benthic habitats in all project phases resulting in indirect effects on ornithological receptors of negligible to moderate significance (chapter 5: Offshore Ornithology).

Table 12.6: Summary of potential inter-related effects on benthic subtidal and intertidal ecology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Benthic subtidal and intertidal ecology				
Impact type	Residual effects			Inter-related assessment
	Construction	Operation and maintenance	Decommissioning	Project lifetime effects
Temporary or long term loss or alteration of benthic habitats	Minor to moderate adverse	Negligible to minor adverse	Negligible to minor adverse	When habitat loss or alteration is considered additively across all phases, the total area of habitat affected is larger than when considered across an individual phase (i.e. just construction). However, it should be noted that the habitats affected are widespread within the vicinity of Hornsea Three and throughout the North Sea. Furthermore, all benthic habitats are predicted to recover within a maximum of five years. Therefore, across the project lifetime, the effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Temporary increases in SSC and deposition may affect benthic ecology	Minor adverse		Minor adverse	The majority of the seabed disturbance (resulting in highest SSC/deposition) will occur during the construction and decommissioning phases, with any effects being short lived (i.e. during the construction and decommissioning phases). Due to this, the low sensitivity (and/or high recoverability) of the species and habitats in question, the interaction of these impacts across the stages of the project life-cycle is not predicted to result in an effect of any greater significance than those assessed in the individual project phases and presented here.
Seabed disturbances leading to the release of sediment contaminants and resulting in potential effects on benthic ecology	TBC		TBC	Site-specific subtidal sediment contamination data are currently not available for the Hornsea Three offshore cable corridor, therefore it is not possible to assess this impact in the PEIR. However, as discussed in chapter 2 Benthic Subtidal and Intertidal Ecology a site-specific survey will be undertaken along the Hornsea Three offshore cable corridor, and sediment contaminant data acquired in this survey will inform the assessment for this impact in the final Environment Statement.
Accidental release of pollutants (e.g. from accidental spillage/leakage) may affect benthic ecology	Negligible	Negligible	Negligible	The likelihood for project lifetime inter-related impacts to arise is low given the mitigation measures that will be applied throughout the various project stages (i.e. a Project Environmental Management and Monitoring Plan (PEMMP) during operation and maintenance, a Code of Construction Practice (CoCP) during construction and a Decommissioning Programme during decommissioning) which will ensure that the risk of occurrence of such effects through time is limited. In addition, the recoverability of habitats is considered to be moderate to high. Across the project lifetime, the effects on benthic ecology receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Introduction of non-indigenous species		Minor adverse		Although the operation of construction/decommissioning vessels in the area (potentially from countries of origin other than the UK) may facilitate the spread of non-indigenous species across all phases, this effect will predominantly arise during the operational phase as non-indigenous species will require the hard substrate to be in place to provide substrate on which to settle. As a result, any additional inter-related effect is judged to be of no greater significance than the operational phase effect assessed.
Alteration of seabed habitats from effects on physical processes, including scour effects and changes in wave and tidal regimes		Minor adverse		This effect will only arise during operation and maintenance and as such there will be no inter-related effects across the project phases.
Seabed disturbance from maintenance operations		Negligible adverse		This effect will only arise during operation and maintenance and as such there will be no inter-related effects across the project phases.

Receptor-led effects

Potential exists for spatial and temporal interactions between the effects arising from habitat loss/disturbance/alteration, increased SSC and associated sediment deposition, and contamination effects on benthic habitats during the lifetime of Hornsea Three.

Based on current understanding, and expert knowledge, the greatest potential for inter-related impacts is predicted to arise through the following:

- i. the interaction of direct (both temporary and permanent) habitat loss /disturbance from foundation installation/jacking-up/anchor placement/scour, indirect habitat disturbance due to sediment deposition and indirect effects of changes in physical processes due to the operational wind farm; and
- ii. the interaction of contamination due to accidental release of pollutants and re-suspension of contaminants from sediments.

With respect to interaction (i), these individual impacts were assigned a significance of minor adverse as standalone impacts and although potential combined impacts may arise (i.e. spatial and temporal overlap of direct habitat disturbance), it is predicted that this will not be any more significant than the individual impacts in isolation. This is because the combined amount of habitat potentially affected would be very limited (typically restricted to the Hornsea Three array), the biotopes affected are widespread across the southern North Sea and, where temporary disturbance occurs, full recovery of the benthos is predicted. In addition, any effects due to changes in the physical processes are likely to be limited, both in extent (i.e. largely within the Hornsea Three array area) and also in magnitude, with benthic ecology receptors having low sensitivity to the scale of the changes predicted. As such, these interactions are predicted to be no greater than the individual effects assessed in isolation.

With respect to interaction (ii), the likelihood for accidental release of contaminants is low in the offshore environment given the mitigation measures proposed across each phase of the development. These impacts were assigned a significance of negligible as standalone impacts and it is concluded that the significance of effect produced by these interactions will be no greater than the individual effects assessed in isolation (i.e. negligible).

Site-specific subtidal sediment contamination data are currently not available for the Hornsea Three offshore cable corridor, therefore it is not possible to assess this impact in the PEIR. However, as discussed in chapter 2 Benthic Subtidal and Intertidal Ecology, and noted above, a site-specific survey will be undertaken along the Hornsea Three offshore cable corridor and will inform the assessment for this impact in the Environmental Statement.

Fish and shellfish ecology

12.7.2.8 For fish and shellfish ecology, the following potential impacts have been considered within the inter-related assessment:

- Temporary or long term loss of fish and shellfish habitats, including feeding, spawning and nursery habitats;
- Increases in SSC and associated sediment resulting in potential effects on fish and shellfish receptors;
- Underwater noise leading to injurious and behavioural impacts on fish and shellfish receptors;
- Electromagnetic field (EMF) emissions leading to behavioural effects;
- Redistribution of fishing pressure; and
- Accidental release of pollutants (e.g. from accidental spillage/leakage) may affect fish and shellfish.

12.7.2.9 Table 12.7 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance phase, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise for fish and shellfish receptors.

Summary of linked receptor group assessments

12.7.2.10 As noted in paragraph 12.7.1.10, effects on fish and shellfish ecology also have the potential to have secondary effects on other receptors and these effects are fully considered in the topic-specific chapters. These receptors and effects are:

- Marine mammals:
 - Changes in the fish and shellfish community during construction, operation and maintenance and decommissioning leading to loss of prey resources for, and indirect effects on, marine mammals of minor adverse significance (chapter 4: Marine Mammals)
- Ornithology:
 - loss/change in distribution of prey resources resulting in indirect effects on ornithological receptors of negligible to moderate adverse significance (chapter 5: Offshore Ornithology);
- Commercial fisheries:
 - potential impacts to commercially fished species of fish and shellfish resulting in indirect effects of negligible to moderate adverse significance on fishing fleets (chapter 6: Commercial Fisheries).

Table 12.7: Summary of potential inter-related effects on fish and shellfish ecology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Fish and shellfish ecology				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Temporary or long term loss of fish and shellfish habitats, including feeding, spawning and nursery habitats	Minor adverse	Negligible to minor adverse	Minor adverse	When habitat loss (temporary and long term) or alteration is considered additively across all phases of the project, although the total area of habitat affected is larger than for the individual project stages, similar habitats are widespread within the southern North Sea. During the operation and maintenance phase, the majority of the disturbance will be highly localised with little repeat disturbance and the habitats affected are predicted to recover. Therefore, across the project lifetime, the effects on fish and shellfish receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Increases in SSC and associated sediment resulting in potential effects on fish and shellfish receptors	Minor adverse		Minor adverse	The majority of the seabed disturbance (resulting in highest SSC/deposition) will occur during the construction and decommissioning phases. Receptors and associated spawning/nursery habitats potentially affected by increased SSC and deposition will have recovered in the intervening period between the construction and decommissioning phases. Therefore, across the project lifetime, the effects on fish and shellfish receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Underwater noise leading to injurious and behavioural impacts on fish and shellfish receptors	Minor adverse	Negligible	Negligible	The majority of disturbance from underwater noise (resulting in greatest potential for injury or behavioural effects) is predicted to result from piling during the construction phase. Noise associated with the operation and maintenance and decommissioning phases was assessed to result in effects of negligible significance with little potential for physiological damage or behavioural effects to fish and shellfish. Therefore, across the project lifetime, the effects on fish and shellfish receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Introduction of turbine foundations and scour/cable protection (hard substrates and structural complexity) leading to the creation of reef habitat		Minor beneficial		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
EMF emissions leading to behavioural effects		Minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Redistribution of fishing pressure		Negligible to minor beneficial		Although construction safety zones may result in temporary, localised displacement of fisheries particularly from the Hornsea Three array, this effect will mainly arise during the operation and maintenance phase as a result of 500 m operational safety zones put in place during major maintenance works and as a result of logistical and safety reasons due to the physical presence of the Hornsea Three infrastructure. Due to the effect mainly arising during operation and maintenance phase there will be no inter-related effects across the project phases.
Contamination due to accidental release of pollutants	Negligible	Negligible	Negligible	The likelihood for project lifetime inter-related impacts to arise is low given the mitigation measures that will be applied throughout the various project stages (i.e. PEMMP, CoCP and Decommissioning Programme) which will ensure that the risk of interaction of such effects through time is limited. Therefore, across the project lifetime, the effects on fish and shellfish receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.

Receptor-led effects

Potential exists for spatial and temporal interactions between habitat loss/disturbance/alteration, increased SSC, sediment deposition, underwater noise, EMF and contamination effects during the lifetime of Hornsea Three.

Therefore, based on current understanding, and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following:

- i. The interaction of habitat loss/change (temporary and long term), increased SSC, underwater noise from piling/drilling during the construction phase and EMF effects during the operational phase; and
- ii. The interaction of contamination due to accidental release of pollutants and re-suspension of contaminants from sediments.

With respect to interaction (i), these individual impacts were assigned a significance of negligible or minor adverse as standalone impacts and although potential combined impacts may arise, it is important to recognise that some of the activities potentially resulting in combined effects are mutually exclusive. For example, the majority of effects associated with an increase in SSC and deposition will arise from seabed preparation works for gravity base foundation installation or from the drilling of piled foundations, whereas the majority of noise effects will arise from foundation piling for monopiles or jackets. Furthermore, underwater noise (should piling occur) will result in the displacement of mobile fish from areas around foundations which in turn will mean that these species will not be exposed to the greatest predicted increases in SSC. Similarly, any potential behavioural effects as a result of EMF would be likely to occur over the same area as habitat loss/change effects (i.e. within metres of the cable) and therefore habitat loss/change effects would not be additive to EMF effects. Therefore effects of greater significance than the individual impacts in isolation (i.e. negligible to minor adverse) are not predicted.

With respect interaction (ii), the likelihood for accidental release of contaminants is low given the controls that will be applied (e.g., implementation of a CoCP, PEMMP and Decommissioning Programme). In addition, the recorded level of offshore sediment contamination has been found to be unlikely to result in adverse biological effects. As such, with the appropriate measures in place, it is concluded that the significance of effect will be no greater than the individual effects assessed in isolation within the individual assessments (i.e. negligible to minor adverse).

Marine mammals

12.7.2.11 For marine mammals, the following potential impacts have been considered within the inter-related assessment:

- Underwater noise causing injury or disturbance to marine mammals;
- EMF affecting marine mammal behaviour;
- Increased suspended sediments reducing water clarity and impairing the foraging ability of marine mammals;
- Increased vessel traffic resulting in an increase in disturbance, collision risk, or injury to marine mammals and;
- Accidental pollution resulting in potential effects on marine mammals; and
- Changes in the fish and shellfish community leading to loss of prey resources for marine mammals.

12.7.2.12 Table 12.8 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise for marine mammal receptors.

Summary of linked receptor group assessments

12.7.2.13 As noted in paragraph 12.7.1.10, marine mammals and fish and shellfish ecology are linked receptor groups and the inter-related effects associated with a change in the distribution and/or abundance of prey species for marine mammals across each phase of the project has been fully assessed in chapter 4: Marine Mammals, with effects of minor adverse significance predicted during construction, effects of minor adverse and minor beneficial significance predicted during operation and maintenance, and effects of minor adverse significance predicted during decommissioning.

Table 12.8: Summary of potential inter-related effects on marine mammals from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Marine mammals				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Underwater noise causing injury or disturbance to marine mammals	TBC	Negligible	Negligible	Underwater noise will be produced at all project stages, including for example piling and vessel noise during construction, and vessel noise during the operational and maintenance phase. The effects of subsea noise from pile-driving are predicted to occur during the piling phase of the offshore construction period and would affect marine mammals directly during the periods when pile-driving activity takes place (up to 604.8 days piling over a two and a half year piling period, split into two phases with a gap of up to six years between phases for the maximum adverse temporal scenario). This PEIR describes the magnitude of impact from subsea noise on marine mammal receptors and the sensitivity of the receptors to the range of impacts. At this stage, however, it was not possible to provide a conclusion with respect to significance of effects due to the current engineering refinements underway, which will have implications for the parameters assessed for piling, noise assessment criteria, and magnitude and sensitivity criteria (see chapter 4: Marine Mammals, section 4.11.1).
Electromagnetic Fields (EMF) affecting marine mammal behaviour		Negligible		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Increased suspended sediments reducing water clarity and impairing the foraging ability of marine mammals	Negligible		Negligible	Project lifetime inter-related effects are unlikely as the majority of disturbance (resulting in highest SSC/deposition) will be during the construction and decommissioning phases with minimal disturbance likely during the operation and maintenance phase. Any elevations in SSC are likely to be short lived (especially so in the context of a project phase being considered here), and as such the effects on marine mammals across the project lifetime are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Increased vessel traffic resulting in an increase in disturbance, collision risk, or injury to marine mammals	Minor adverse	Minor adverse	Minor adverse	The potential for vessel strikes will arise at all stages of the project, resulting in a potential project lifetime effect. However, it is not predicted that the significance of any potential vessel strikes will increase due to the interaction of this impact across all project stages, rather be maintained at the same level throughout the project (with resultant minor adverse significance prediction). Therefore, across the project lifetime, the effects on marine mammals are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Accidental pollution resulting in potential effects on marine mammals	Negligible	Negligible	Negligible	The likelihood for project lifetime inter-related impacts to arise is low given the mitigation measures that will be applied throughout the various project stages (i.e. a CoCP, PEMMP and Decommissioning Programme) which will ensure that the risk of interaction of such effects through time is limited. Therefore, overall, across the project lifetime, the effects on marine mammal receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Changes in the fish and shellfish community leading to loss of prey resources for marine mammals	Minor adverse	Minor beneficial	Minor adverse	Impacts to fish and shellfish receptors will not result in an on-going, additive loss of prey, rather an initial loss during the construction phase (i.e. from underwater noise impacts, temporary habitat loss etc.), followed by recovery of areas, leading to no large-scale and long-term loss of prey items. The implementation of a CoCP during construction, a PEMMP in the operation and maintenance phase and a Decommissioning Programme during decommissioning means that the likelihood of accidental spillages will be low. Therefore, the significance of this inter-related effect is not predicted to increase over and above the predictions made for the individual project phases.

Receptor-led effects

Potential exists for spatial and temporal interactions between underwater noise, EMF, increased SSC, contamination effects and changes/disturbance of prey resources during the lifetime of Hornsea Three. As effects associated with EMF are highly spatially localised to the immediate vicinity of the cable and are temporally restricted to the operation and maintenance phase, the potential for interaction with other effects is deemed unlikely.

The greatest scope for interaction of different effects on marine mammals is during the construction phase, when the most significant impact to marine mammals (i.e. underwater noise from piling) is likely to interact with other impacts. Therefore, based on current understanding, and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following:

- i. The interaction of noise, increased suspended sediments, increased vessel traffic (and collision risk) and disturbance / change to prey species abundance and distribution during the construction phase affecting marine mammals.

With respect to interaction (i), with the exception of underwater noise effects, these individual impacts were assigned a significance negligible to minor adverse significance as standalone impacts and although combined impacts may arise, it is important to recognise that some of the activities potentially resulting in combined effects are mutually exclusive and therefore will not interact to produce effects of greater significance. For example, the largest increases in SSC will, on the whole, arise from seabed preparation works for gravity base foundation installation or from the drilling of piled foundations, whereas the greatest noise effects will arise from foundation piling for monopiles or jackets. Furthermore, underwater noise (should piling occur) will result in the displacement of marine mammals from the Hornsea Three array which will, in turn, mean that these species will not be exposed to the greatest predicted increases in SSC and will also be displaced from the areas of highest vessel traffic within the Hornsea Three array area. Although displacement effects for marine mammals is unlikely to occur due to installation of the export cable which might increase the potential for the interaction of effects associated with suspended sediments, these effects will be short lived and localised along the Hornsea Three offshore cable corridor. A situation may also arise where any potential disturbance to prey species is offset by the fact that as marine mammals are temporarily displaced from areas around piling, the fish that form part of their diet may also be temporarily displaced, thus remaining available for marine mammal feeding. Therefore, it is predicted that the interaction of these impacts may act, to some extent, to counter certain potential effects occurring and so effects of greater significance than the individual impacts in isolation are not predicted for marine mammals.

Offshore ornithology

12.7.2.14 For ornithology, the following potential impacts have been considered within the following inter-related assessments:

- Disturbance and displacement due to construction activity;
- Indirect effects, such as changes in habitat of and abundance and distribution of prey species;
- Displacement due to presence of turbines and other ancillary structures;
- Mortality from collision with rotating turbine blades;
- Barrier effects may prevent clear transit of birds between foraging and breeding sites, or on migration;
- Attraction to lit structures by migrating birds may cause disorientation, reduction in fitness and possible mortality; and
- Accidental pollution leading to effects on ornithological receptors.

12.7.2.15 Table 12.9 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise.

Summary of linked receptor group assessments

12.7.2.16 As noted in paragraph 12.7.1.10, ornithological receptors and fish and shellfish receptors are linked and the inter-related effects associated with a change to the prey resources of ornithological receptors has been fully assessed in chapter 5: Offshore Ornithology, with effects of negligible significance predicted during construction, effects of negligible to minor adverse significance predicted during the operational and maintenance phase and effects of negligible to minor adverse significance during decommissioning.

Table 12.9: Summary of potential inter-related effects on offshore ornithology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Offshore ornithology				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Disturbance and displacement due to construction activity	Negligible to minor adverse	Negligible to minor adverse	Negligible to minor adverse	Vessel activity in any one given year will be at its peak in the construction phase, reducing in the operation and maintenance phase as major installation vessels leave the site leaving smaller numbers of predominantly smaller crew and supply vessels operating each year. Since impacts on individuals will be intermittent and likely to be relatively brief during all phases these effects are not predicted to be significant. This will result in birds that were subject to disturbance effects during the construction phase returning to the site in the operation and maintenance phase. Overall, across the project lifetime, the effects on ornithological receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Indirect effects, such as changes in habitat or abundance and distribution of prey	Negligible	Negligible to minor adverse	Negligible to minor adverse	Impacts to prey species (i.e. fish and shellfish) will be at their maximum during the construction phase as a result of effects associated with underwater noise from piling, increased suspended sediments and habitat loss. In addition, the ornithological species present in the vicinity of the Hornsea Three array demonstrate a high degree of habitat/prey flexibility. As a result, across the project lifetime, the effects on ornithological receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Displacement due to presence of turbines and other ancillary structures		Negligible to minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Mortality from collision with rotating turbine blades		Negligible to minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Barrier effects may prevent clear transit of birds between foraging and breeding sites, or on migration		Negligible to minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Attraction to lit structures by migrating birds may cause disorientation, reduction in fitness and possible mortality		Negligible to minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Accidental pollution leading to effects on ornithological receptors	Negligible	Negligible	Negligible	As discussed previously in this chapter, the likelihood for project lifetime inter-related impacts to arise is low given the mitigation measures that will be applied throughout the various project stages. Across the project lifetime, the effects on ornithological receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Receptor-led effects				
<p>Potential exists for spatial and temporal interactions between disturbance from construction activity, changes to prey, accidental pollution, collision effects, displacement and barrier effects during the lifetime of Hornsea Three. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following:</p> <ul style="list-style-type: none"> ii. The interaction of disturbance events, loss/displacement of prey species and loss of loafing/foraging habitat during the construction phase; and iii. The interaction of collision, displacement and barrier effects from the operational turbines. <p>With regards to interaction (i), although there are relatively high peak abundances for some species within the survey area compared to regional populations, it is likely that only birds in close proximity to construction activities will be affected intermittently, over a short-term period. For the potential loss/displacement of prey species, a situation may arise where any loss/displacement of prey items is offset by the fact that, if birds are displaced by construction activities, the fish that form part of their diet may also be displaced. Therefore, the interaction of these impacts may act, to some extent, to counter certain potential effects occurring. As such, effects of greater significance than the individual impacts in isolation (i.e. negligible to minor adverse) are not predicted during the construction phase.</p> <p>With regards to interaction (ii), mortality arising from collisions and also from operational displacement are mutually exclusive as a species cannot simultaneously exhibit a high level of avoidance (displacement) and a high level of collision risk. Therefore quantification of inter-related effects is not easily achievable, for example by summing predicted mortality rates for each impact. Whilst the impacts may interact for some species, this would not be in such a way as to increase the significance of any of the individual effect significances (i.e. negligible to minor adverse).</p> <p>With regards to the potential for receptor-led impacts on populations of non-seabird migrants (i.e. waders and wildfowl), arising from the interaction of offshore collision risk, collision mortality numbers for each species were predicted to be very low and it is not anticipated that these impacts will interact in such a way as to increase any of the individual significances of effect (assessed as negligible, as presented within chapter 5: Offshore Ornithology).</p>				

Human environment

Commercial fisheries

12.7.2.17 For commercial fisheries, the following potential impacts have been considered within the inter-related assessment:

- Reduction in access to, or exclusion from, potential and/or established fishing grounds within the Hornsea Three array;
- Reduction in access to, or exclusion from, potential and/or established fishing grounds within the Hornsea Three offshore cable corridor;
- Displacement from the Hornsea Three array leading to gear conflict and increased fishing pressure on adjacent grounds;
- Displacement from the Hornsea Three offshore cable corridor leading to gear conflict and increased fishing pressure on adjacent grounds;
- Displacement or disruption of commercially important fish and shellfish resources;
- Additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the array and export cable areas;
- Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic leading to interference with fishing activity;
- Gear snagging and obstruction due to seabed objects/ deposits within the Hornsea Three array; and
- Gear snagging and obstruction due to seabed objects/ deposits within the Hornsea Three offshore cable corridor.

12.7.2.18 Table 12.10 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise for commercial fisheries receptors.

Summary of linked receptor group assessments

12.7.2.19 As noted in paragraph 12.7.1.10, commercial fisheries and fish and shellfish ecology are linked receptors and the inter-related effects associated with a change to the targeted species of commercial fisheries has been fully assessed in chapter 6: Commercial Fisheries, with effects of minor adverse significance predicted for all project phases.

Table 12.10: Summary of potential inter-related effects on commercial fisheries from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Commercial fisheries				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Reduction in access to, or exclusion from, potential and/or established fishing grounds within the Hornsea Three array	Minor to moderate adverse	Minor to moderate adverse	Minor to moderate adverse	During construction and decommissioning phases of project, safety zones, and therefore the areas from which commercial fishing will be excluded, will be highly localised. During construction, for example, fishing will be excluded from 500 m safety zones around turbines and platforms. During operation, fishing activity will be excluded from the Hornsea Three array due to the presence of anchor and mooring systems for floating turbines. However, the mobile gear fleets that operate within the Hornsea array can fish across the North Sea and are not exclusively tied to the Hornsea Three array area. Therefore, while access may be completely removed during operation, during construction and decommissioning vessels will be able to operate across the Hornsea Three array area where activity is not taking place. While there will be a small incremental increase in the area in which fishing may be disrupted as the project is built out, as fishing activity is likely to be able to continue elsewhere during the operational and maintenance phase, effects on commercial fisheries across the phases are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Reduction in access to, or exclusion from, potential and/or established fishing grounds within the Hornsea Three offshore cable corridor	Negligible to moderate adverse	Minor adverse	Negligible to moderate adverse	During all phases of the project, safety zones, and therefore the areas from which commercial fishing will be excluded, will be highly localised. During construction, for example, fishing will be excluded from temporary 500 m roaming safety zones around cable installation activities. During operation, there will be no formal exclusion of fishing activity except for within the 500 m safety zones around manned platforms along the Hornsea Three offshore cable corridor and within temporary 500 m roaming safety zones implemented during major maintenance activities. In addition, disruption to UK potters along the Hornsea Three offshore cable corridor during construction will reduce during the operational and maintenance phase. Therefore, although there will be a small incremental increase in the area in which fishing may be disrupted as the project is built out, as fishing activity is likely to be able to continue, effects on commercial fisheries across the phases are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Displacement from Hornsea Three array leading to gear conflict and increased fishing pressure on adjacent grounds	Negligible to minor adverse	Negligible to minor adverse	Negligible to minor adverse	As discussed above, although fishing may be disrupted and partial exclusion may occur during the construction and decommissioning phases of Hornsea Three, it is unlikely that fishing will still be possible within the Hornsea Three array area over the lifetime of the project with the presence of floating foundations and mooring lines. However, due to the availability of alternate fishing grounds for the fleets that operate across the Hornsea Three array, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Displacement from the offshore cable corridor leading to gear conflict and increased fishing pressure on adjacent grounds	Negligible to minor adverse	Negligible to minor adverse	Negligible to minor adverse	The majority of disturbance (resulting in displacement of fisheries) will be during the construction and decommissioning phases with minimal disturbance likely to arise from maintenance activities (from temporary 500 m roaming safety zones for major maintenance activities) during the operation and maintenance phase. The expected level of significance stated for the construction and decommissioning phases is based upon the reduction in access to, or exclusion from fishing grounds only. Therefore, across the project lifetime, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Displacement or disruption of commercially important fish and shellfish resources	Negligible to minor adverse	Negligible to minor adverse	Negligible to minor adverse	Impacts to prey species (i.e. fish and shellfish) will be at their maximum during the construction phase as a result of effects associated with underwater noise from piling, increased suspended sediments and habitat loss. Across the project lifetime, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Additional steaming to alternative fishing grounds for vessels that would otherwise be fishing within the array and export cable areas	Negligible to minor adverse	Negligible adverse	Negligible to minor adverse	Any combined increase in steaming times across the construction and decommissioning phases (e.g. to avoid safety zones) will not be significant due to the limited scale and duration of safety zones. During the operation and maintenance phase, it is expected that fishing will resume across the offshore export cable and, as such, additional steaming will not be necessary. A shipping corridor will be maintained (immediately west of Hornsea Three array area) to allow steaming to grounds north of Hornsea Three (namely to Dogger Bank). Although, it should be noted that commercial fisheries will not be restricted to these lanes. The required deviation during the operational and maintenance phase has therefore been assessed as negligible significance. As such, across the project lifetime, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.

Commercial fisheries				
Increased vessel traffic within fishing grounds as a result of changes to shipping routes and construction vessel traffic leading to interference with fishing activity;	Negligible to minor adverse	Negligible to minor adverse	Negligible to minor adverse	With the successful implementation of measures adopted for this development (i.e. issue of Notices to Mariners (NTMs), preparation of a fisheries co-existence and liaison plan, close liaison with the local vessels, see chapter 6: Commercial Fisheries, section 6.10), no significant effects are predicted for the construction, operation and maintenance, and decommissioning phases of the project. As such, across the project lifetime, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Gear snagging and obstruction due to seabed objects / deposits within the Hornsea Three array		Negligible to minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Gear snagging and obstruction due to seabed objects/ deposits within the offshore cable corridor		Negligible to minor adverse	Negligible to minor adverse	Impacts due to gear snagging will occur during the operation phase due to the presence of cable protection on the seabed and the presence of the export cable. During decommissioning this infrastructure will be removed although some may be left in situ following decommissioning. However, across the project lifetime, the effects on commercial fisheries are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Receptor-led effects				
<p>Potential exists for spatial and temporal interactions between the majority of the impacts outlined above. However, it should be noted that many of the effects will be mitigated through all project phases via use of mitigation measures such as on-going communication via issue of NTMs and undertaking a post-construction debris survey (see chapter 6: Commercial Fisheries, section 6.10). Therefore, based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following:</p> <p>i. Reduction in access to fishing grounds and the subsequent increased pressure on adjacent grounds.</p> <p>With regards to interaction (i), during the construction and decommissioning phases, both effects will be temporary and short lived, with access to fishing grounds being prevented where construction and decommissioning activity is taking place. During construction and decommissioning phases of Hornsea Three, safety zones, and therefore the areas from which commercial fishing will be excluded, will be highly localised. During construction and decommissioning, for example, fishing will be excluded from 500 m safety zones around turbines and platforms. During operation the effects will be different depending on the receptors affected. For instance if floating foundations are present, the moorings and anchor systems in the Hornsea Three array area will exclude mobile fishing fleets. As the mobile fishing fleets will be unable to fish in the grounds in the Hornsea Three array area, they will move to other fishing areas in the North Sea, which could put them into conflict with static gear (i.e. potting) fleets operating closer to shore and along the Hornsea Three offshore cable corridor. As a result, the static fleets will be subjected to potential increases in pressure on their grounds. Mobile gear fleets are less sensitive to increases in fishing pressure as they can move to target other areas where pressure is less. It should be noted that while potting vessels may be required to move pots from the Hornsea Three offshore cable route corridor during the construction and decommissioning phases, this will occur only temporarily during these phases and with sufficient notice, together with a guard vessel where appropriate, to facilitate this process. As a result it is unlikely that the two effects will act together and that any inter-related effect will not be of any greater significance than those already assessed in isolation (i.e. negligible to moderate adverse significance).</p>				

Shipping and navigation

12.7.2.20 For shipping and navigation, the following potential impacts have been considered within the inter-related assessment:

- Increased journey times during periods of adverse weather;
- Increase in vessel to structures allision risk (including emergency situations) both externally and internally within the array;
- Increase in vessel to vessel collision risk;
- Increased risk of gear snagging for commercial fishing vessels; and
- Diminished emergency response capability (including search and rescue (SAR)) within the Hornsea Three array area and Hornsea Three offshore cable corridor.

12.7.2.21 Table 12.11 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Project Two and also the inter-related effects (receptor-led effects) that are predicted to arise for shipping and navigation receptors.

Summary of linked receptor group assessments

12.7.2.22 As noted in paragraph 12.7.1.10, effects on shipping and navigation, due to an increase in vessels numbers also has the potential to have direct effects on marine mammals which has been fully assessed in chapter 4: Marine Mammals with effects of minor adverse significance predicted across all project phases and chapter 5: Offshore Ornithology with effects of no greater than minor adverse significance across all project phases.

Table 12.11: Summary of potential inter-related effects on shipping and navigation from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Shipping and navigation				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Increased journey times and distances during periods of adverse weather	Minor adverse	Minor adverse	Minor adverse	Any combined increase in journey times and distances across the construction and decommissioning phases (e.g., to avoid buoyed construction or decommissioning area), will not be significant due to the low frequency of adverse weather and low number of adverse weather routes identified (through consultation and data collection). However, the required deviation during the operational and maintenance phase has been assessed as minor adverse significance. It is expected that the significance of this effect will be maintained at the same level throughout the project. As such, across the project lifetime, the effects on shipping and navigation are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Increase in vessel to structures allision risk (including in emergency situations) – Hornsea Three array area	Minor adverse	Minor to moderate adverse (external and internal risk)	Minor adverse	The scale of effects to shipping receptors progressively increases during construction as the wind turbines and ancillary structures are installed and the offshore cable corridor (including offshore HVAC booster stations) are installed. The designed in mitigation, including lighting and marking, advisory safety zones of up to 500 m around Hornsea Three structures during construction (and decommissioning) and 500 m safety zones around manned offshore platforms during operation, should reduce the likelihood of allision from a powered vessel as well as reducing the consequence. In addition, the frequency of vessels not under command is extremely low. Although the temporal effect is lengthened, with the proposed mitigation implemented, across the project lifetime, the effects on shipping and navigation are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Increase in vessel to vessel collision risk – Hornsea Three array area		Minor to moderate adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Design of the Hornsea Three array area may impact on the ability of coastguard helicopters to access the area to undertake SAR operations.		Minor adverse		This effect will only arise during the operation and maintenance phase and as such there will be no inter-related effects across the project phases.
Increased risk of gear snagging for commercial fishing vessels	Minor adverse	Minor adverse	Minor adverse	The potential for gear snagging will arise during the construction as cables are laid and subsurface elements are installed and during the operation and maintenance phases of the project while they are in situ and during decommissioning as they are removed. However, across the project lifetime, the effects on shipping and navigation from gear snagging are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Receptor-led effects				
<p>The potential exists for spatial and temporal interactions between deviations resulting in vessel collision risk, vessel to structure allision risk and diminished emergency response capability. The greatest scope for potential inter-related impacts could arise from the following:</p> <ul style="list-style-type: none"> i. The interaction of vessel collision risk and commercial shipping route deviation on shipping receptors; and ii. The interaction of vessel allision risk and commercial shipping route deviation on shipping receptors. <p>With regards to interaction (i), the deviation of commercial shipping routes may lead to an increase in encounters and therefore vessel to vessel collisions, however this has been fully assessed in the Navigation Risk Assessment (NRA). Whilst impacts to vessels may interact, this would not be in such a way as to increase the significance of any of the individual effect significances (i.e. minor adverse).</p> <p>With regard to interaction (ii), impacts to vessels arising from allision with offshore structures and also from deviation of vessels, are mutually exclusive as a vessel will not simultaneously exhibit a high level of displacement from the area and a high level of collision risk with the wind farm structures. Impacts to vessels would not therefore interact.</p>				

Aviation, military and communication

12.7.2.23 For Aviation, Military and Communication, the following impacts have been considered within the inter-related effects assessment:

- Interference with operations within Military Practice Areas;
- Disruption to helicopters using Helicopter Main Routes (HMRs);
- Impact on available airspace for other users;
- Disruption to cross-zone transit helicopter traffic;
- Disruption of helicopter access to oil and gas platforms, drilling rigs and operational vessels; and
- Disruption of radar coverage.

12.7.2.24 Table 12.12 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise for Aviation, Military and Communication receptors.

Summary of linked receptor group assessments

12.7.2.25 Aviation, military and communication receptors and Infrastructure and other users receptors are linked receptors and the inter-related effects (i.e. restriction on access to infrastructure by both helicopter and vessel) are described in Table 12.12 below, with effects of minor adverse significance predicted.

Table 12.12: Summary of potential inter-related effects on Aviation, Military and Communication from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Aviation, military and communication				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Interference with operations within Military Practice Areas	Minor adverse	Minor adverse	Minor adverse	Construction, operational and maintenance, and decommissioning activities with associated vessel movements, safety zones and advisory safety distances may interfere with operations within the Military Practice Area in the Outer Silver Pit area which overlaps with the Hornsea Three array area (albeit negligibly). The effect can be considered to be continuous across all project phases. Consultation with the MOD/DIO to date has not raised any concerns with regard to the proximity of the Hornsea Three array area to this Submarine Exercise Area. Hornsea Three will carry out further consultation with MOD on the accuracy of the boundary, and there is the potential that this negligible area of overlap would be restricted from being used as a Submarine Exercise Area. Therefore, across the project lifetime, the effects on Aviation, Military and Communication receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Disruption to helicopters using HMRs	Minor adverse	Minor adverse	Minor adverse	The presence of wind turbines during the construction, operational and maintenance, and decommissioning phases within the area of HMR2 would preclude the use of this route by helicopters when flying in instrument meteorological conditions (IMC). This potential impact would apply from when the turbines are installed until they are removed and therefore the effect can be considered to be continuous across all project phases. A similar impact but of lesser magnitude applies for the offshore cable corridor, where the presence of the offshore HVAC booster stations may be located within the area of HMR3 and HMR5. An obstacle free route is available as a deviation around the Hornsea Three array area and a minor deviation may be required around the offshore HVAC booster stations. Therefore, across the project lifetime, the effects on Aviation, Military and Communication receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Impact on available airspace for other users	Minor adverse	Minor adverse	Minor adverse	Helicopters will be used during the construction, operational and maintenance, and decommissioning phases of Hornsea Three and these flights would be in addition to existing helicopter traffic levels in the southern North Sea. The effect can be considered to be continuous across all project phases. Helicopter flights in the UK are highly regulated. The same rules of the air and Air Traffic Control (ATC) services will continue to apply to helicopter operators within the southern North Sea and the provision of a service to Hornsea Three is not considered to affect the provision of a service to another user of the airspace. Therefore, across the project lifetime, the effects on Aviation, Military and Communication receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Disruption to cross-zone transit helicopter traffic		Minor adverse		This effect will only arise during the operational and maintenance phase and as such there will be no inter-related effects across the project phases.
Disruption of helicopter access to oil and gas platforms, drilling rigs and operational vessels		Negligible to minor adverse		This effect will only arise during the operational and maintenance phase and as such there will be no inter-related effects across the project phases.
Disruption of radar coverage		No impact to minor adverse		This effect will only arise during the operational and maintenance phase and as such there will be no inter-related effects across the project phases.

Receptor-led effects

Potential exists for spatial and temporal interactions between direct impacts to Aviation, Military and Communication receptors. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise from the following:

- i. The interaction of the disruption to helicopters using HMRS, impact on available airspace, and disruption to cross-zone transit helicopter traffic on the same receptor (helicopter operator); and
- ii. The interaction of disruption of helicopter access to oil and gas platforms, drilling rigs and operational vessels and disruption of vessel access to oil and gas platforms and subsea infrastructure on the same receptor (oil and gas licence block operator).

With regard to interaction (i), helicopters using HMRS may need to deviate around the Hornsea Three array area and/or offshore HVAC booster stations and may also be affected by increased helicopter traffic and associated impacts on available airspace. Where helicopters are using an HMR that is deviated around the Hornsea Three array area, the deviation itself would mean that there is unlikely to also be an interaction with the impact of disruption to cross-zone helicopter traffic (and vice-versa). Helicopter flights in the UK are highly regulated and the same rules of the air and ATC services will continue to apply to helicopter operators within the southern North Sea. No significant inter-related effect has therefore been identified.

With regards to interaction (ii), disruption of helicopter access to oil and gas platforms, drilling rigs and operational vessels has been assessed as minor adverse (with a 'Hold' currently included for a number of licence blocks where the sensitivity and hence significance of effects is yet to be determined). Disruption of vessel access to oil and gas platforms and subsea infrastructure has also been assessed as minor adverse (see chapter 11: Infrastructure and Other Users). It is possible for both helicopter and vessel access to existing and future infrastructure to be disrupted by the presence of Hornsea Three. The suspended wells within the Hornsea Three array area (49/08c-4) and within 1 km of the Hornsea Three array area (Topaz) are the only existing infrastructure that fall within the relevant study areas for both Aviation, military and communication and Infrastructure and other users. Consultation has advised that these wells are likely to be decommissioned prior to Hornsea Three construction (see chapter 11: Infrastructure and Other Users). Close communication will be established between Hornsea Three and the relevant operators to ensure that future activities can be coordinated and any future operator will be aware of the Hornsea Three project and will have taken potential coexistence into consideration. Therefore, the significance of these combined effects on oil and gas operators will not be of any greater significance than the effects when assessed in isolation (i.e. minor adverse).

Marine archaeology

12.7.2.26 For marine archaeology, the following potential impacts to heritage assets have been considered within the inter-related assessment:

- Removal or disturbance of sediments resulting in a potential effect on near-surface prehistoric land surfaces;
- Potential effects on maritime and aviation wrecks; and
- Sediment deposition resulting in a potential effect on a variety of heritage assets.

12.7.2.27 Table 12.13 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Project Two and also the inter-related effects (receptor-led effects) that are predicted to arise for marine archaeological receptors.

Summary of linked receptor group assessments

12.7.2.28 As noted in paragraph 12.7.1.10, marine archaeology and physical processes (i.e. sediment deposition) are linked receptors and the inter-related effects associated with a change to marine archaeological receptors has been fully assessed in chapter 9: Marine Archaeology with effects of negligible significance predicted during construction.

Table 12.13: Summary of potential inter-related effects on marine archaeology from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Marine archaeology				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Removal or disturbance of sediments resulting in a potential effect on near-surface prehistoric land surfaces	Minor adverse	Minor adverse	Minor adverse	The majority of sediment disturbance/removal (resulting in greatest potential effects on prehistoric land surfaces) will be during the construction and decommissioning phases, with minimal disturbance likely from maintenance activities. Therefore, across the project lifetime, the effects on marine archaeological receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Potential effects on maritime and aviation wrecks	Minor adverse	Minor adverse	Minor adverse	As noted above, the majority of sediment disturbance/removal will be during the construction and decommissioning phases. Therefore, across the project lifetime, the effects on marine archaeological receptors are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Sediment deposition resulting in a potential effect on a variety of heritage assets	Negligible			This effect will only arise during the construction phase and as such there will be no inter-related effects across the project phases.
Receptor-led effects				
<p>Potential exists for spatial and temporal interactions between direct and indirect impacts to marine archaeological receptors. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following:</p> <ul style="list-style-type: none"> i. Combined effects on different elements of the historic environment (e.g. submerged prehistoric land surfaces and wrecks); and ii. The direct physical impact on heritage assets interacting with indirect impacts from sediment deposition which may lead to further damage to the same receptor, via increased exposure. <p>With regards to interaction (i), the mitigation measures proposed for Hornsea Three, which include implementation of Archaeological Exclusion Zones (AEZs) to avoid sites of identified archaeological significance as well as micro-siting of turbines to avoid archaeological constraints, will minimise combined effects on different elements of the historic environment. It is therefore, predicted that any inter-related effect will not be of any greater significance than those already assessed in isolation (i.e. minor adverse).</p> <p>With regards to interaction (ii), the implementation of AEZs will minimise the combined inter-related effect so that it will not be of any greater significance than those already assessed in isolation (i.e. negligible).</p>				

Seascape and visual resources

12.7.2.29 For seascape and visual resource receptors, the following potential impacts have been considered within the inter-related assessment:

- Change to the existing present day seascape character through the introduction of new or uncharacteristic elements/features;
- Change to the existing historic seascape character through the introduction of new or uncharacteristic elements/features; and
- Change in the existing visual scenario may cause effects on a variety of visual receptors.

12.7.2.30 Table 12.14 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Project Two and also the inter-related effects (receptor-led effects) that are predicted to arise for seascape and visual receptors. The significance of effects presented for this topic for the impacts in isolation, varies due to the differing sensitivity of the various seascape and visual receptors; this applies to each phase of the project.

Summary of linked receptor group assessments

12.7.2.31 Seascape and visual resources are not considered to be linked with any other offshore receptor group considered within the inter-related effects assessment.

Table 12.14: Summary of potential inter-related effects on seascape and visual resources from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Seascape and visual resources				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Change to the existing present day seascape character through the introduction of new or uncharacteristic elements/features	Negligible to minor adverse	Negligible to minor adverse	Minor adverse	The scale of effects to the present day seascape character progressively increases during construction as the wind turbines and ancillary structures are installed. However, during decommissioning the scale of effects decreases with time as more structures are removed. Although this indicates that there is a potential lengthening of the temporal effect, across the project lifetime, the effects on seascape and visual resources are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Change to the existing historic seascape character through the introduction of new or uncharacteristic elements/features	Minor adverse	Minor adverse	Minor	See above.
Change in the existing visual scenario may cause effects on a variety of visual receptors	Negligible to moderate adverse (moderate adverse for receptors closest to the turbine array)	Negligible to moderate adverse (moderate adverse for receptors closest to the turbine array)	Negligible to moderate adverse (moderate adverse for receptors closest to the turbine array. Note: not significant in terms of the SVIA methodology) ^c	Only those receptors closest to the array are predicted to experience effects of moderate significance. All operational visual effects are capable of being reversed through the removal of the above sea level elements of Hornsea Three during decommissioning. Although this indicates that there is a potential lengthening of the temporal effect, across the project lifetime, the effects on seascape and visual resources are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Receptor-led effects				
<p>Potential exists for spatial and temporal interactions between the direct and indirect impacts to seascape and visual resources outlined above. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise through the following:</p> <p>i. The interaction of impacts on all visual receptors known to be present within the seascape and visual resources study area.</p> <p>With respect to interaction (i), combined effects on visual receptors will vary temporally and spatially across the seascape and visual resources study area according to the activities being undertaken. Due to the mobile nature of many of the visual receptors (e.g., people working on fishing vessels, dredging vessels, commercial ferries or commercial vessels), impacts will only occur when those receptors are in the vicinity of/passing by Hornsea Three and therefore the significance varies depending on the receptor's distance to the turbine array with only those receptors closest to the turbine array predicted to experience moderate effects. Construction effects will cease upon completion of construction and will give way to operation and maintenance phase effects which will be fully reversible when Hornsea Three is decommissioned. Therefore, the significance of these combined effects on visual receptors will not be of any greater significance than the effects when assessed in isolation (i.e. negligible to moderate adverse).</p>				

Infrastructure and other users

12.7.2.32 For infrastructure and other users, the following potential impacts have been considered within the inter-related effects assessment:

- Physical restriction on space for recreational activity/recreational fishing;
- Physical impact on or loss of access to existing cables and pipelines;
- Changes to physical processes resulting in impacts on aggregate resources;
- Physical restriction on space for future oil and gas seismic survey;
- Physical restriction on space for future oil and gas drilling and placement of infrastructure;
- Underwater noise generated by piling may acoustically interfere with oil and gas seismic survey operations;
- Potential impact on performance of Radar Early Warning Systems (REWS) on oil and gas platforms from physical presence of wind turbines; and
- Disruption of vessel access to oil and gas platforms and subsea infrastructure.

12.7.2.33 Table 12.15 lists the inter-related effects (project lifetime effects) that are predicted to arise during the construction, operation and maintenance, and decommissioning of Hornsea Three and also the inter-related effects (receptor-led effects) that are predicted to arise for infrastructure and other users receptors.

Summary of linked receptor group assessments

12.7.2.34 As noted in paragraph 12.7.1.10, infrastructure and other users receptors and physical processes are linked receptors and the inter-related effects (i.e. a change to the sediment regime) on aggregate receptors has been fully assessed in chapter 11: Infrastructure and Other Users, with effects of negligible significance predicted across all project phases.

12.7.2.35 Infrastructure and other users receptors and Aviation, military and communication receptors are also linked receptors and the inter-related effects (i.e. restriction on access to infrastructure by vessel and helicopter) are described in Table 12.15 below, with effects of minor adverse significance predicted.

Table 12.15: Summary of potential inter-related effects on infrastructure and other users from individual effects occurring across all phases of the project (project lifetime effects) and from multiple effects interacting across all phases (receptor-led effects).

Infrastructure and other users				
Impact type	Residual effects			Inter-related assessment
	Construction	Operations and maintenance	Decommissioning	Project lifetime effects
Physical restriction on space for recreational activity/recreational fishing	Negligible	Negligible	Negligible	The presence of infrastructure, safety zones and advisory safety distances during the construction phase may result in the displacement of recreational craft and recreational fishing vessels from the Hornsea Three array area and along the offshore cable corridor. During the operational and maintenance phase, the presence of infrastructure, operational safety zones and temporary safety zones and advisory safety distances around maintenance activities may result in the displacement of recreational craft and recreational fishing vessels from the Hornsea Three array area and along the offshore cable corridor. During the decommissioning phase, the presence of infrastructure, safety zones and advisory safety distances may result in the displacement of recreational craft and recreational fishing vessels from the Hornsea Three array area and along the offshore cable corridor. The level of recreational activity within the Hornsea Three array area is low. There is low to medium recreational vessel activity in nearshore areas of the offshore cable corridor, with boating and angling also taking place closer to shore, however any displacement along the offshore cable corridor will be temporary with the exception of at the offshore HVAC booster station locations. Therefore, across the project lifetime, the effects on recreational users and recreational fishing are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Physical impact on or loss of access to existing cables and pipelines	Minor adverse	Minor adverse	Minor adverse	Existing cables and pipelines may be affected where they are crossed by Hornsea Three cables. In addition, the presence of Hornsea Three infrastructure, safety zones and advisory safety distances may restrict access to existing cables and pipelines during construction, maintenance and decommissioning activities. Cable and pipeline crossing and proximity agreements will be developed and implemented with each relevant cable and pipeline operator to minimise the potential for any impact. Crossing agreements will include the ability of a cable/pipeline operator to access their infrastructure as far as practical during the Hornsea Three construction and decommissioning phases and the crossing agreements will ensure close communication and planning between the affected parties to ensure disruption of activities is minimised. Therefore, across the project lifetime, the effects on infrastructure and other users are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Changes to physical processes resulting in impacts on aggregate resources	Negligible		Negligible	The installation and removal of Hornsea Three infrastructure during the construction and decommissioning phases has the potential to increase SSC within the water column and also to deposit disturbed sediments on the surrounding seabed. The impact will be short term. During the operational and maintenance phase it was concluded that the presence of Hornsea Three will not result in a change to regional sediment transport pathways that would indirectly affect aggregate resources. Therefore, across the project lifetime, the effects on aggregate extraction areas are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Physical restriction on space for future oil and gas seismic survey	Negligible to Minor adverse	Negligible to Minor adverse	Negligible to Minor adverse	The installation/removal and presence of Hornsea Three infrastructure and the presence of safety zones and advisory safety distances will exclude seismic survey vessels from the Hornsea Three array area and along the offshore cable corridor during the construction and decommissioning phases. The physical presence of infrastructure and presence of operational safety zones and safety zones/advisory safety distances associated with maintenance activities within the Hornsea Three array area will continue to restrict activity throughout the operational and maintenance phase however seismic survey activity will not be restricted along the offshore cable corridor with the exception of at the offshore HVAC booster station locations and during any temporary maintenance activity. The effect can be considered to be continuous across all project phases for the Hornsea Three array area but intermittent along the offshore cable corridor with the exception of at the offshore HVAC booster station locations. The receptors are the operators of the licence blocks coincident with the Hornsea Three array area and offshore cable corridor who may change over the project lifetime. Consultation with the operators of the affected blocks has aimed to address any future operational issues and establish a line of communication to ensure coexistence can be achieved. Any future operator will be aware of Hornsea Three and will have taken potential coexistence into consideration. Therefore, across the project lifetime, the effects on infrastructure and other users are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.

Infrastructure and other users				
Physical restriction on space for future oil and gas drilling and placement of infrastructure	Negligible to Minor adverse	Negligible to Minor adverse	Negligible to Minor adverse	Drilling and the placement of infrastructure will be restricted (but not prohibited) within the Hornsea Three array area and from within 1 km of the array area during the construction, operational and maintenance and decommissioning phases, with further restrictions from any advisory safety distances associated with construction, maintenance and decommissioning vessels. Drilling activities will also be restricted within the offshore cable corridor during the construction, operational and maintenance and decommissioning phases and from within 1 km of the offshore HVAC booster station search area, with further restrictions from any advisory safety distances associated with installation, maintenance and decommissioning vessels. The effect can be considered to be continuous across all project phases for the Hornsea Three array area and offshore cable corridor. The receptors are the operators of the licence blocks coincident with the Hornsea Three array area and offshore cable corridor who may change over the project lifetime. Consultation with the operators of the affected blocks has aimed to address any future operational issues and establish a line of communication to ensure coexistence can be achieved. Any future operator will be aware of Hornsea Three and will have taken potential coexistence into consideration. Therefore, across the project lifetime, the effects on infrastructure and other users are not anticipated to interact in such a way as to result in combined effects of greater significance than the assessments presented for each individual phase.
Underwater noise generated by piling may acoustically interfere with oil and gas seismic survey operations	Minor adverse			This effect will only arise during the construction phase and as such there will be no inter-related effects across the project phases.
Potential impact on performance of Radar Early Warning Systems (REWS) on oil and gas platforms from physical presence of wind turbines.		Minor to moderate adverse		This effect will only arise during the operational and maintenance phase and as such there will be no inter-related effects across the project phases.
Disruption of vessel access to oil and gas platforms and subsea infrastructure		Minor adverse		This effect will only arise during the operational and maintenance phase and as such there will be no inter-related effects across the project phases.
Receptor-led effects				
<p>Potential exists for spatial and temporal interactions between direct and indirect impacts to infrastructure and other users receptors. Based on current understanding and expert knowledge, the greatest scope for potential inter-related impacts is predicted to arise from the following:</p> <ul style="list-style-type: none"> i. The interaction of the physical restriction of seismic survey activity, the interference of piling noise with seismic survey activity and the physical restriction of drilling and the placement of infrastructure on the same receptor (oil and gas licence block operator); ii. The interaction of the physical presence of wind turbines within the Hornsea Three array area on REWS and the deviation of shipping routes towards platforms with REWS installed; and iii. The interaction of disruption of vessel access to oil and gas platforms and subsea infrastructure and disruption of helicopter access to oil and gas platforms, drilling rigs and operational vessels and subsea infrastructure on the same receptor (oil and gas licence block operator). This potential inter-related effect is considered and presented in Table 12.12 <p>With regard to interaction (i) the operator of a licence block will typically conduct seismic survey activity, drilling and the laying of infrastructure in a progressive order within a licence block. Restrictions on seismic survey activity, physically or due to noise interference, may therefore prevent the potential for drilling and so has an interactive effect. The licence blocks which have the greatest potential to be affected by all three impacts are those located within the Hornsea Three array area. There is also potential for an interactive effect where a licence block coincides with both the Hornsea Three array area and offshore cable corridor, whereby a greater area of that licence block will be affected in total when considering both project areas, although this scenario only applies to three licence blocks (49/2, 49/7 and 49/8) which are all currently unlicensed. In all instances, consultation with the operators of the blocks in proximity to the Hornsea Three array area has aimed to address any future operational issues and establish a line of communication to ensure coexistence can be achieved. Any future operator of the unlicensed blocks will be aware of the Hornsea Three project and will have taken potential coexistence into consideration. No significant inter-related effect has therefore been identified.</p> <p>With regards to interaction (ii) the displacement of shipping routes and its impact on oil and gas platforms will be assessed and presented in the Environmental Statement.</p> <p>For interaction (iii) this potential inter-related effect is considered and presented in Table 12.12.</p>				

12.8 Summary

- 12.8.1.1 The tables presented within this chapter assess potential inter-related effects arising from Hornsea Three on a range of receptor groups. Much of the content of these tables has been based upon assessments of individual impacts presented in the topic specific PEIR chapters. The identification of potential inter-related effects has been based on a largely qualitative assessment using expert judgement, and noting that inter-related effects have already been accounted for, in many instances, within the assessments in the topic specific chapters. The following conclusions arise in the context of physical, biological and human environments.

12.9 Conclusion

- 12.9.1.1 This chapter has defined the potential inter-related effects considered to arise from Hornsea Three. Project lifetime and receptor-led effects have been defined in order to differentiate the two types of inter-related effects that may arise as a result of Hornsea Three.
- 12.9.1.2 Based on the detailed assessments presented in the preceding offshore chapters of this PEIR, both project lifetime and receptor-led related effects have been identified. However, based on one or a combination of the following factors: the low sensitivity of receptors; temporary and small scale nature of effects; availability of alternative habitats; and also factoring in proposed mitigation measures adopted as part of the project, the overall significance of any inter-related effects was not judged to increase above the significance value assessed for individual effects in the topic-specific chapters.

12.10 References

Department for Energy and Climate Change (DECC) (2011a). Overarching National Policy Statement for Energy (EN-1). Presented to Parliament pursuant to Section 5(9) of The Planning Act 2008. July 2011. London: The Stationery Office.

Department for Energy and Climate Change (DECC) (2011b). National Policy Statement for Renewable Energy Infrastructure (EN-3). Presented to Parliament pursuant to Section 5(9) of The Planning Act 2008. July 2011. London: The Stationery Office.

Department of Energy and Climate Change (DECC) (2011c). National Policy Statement for Electricity Networks Infrastructure (EN-5). Presented to Parliament pursuant to Section 5(9) of The Planning Act 2008. July 2011. London: The Stationery Office.

DONG Energy (2016) Hornsea Project Three Offshore Wind Farm Environmental Impact Assessment Scoping Report. London, DONG Energy [online] Available at: < <https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000065-Scoping%20Report.pdf> > [Accessed 19 May 2017].

HM Government (2011) UK Marine Policy Statement. [Internet, available <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf>, accessed 18 April 2017]

PINS (2012). Advice Note nine: Using the “Rochdale Envelope”. Bristol, PINS

PINS (2016). Scoping Opinion Proposed Hornsea Three Offshore Wind Farm. PINS Reference EN010080 [online] Available at: < <https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000069-Scoping%20Opinion.pdf>> [Accessed 19 May 2017].